Small Scale Hydropower

Rivers and waterfalls have been an important source of power in Ireland for centuries. Waterwheels have been used for milling since early times, and with the advent of the turbine in the 19th century, hydropower has been used to supply mechanical power for industry and, in later years, to generate electricity. Today, hydropower is a mature and reliable technology, supplying almost 20 percent of world electricity. In recent years, however, the emphasis has shifted from large-scale development on major rivers to smaller projects with inherently lower local environmental impact. This scale of technology is the focus of this leaflet.

Hydropower in Ireland

Today, about 6 percent of Ireland's electricity generating capacity is in the form of hydropower. This power derives mainly from ESB's large-scale hydropower stations, with minor but increasing contributions coming from smaller, independently owned sites in recent years.

The Ardnacrusha hydroelectric station, with a rated capacity of 86MW, is the country's largest hydropower development. The station became operational in 1927 - the same year as ESB was founded - and that it is still producing electricity today is a testament to the reliability of hydropower technology.

Today, the focus of development is on much smaller projects of less than 10 MW. To put this in context, in terms of International Energy Agency classifications, hydropower plants with an electrical generating capacity of

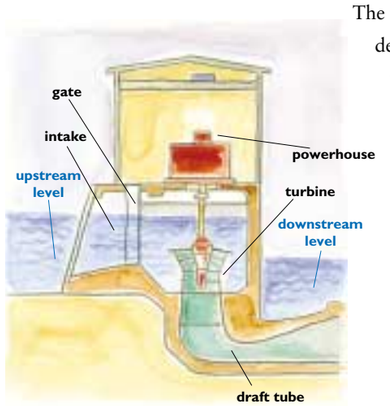
- 10 MW to 1 MW are described as small-scale
- 1 MW to 100 kW are termed mini installations
- 100 kW to 1 kW are described as micro-scale.

Considerable unexploited hydropower potential exists in Ireland at the small to micro-scale level, and currently some of this potential is being developed through the Alternative Energy Requirement (AER) - a series of competitions in which prospective renewable energy generators tender for contracts to sell electricity to ESB. In 1995, 10 proposals for hydropower projects totalling 4 MW capacity were approved under the first of these competitions, AER1, and there are targets to acquire an additional 3 MW from small-scale hydropower by 1999 through a further competition, AER3.

The Hydropower Plant

THE CIVIL ENGINEERING WORKS

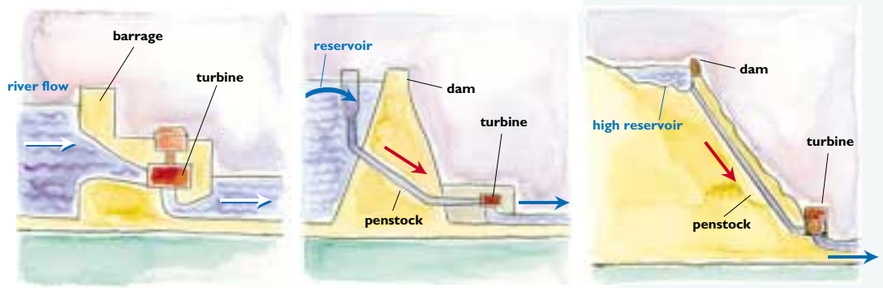
The main civil engineering elements in a small-scale development are the dam, spillway or diversion weir and the channels and pipelines. The dam directs water through the channels and pipelines to the powerhouse, where the turbine, generator and control equipment are located. Hydraulic power is converted to mechanical shaft power at the turbine, and the generator converts mechanical shaft power to electric power.



1 LOW-HEAD SCHEME

Depending on their mode of operation, hydropower systems are classified as reservoir or run of the river schemes. Run of the river schemes operate in response to the natural variation of river flow - when flow is low, power production is reduced accordingly. In contrast, reservoir schemes make use of an upstream reservoir or lake for the purpose of water storage, allowing the flow of the river to be regulated and electricity production scheduled to match demand. Because of cost considerations, small-scale developments are usually run of the river schemes employing a low dam or diversion weir of simple construction.

Hydropower schemes can be classified further according to the geographic characteristics of the site - or in technical terms by what is known as the head, i.e. the vertical distance between the water inlet and outlet levels.



