Peter Bowyer PHYS2015 First assignment

Weighing up the benefits against the environmental disadvantages, is it feasible or desirable for hydroelectric power to be developed on a much larger scale in the future?

Hydroelectric power has been feted as a cheap, clean and renewable source of energy. However there are environmental costs which are often overlooked in the drive to generate electricity.

There are three categories of hydroelectric power generation.

- Large Hydroelectric Power (LHP) plants are defined in the EU as schemes that generate more than 10MW. Often they involve large-scale civil engineering work, such as damming a river in order to provide a constant flow of water.
- Small Hydroelectric Power (SHP) schemes produce less than 10MW and usually don't dam a river, but use part of its flow. Often these provide power for the local community, and do not feed into the country's national grid.
- Pumped storage plants generate electricity in the same way as hydroelectric power, but are not renewable energy sources. They are a way of storing energy generated by other power sources, and are net consumers of electricity. They are used because this method allows electricity to be re-generated on-demand. For example First Hydro's Dinorwig pumped storage scheme can produce 1728MW within 16 seconds of a demand.

One main difference between conventional power stations and hydroelectric power plants is that conventional power stations destroy the fuel they use and produce a waste product, whereas hydroelectric power generation does not consume its fuel – the water may be used downstream for example in irrigation and for drinking water.

The life expectancy of a hydroelectric plant is over 100 years which is long when compared with 20 years for a wind farm and 30 years for a coal-fired power station (Diesendorf, 2004). Also low running costs have been a favourable feature when promoting hydroelectric power in comparison with conventional sources.

SHP is often the most straightforward and reliable way to provide electricity in remote areas, although this is clearly dependent on the geographic and hydrological suitability. SHP often makes little environmental impact as all that is required is either to divert some of the water from a river which then rejoins the river lower down, or to construct small dams.

Constructing large dams in LHP schemes has the benefit of regulating seasonal variations in water level, preventing flooding downstream. However this also stops nutrient-rich silt from reaching the downstream land, which in the case of Egypt's Aswan dam has led to more fertilizers being used in agriculture along the river. Twenty-five per cent of the sediment flux destined for coastal areas is estimated as being impounded behind dams (Vorosmarty et al., 2003), increasing costal erosion.

Like many renewable energy sources, hydroelectric power is dependent on the environment staying constant. If climate change affects the hydrology, there may not be enough water to continue the production of electricity (Lehner et al., 2005), particularly in the face of competing demands from agriculture, people, and (most recently) from a consideration of wildlife. Already this is becoming a problem, particularly for hydroelectric schemes in Africa (McCully, 2000) where low rainfall is becoming more frequent.

Suitable locations for hydroelectric power are generally in remote areas which leads to problems with transmitting power over long distances. As with any scheme that requires the storage of water there is the risk that dam failure will occur, with devastating consequences.

LHP developments have a huge environmental impact. They destroy much habitat, converting river or land ecosystems into lake ecosystems. Downstream ecosystems are also affected, due to the lack of sediment passing through the dams, acidic water due to the rotting vegetation within the dam and either too much aeration or too much of other gases (CO_2, methane) dissolved in the water. The local population is also affected by the construction of a LHP system. Some of the effects are positive, and the construction of dams can prove a boon to the local economy as it provides a good location for water sports and fishing, increasing tourism. However, forced resettling occurs for people who are displaced by the flooding, and in rural areas this often means loss of land used to grow food.

Lifetimes for dams may be far shorter than predicted due to silting occurring, reducing the volume of water available and eventually blocking the turbine intakes. While studies are done before dams are built to work out how long it will take to silt up, it is the unforeseen deforestation that occurs after the reservoir is created that poses problems. This is often due to displaced people creating new grazing land around the reservoir by clearing the land. Generally this deforestation leads to erosion, greatly increasing the amount of sediment entering the reservoir.

While many LHP projects provide expanded habitats for fish and water birds, overall they have an adverse impact on wildlife, particularly fish. Dams block fish migration routes, and have been linked to the decline of salmon in the North-West Pacific region. Fish-ladders have been provided at many dams to enable the salmon and other fish to continue upriver, but these are not as effective as a unchanged river. Assuming the fish get upriver to spawn, there is then a high mortality rate for the small fish on the way down – due to injuries sustained in the turbines.

The low oxygen and slightly acidic conditions in reservoirs promote the growth of bacteria that release metals such as mercury, from the material decomposing in the reservoir. Fish absorb these heavy metals which then pass up the food chain. This has been a particular problem in Canada, where the indigenous Cree have become poisoned from eating fish from reservoirs (Hoey and Postl, 1998).

Recently the issue of greenhouse gas emissions from reservoirs has been raised (Graham-Rowe, 2005). The issue is whether flooded areas in tropical regions, and hence the hydropower generated, produce more greenhouse gases per MW than an efficient gas-fired power station. Much research has been done by Fearnside (Fearnside, 2004, Fearnside, 2002), who argues that reservoirs in the tropical regions are producing as much greenhouse gas as a conventional power station.

The debate has moved beyond being an academic discussion and in 2003 the International Hydropower Association (IHA) presented a paper (IHA, 2003) outlining why emissions from hydroelectric power were “up to 40 times lower” than from thermal power plants, and could absorb and store more CO_2 than they emit. The International Rivers Network (IRN) published two counter-papers (Parekh, 2004, McCully, 2004) outlining the reasons that flooded areas my be sources of CO_2 rather than sinks if more factors are taken into account.

Other scientists disagree with Fearnside’s findings: Rosa and Santos (Rosa et al., 2004) investigated and concluded that the findings are currently inconclusive. They are critical of Fearnside’s 2004 paper on the topic, noting that he includes some discrepancies and many uncertainties. In return, Fearnside accuses them of being in the pay of the government (Fearnside, 2004).

Another source of emissions not yet taken into account is those generated during the long construction period which must be added in when considering the total emissions of a hydroelectric power scheme.

Conclusion

Should hydroelectric power be encouraged? I believe the answer to be a cautious 'Yes'.

Weighing up the benefits and environmental disadvantages is difficult. Until recently, projects deemed to be for 'the greater good' of the country were carried out regardless of the local human and environmental cost. This has changed recently, but it is still very difficult to balance. For example, Egypt's communities have benefited from receiving electricity, yet the effect of building the Aswan dam has been to starve the farming communities of nutrient-rich silt that used to be brought down on the floods each year.

The benefits of electricity are undisputable for both economic and social development, and if the balance is between providing electricity that reduces the human mortality rate and protecting the environment, the former must be chosen. To choose the latter is arrogance on our part, sitting in well-lit comfy buildings, legislating for an effect that will never harm us.

The theoretical amount of hydroelectric power available world-wide is about four times more than has been exploited at the present time (Lamark et al., 1998). It is clear that the actual amount of hydroelectricity generated will be much less than this total, due to the growing anxiety about environmental costs and the economic cost of developing many of these sites.

Although it is feasible for large scale hydroelectric power projects to be developed I do not believe this to be desirable because of the huge environmental impact. However an increase in SHP schemes should be encouraged to meet local needs.

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