Development of Mini-hydropower in Remote Areas - Some experiences and Challenges

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Introduction

The Hydropower Act of 1993 has delicensed hydropower schemes of up to 1,000kW and liberalised investment in this sector. As a result of this act, private sector companies have begun to show an interest in investing in hydropower and four new private mini-hydro power companies were established in 1993.

Although mini-hydro schemes can be commercially profitable, the financial, technological, and socioeconomic risks associated with these schemes are greater than those of micro-hydropower plants. Therefore, during the feasibility stage, careful consideration must be given to these aspects and more attention must be paid to the engineering design of these schemes. This paper describes the experiences of and challenges faced by the mini-hydro sector, using the Jhankre mini-hydro project as an example.

Introduction to the Jhankre Mini-hydro

The Jhankre Mini-Hydro Project, a 500kW scheme in Ramechhap district, is being built by Development and Consulting Services (DCS). The source of the Jhankre Plant is the Jhankre river which is one of the tributaries of the Khimti river. The design head and flow of the plant are 180m and 455 l/s respectively. It will have three Pelton turbines with two nozzles in each unit. The penstock length and diameter are 550m and 450mm respectively.

The Jhankre mini-hydro scheme, together with a diesel plant, will supply power for the construction of the 60MW Khimti Project being developed by the Butwal Power Company (BPC). This project aims to save fuel costs and reduce the pollution associated with the construction. After the completion of the Khimti Project, BPC using the Jhankre Scheme, will commence a rural electrification programme, to make electricity available to most of the households in the nearby areas and also to involve the local community in plant management and operation.

This scheme is designed to operate at full capacity four months a year during the monsoon. During the dry season, the available flow is just enough to operate one turbine with a single nozzle. Such a design is feasible because the scheme will operate

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initially in conjunction with diesel generators and later supply power to the national grid.

Water Rights and Socioeconomic Aspects

The Jhankre mini-hydro plant shares the river water that is also used for irrigation purposes. The proposed mini-hydro site is being used by the farmers of Jhankre as an irrigation intake. The current use of water for irrigation is illustrated in the hydrograph (see Fig. 1). The hydrograph shows that 75 per cent of the river flow has been assumed to be available for irrigation and power generation. The remaining 25 per cent of the flow accounts for downstream seepage as well as some flow release to meet environmental requirements.

The agreement between the Khimti project and the local community about sharing the Khimti water stipulates that the villagers will retain the water use rights for irrigation as practised presently (shown in Fig. 1). The above example indicates one of the ways in which water rights' issues can be resolved.

Employment is given to the villagers of Jhankre on a priority basis and is an incentive for the villagers to sign the agreement for water sharing with the Khimti Project. Income-generating opportunities have also been provided to women by buying gravel from them for the project at a guaranteed rate. Some of the villagers will be trained to operate and manage the mini-hydro scheme. The area surrounding the project will be electrified, and this is yet another incentive for the villagers.

Mini-hydro can help conserve resources, such as forests and imported fossil fuel, and reduce environmental pollution. For example, due to mini-hydro, the use of diesel during the construction of the Khimti Project will be reduced. Similarly, the 400kW Salleri-Chialsa Mini-hydro Scheme has been providing the power required for a wool dying industry — the Chialsa Handicraft Centre — thus substituting fuelwood, which is the traditional fuel used in the dyeing industry.

The Salleri-Chialsa Mini-hydro has promoted industries prior to the arrival of the national grid. As of 1992, besides supplying electricity to more than 400 houses, this scheme has been supplying electricity to the Chialsa Handicraft Centre, the Sagarmatha Water Turbine Enterprise (wood-work, paper production, and cereal milling), a bakery, and a 25kW paper mill.

Technological Aspects

The engineering design in mini-hydro schemes is more critical than in micro-hydro schemes. Due to the high capital costs, design errors can be expensive. Thumb rules in civil design are either risky or too conservative. On the other hand, detailed design will make the scheme economically more viable as well as help in quality control. Some innovative technological approaches used in mini-hydro schemes are discussed below.

At the Jhankre Mini-hydro plant, high grade steel (conforming to IS 2062) was used for the penstock in order to decrease the transportation/portering costs by decreasing the weight. This has also decreased the weld thickness. The use of plum concrete in anchor and thrust blocks has reduced the transportation and overall costs without compromising the quality. These blocks are constructed out of Plain Cement Concrete (1:3:6) with 40 per cent plum (boulder content). Nominal reinforcement is provided to resist tensile forces. The mass needed primarily to resist the hydrostatic forces on bends can be partially provided by the use of plums. In order to facilitate penstock movement caused by thermal expansion, steel slide plates and tar paper have been incorporated into the design of support blocks. To hold the base plates firmly on the support piers, anchor rods are welded into them. The top 500mm depth of the support piers is made of PCC for anchorage.