(A) LOW-HEAD (B) MEDIUM-HEAD (C) HIGH-HEAD

2 TYPES OF HYDRO ELECTRIC INSTALLATIONS

Plants operating with a head of over 150 m are referred to as high-head, those with a head in the 150 to 20 m range are described as medium-head and systems with a head of less than 20 m are referred to as low-head. High-head sites are generally less expensive to develop than low-head projects because, for the same output, the flow through the turbine and the required hydraulic structures will be smaller.

Site Potential

When assessing the hydropower potential of a specific site, it is essential to consider two parameters - head and flow. The head is the vertical distance between the water intake and outlet level (minus losses due to turbulence and friction). This is easily measured. Assessing the flow and its variation with time is a more complex matter. It is a function of the site hydrology and topology.

A rough estimate of the power available at a specific site can be calculated from the equation -

Power (kW) = 8 x Head (m) x Design Flow (m^3/sec)

The quality of and distance from the local electricity distribution network should be considered in any site evaluation as grid connection and upgrade charges can have a significant impact on project economics. It is also wise to commence informal discussions with planning and fishery board authorities early on in the assessment to get a feeling for their attitude towards the project.

ale Hydropower

Environmental Impact

EMISSION	EACH UNIT OF ELECTRICITY (kWh) SAVES (grammes of oxide)	TYPICAL ANNUAL SAVING FOR 1 MW SCHEME (tonnes of oxide)
Carbon dioxide	800	5,000
Sulphur dioxide	10	75
Nitrogen oxides	3.4	25

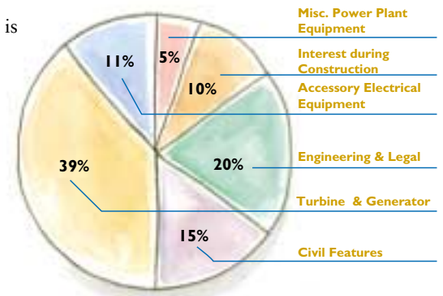
3 TYPICAL EMISSIONS PREVENTED
when hydropower displaces traditional fossil fuel generation

Hydropower is a clean energy source. Unlike fossil fuel combustion, hydropower can be harnessed without the release of chemical emissions. Every MW of hydropower that displaces traditional fossil fuel generation prevents significant emissions of some of the main gases that cause global warming, acid rain and air pollution - carbon dioxide, sulphur dioxide and nitrogen oxides.

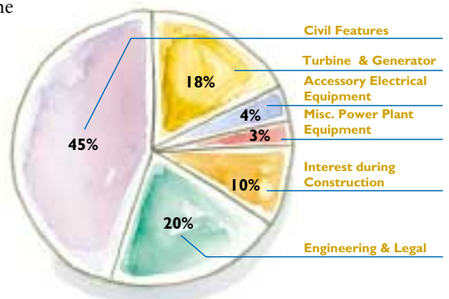
Economics

The economic viability of hydropower development is highly site specific. To generalise, though, capital costs in the region of £800 to £1,200 per kW installed would be typical in viable projects, based on current energy prices.

Although these costs are comparably high, after the initial pay-back period, the developer is rewarded with power production from a "free fuel" at relatively low operating costs.



4 MINIMUM CIVIL FEATURES COSTS



5 MAXIMUM CIVIL FEATURES COSTS

Experience indicates that hydropower development can be commercially attractive at the current tariffs being offered for electricity generated from renewables, when a portion of the capital investment is secured through EU energy grant schemes such as THERMIE.

A large proportion of the capital costs is associated with the civil engineering works and, for plants in remote locations, the grid connection charges can also be significant. For this reason, the rehabilitation of an existing mill can be more economically attractive than the development of a green field site as the civil works are generally already in place and the mills are often in close proximity to the grid.

The Future

The hydropower industry in Ireland is expected to continue to expand in the future, with the emphasis on small-scale projects.

In the policy document *Renewable Energy: A Strategy for the Future*, targets have been set to acquire 3MW generating capacity from hydropower by the end of 1999 and to secure an additional 10 MW generating capacity through further competitions held up to the year 2010.

Other positive elements of the strategy for future hydropower projects include the development of a scheme to encourage small-scale renewable energy projects and the provision of third party access to the electricity network to allow renewable energy generators sell electricity directly to users.

For Further Information

Further information about hydropower including

- ~ locations of hydropower sites around the country;
- ~ details of equipment suppliers, consultants and developers;
- ~ advice on planning and financial consideration;
- ~ a list of useful contacts

is available from the Irish Energy Centre's Renewable Energy Information Office.

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