MINI HYDROPOWER

KILKENNY (Ireland)

Among the renewable energy sources, hydropower is the one that is used most. In some European countries, it covers more than 30% of the national electricity needs. New, big hydropower stations will – because of the damming up of rivers and the related environmental laws – only very rarely be constructed. But there is a big potential for the mini-hydropower below 1MW. It can be very cheaply (re-) activated in those places where there are still old exploitation rights and where old installations can be reactivated in the case where dams exist. In Kilkenny, in Ireland, a joint venture between a saw mill owner and a consultant resulted in the refurbishment of an old installation now supplying the saw mill with electricity and selling surplus electricity to the grid.

THE CITY

Kilkenny is a town in Ireland with 18,000 inhabitants and is the capital of the county of Kilkenny located in the South-eastern part of the Republic. The city features a gothic cathedral and a castle from the 13th century. Having been a commercial centre since its beginning and being sufficiently far away from the bigger Irish cities, it is still a regional commercial centre. The world famous Kilkenny beer is brewed in this city.

Climatic data:
Annual mean temperature: 10.5 °C

CONTEXT

Since the 14th century, a small water mill has been located in the river called The Nore. The water mill was originally used as a grain mill. Later on a nearby saw mill owner used the power for a direct drive operated mill wheel. With the objective of minimising the electricity bill the saw mill owner set up a joint venture with the consultant company ArCogen International to refurbish the old mill and install a water turbine which could utilise the head (the difference in water level). The consultant's objective was to demonstrate the manufacture, installation and operation of alternative low head technologies for use in self built projects. It should be mentioned that retention with upgrading and redesigning of waterwheels and old turbines is essentially done from a heritage and planning point of view. In the 17th century, Ireland had approximately 3,000 mill wheels, almost all low head applications. Another scheme in the area is located 4 kilometres downstream and includes a 100 kW turbine installed in 1920.
Other renewable energy resources, which should be mentioned in the county of Kilkenny include a biogas plant at Camphill community. Wind power is not viable in the area due to low wind speeds. In general, hydropower, biogas and biodiesel are the resources which are most likely to be exploited in the future.

EXPERIENCE OF KILKENNY

The mill is listed as being of industrial heritage value. Therefore, a mandatory retention of the existing wheel was the case. Substantial alterations were not allowed. Thus, these planning restrictions meant that only refurbishing of the existing site was possible - one large, efficient turbine could not be installed in the river. Therefore, three different applications with different techniques have been installed. The project was a demonstration project with the objective of monitoring the use of these techniques.

The installation

The refurbishment implied the installation of: an open flume propeller turbine, an undershot waterwheel and a horizontal-axis tube turbine. All three machines were manufactured on site.

- The open flume propeller turbine is 1 metre in diameter supplied with cast steel blades of the owner's own design welded onto a cylindrical hub. It runs at 230 rpm. The transmission is via a V-belt to a 750 rpm induction generator. This means that only one bearing is present. The lifetime of the installation and the yearly maintenance costs are thereby minimised. This is true for all three different types of turbines in the installation.

- The undershot waterwheel is a 5 metre diameter mill wheel with aluminium curved blades designed for air induction to improve the aeration of the river.

- The horizontal-axis tube turbine is 1 metre in diameter. The blades were made out of flat plate. The transmission is taken from a 400 mm toothed pulley to a 130 mm toothed pulley via a Gates Powergrip HTD belt hydraulic design with a simple extremely compact and long life transmission with no oil, hence no risk of contaminating the river.

Other facts

The river
- Average flow of water: 30 m^3/s
- Min. and max. head: 0.6 – 2.0 m
- Average head: 1.5 m

The open flume propeller
- Nominal power production: 30 kW
- Nominal head: 1.8 m

The undershot waterwheel turbine
- Nominal power production: 22 kW
- Nominal head: 1.5 m

The horizontal-axis tube turbine
- Nominal power production: 40 kW
- Nominal head: 2.0 m

The average year round output is 65 kW, though the load factor on the generators is 65/92.

The fact that the installation has been made as simple as possible has been crucial for the realisation of the project. When talking about small scale power production it is of great importance to reduce both the installation costs and as well the yearly running costs for maintenance. Simply because of the limited energy output and therefore the limited gain.

Investments and finance
The construction work was taken care of by the two partners, which meant that the cost of labour has not been included in the economic calculations. The fact that all the parts were produced on site is another factor minimising the investments. The total investments, paid solely by the two partners with no loans or grants, can be estimated at around Eur 47,300.

The investment has paid off by minimising the electricity bill for the saw mill owner and the additional sale of surplus electricity that is fed into the grid. Electricity is sold at a price of 0.053 Eur/kWh. The price is slightly higher 65 hours a week (day hours from Monday to Friday) and lower at the night time and on the weekends. Electricity bought at the local utility is on average 0.127 Eur/kWh. At the time, when the installation was installed, there were no restrictions regarding the amount of surplus electricity sold.

Keeping all the "non visible" parameters such as the non existent cost of labour in mind and using the above mentioned figures, the simple pay back time can be estimated at only 3 years.

The estimated life time of the installation is about 50 years. This high figure is mainly due to the simplicity of the installation.

Energy and the environment:
The annual energy output from the hydropower plant is between 400 MWh and 600 MWh depending on rainfall. For an average output of 65 kW, the number of running hours per year is on average 7,700 (88 % of the year). This illustrates the reliability of such an installation. It is not dependent on the blowing of the wind for example. The only reason for a production stop caused by nature is flooding, making the head non existent. The total yearly flood period is on average 3 weeks per year. The flood period is at its smallest when a wet summer and a dry winter follow one another.

The clean production of electricity corresponds to a saving on CO_2-emissions of approximately 5,000 tons per year. When comparing with electricity produced on a conventional coal power plant, the environment is also spared from gases that contribute to acid rain and air pollution. Furthermore, the mill wheel has a beneficial aerator effect. It should also be noted that aquatic life in the river is protected through the installation of electric fish barriers on the tail race.

EVALUATION AND OUTLOOK

The project has successfully demonstrated the manufacture installation and operation of the open flume propeller turbine, the undershot waterwheel and the horizontal-axis tube turbine as alternative low head technologies for use in self built projects – at a relative low cost if labour is provided by the owners of the installation as no extra costs arise.

The simple technology is particularly applicable to developing countries which can use local labour resources and materials to eliminate dependence on imported fuels and expensive diesel generation. The potential for duplication of this project is widespread and can be undertaken as part of heritages conservation at disused mill sites. The easy and cheap running and maintenance costs are also a positive aspect. The mill wheel is a satisfactory solution to low-power and low-head hydropower in terms of construction, reliability and ease of maintenance. In addition, it is benign to fish movements and provides excellent aeration.

Low head hydro installations in municipal areas contribute power when it is needed most, for example during peak winter periods, without transmission costs. The embedded power reduces infrastructural requirements and contributes to sustainable development.

The project is a small simple project which helps to demonstrate that power generation is not always confined to large utilities. Individuals, small groups of people, SMEs (as contractors), or Municipalities can implement a power project to meet local requirements.

FURTHER INFORMATION

Rick McGrath
ArCogen International
4 Maiden Hill, Kells Road
Kilkenny, Ireland
Tel: +353 56 71 144
Fax: +353 56 71 145
E-mail: rick@eircom.net

This case study was prepared by Energie-Cités in co-operation with ArCogen International. It received funding from the ALTENER Programme of DG Energy and Transport of the European Commission.