The proposed intake of the Jhankre mini-hydro is on the left bank of the river, downstream from a waterfall. Due to the waterfall and a drystone dam downstream, there is a wide pool at the intake area which decreases the sediment load. A suitable site for the desilting basin and forebay could not be found close to the intake, and placing them further away meant losing head. Therefore, a combined desilting/forebay structure has been designed at the intake. This has made silt and gravel-flushing activities simpler as well. Gravel and silt can be flushed back into the river.

The headrace canal of the Salleri Chialsa plant was torn away several times by landslides. Slope stabilisation and afforestation programmes were initiated in 1983, after which the construction work continued. Similarly, a landslide occurred above the powerhouse area of the Jhankre Mini-hydro plant during monsoon during excavation and blasting. There was also a rockslide which landed 220 cubic metres of boulders at the intake area. Therefore, the cost of a preliminary geotechnical survey in mini-hydro schemes is justifiable.

Fig. 1

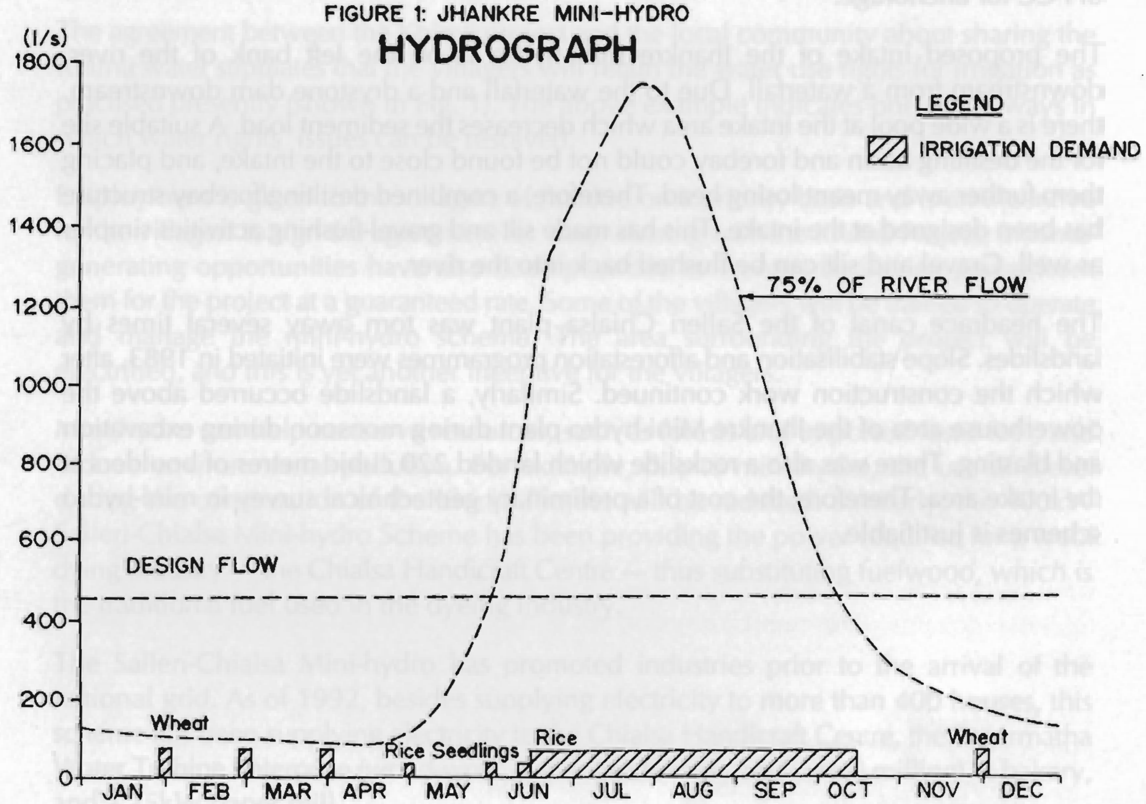
FIGURE 1: JHANKRE MINI-HYDRO
HYDROGRAPH
(l/s)
1800
1600
1400
1200
1000
800
600
400
200
0
LEGEND
IRRIGATION DEMAND
75% OF RIVER FLOW
DESIGN FLOW
Wheat
Rice Seedlings
Rice
Wheat
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC