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Mini hydro-power development in Pakistan

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MINI HYDRO-POWER DEVELOPMENT IN PAKISTAN

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1. The interconnected power system in Pakistan is characterised by a combination of hydro and thermal plants designed to meet seasonal variations in energy demand. Due to the scarcity of indigenous fuel resources in Pakistan and a steep rise in fuel cost in the world market, the national strategy is to exploit hydropower potential to the maximum extent, taking into account all possibilities for short-term peaking. The high growth in demand for electricity, caused by the pace of the economic development has resulted in a serious power short-fall throughout the country. It is not practically/economically feasible to construct long transmission lines for the isolated/scattered communities in the Northern hilly parts of Pakistan. It is therefore essential to build mini hydel schemes in these areas by integrating with drinking water and irrigation projects in order to share cost for providing cheap power.

2. The mini energy schemes which do not rely on foreign currency are the requirement of the development countries like Pakistan. The recent successful approach to mini hydropower offers great promise for a proven technology and good hope for hundreds of isolated/scattered communities with hydropower potential. Pakistan has great potential of mini hydropower development in Northern parts comprising NWFP, Azad Jammu & Kashmir, Tribal Areas and Northern Areas.

3. Mini hydropower upto 500 KW offers an alternative source of affordable energy for the Northern parts of Pakistan. Mini hydropower has several advantages over other small commercial energy systems.

   i) It is based on technology developed centuries ago.

   ii) It is a well proven and accepted method of supplying energy.

   iii) It relies on a non-depletable energy source that coincides with the dispersed nature of rural population.

   iv) It can be integrated with drinking and irrigation water projects, in order to share the cost between different beneficiaries.

   v) It is versatile and can serve as a general energy source for lighting, Commercial, industrial etc.

   Inadequate planning and inappropriate designs often result in excessively complex and costly mini hydropower projects. In these cases, civil works are overdesigned, the power generating equipment is very sophisticated, and usually imported. Thus require more foreign exchange than is necessary.

4. However, a different approach to mini hydropower is being developed in a number of countries, which focuses on adapting energy schemes to social and economic realities and the unique conditions of each site. The designs developed under this approach include only essen-

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unique conditions of each site. The designs developed under this approach include only essential components, and the one that takes the greatest possible advantage of local resources, materials equipment and manpower, is chosen. These projects costs about Rs.20,000/- per KW. The low costs and the success of several schemes worldwide have rekindled interest among governments and international development agencies in pursuing mini hydropower projects.

5. A typical layout for a mini hydropower schemes is shown in Figure 1. The local design is the ideal that takes better advantage of available resources and the physical features encountered at the site. By maximizing the use of locally available materials/equipment and employing more labour-intensive construction techniques, reduces both the cost and the foreign currency requirements. It is estimated that with a local design approach, the foreign currency costs could be reduced to about 20 percent of the project cost. The details of a mini hydropower scheme and cost reducing measures are described below:

i) **Dams or Wiers.** One reason for the high cost of conventional mini hydropower project is the inclusion of components that are simply unnecessary to the plant's operation. Because dams are conventionally associated with hydropower, they are usually part of small hydel schems. However, dams defined as structures required to either store water or increase head, are not always required for mini hydel projects. For meeting the energy needs of isolated communities, maximizing the power output of a stream is not the primary goal. There is usually more flexibility in the scheduling of loads on an annual monthly or daily basis. In such cases run of river hydel schemes commonly suffice, and only a weir is needed. The Weirs may simply be temporary barriers made of stone/ boulders across the stream. The cost for stone weir is primarily for labour, which is readily available. The stone weirs are generally needed during periods of low flow and can be replenished after each flood season.

ii) Intake structure. In conventional design there are generally mechanical gates at the water intake. An alternative design provides simple timber stop logs, which are manually removed and replaced to control water entering the intake channel.

iii) **Penstock.** The penstock is made normally from preformed steel pipe in ready-to-assemble lengths. The penstocks however form a substantial part of the foreign exchange cost of the scheme. Alternatively, steel pipe may be rolled and welded in the country from sheet metal, thereby saving in foreign labour and transport costs. In Pakistan the penstocks can be made from the steel sheets manufactured by Pakistan steel Mills Karachi.

iv) **Powerhouse.** The powerhouse should be smaller but large enough to house the equipment. This should be constructed mostly with local materials and labour to save costs. The building should protect the turbine-generator and allow access to machinery and light.

v) **Turbo-generator equipment.** The greatest potential for reducing the foreign exchange costs of small hydel schemes is the turbo-generator equipment. The cost reducing efforts in the local mini hydropower project have been concentrated in this area. Mass-produced generators available from industrial countries are inexpensive, so these are typically imported for either type of mini hydropower project. And although turbines are frequently built to fit site specifications and are therefore expensive. Cross flow/francis pelton wheel and other types of turbines commonly used with mini hydropower schemes lend

themselves to simple designs and fabrication techniques. If there is sufficient water in the stream, efficiency is not necessarily a major consideration, so the design and construction of these turbines need not be too precise.

vi) **Governors.** These represent a major foreign exchange cost in a mini hydropower scheme. A conventional hydraulic/mechanical governor for a mini hydropower installation costs approximately U.S. Dollars 15,000. The recent development of electronic controllers, has resulted in a high quality control system at only a fraction of the cost. Electronic systems consist mainly of circuit boards which are inexpensive to import and easily replaceable.

6. Mini hydropower turbines and auxiliary equipment can be locally manufactured in Pakistan by Heavy Mechanical Complex, PECO, CLIMAX, Siemens, etc. The programme of Mini hydel Schemes in the Northern parts of Pakistan was initiated in 1975 and about 60 schemes with varying capacity have been completed so far by Northern Areas Works Organisation and Appropriate Technology Development Organisation. The names of the proposed projects are detailed below:–

i) **Northern Area**
The Appropriate Technology Development Organisation and Northern Areas Works Organisation are undertaking the construction of following mini hydel schemes:–

(i) Narai (ii) Seer (iii) Thothi (iv) Soor Garhi (v) Harbankot (vi) Sazine (vii) Slove (viii) Berh (ix) Sogo Chillari (x) Songlo Kehlo (xi) Kass (xii) Kothay (xiii) Sakru (xiv) Khyber (xv) Symayar (xvi) Siggal (xvii) Stak (xviii) Mehdi (xix) Hashupi (xx) Kayo (xxi) Thalley (xxii) Manthokha (xxiii) Niaslo Shigar (xxiv) Ghandus (xxv) Thore (xxvii) Chilas (xxviii) Astore (xxix) Gorikote (xxx) Rattu and (xxxi) Brashing.

ii) Azad Jammu & Kashmir
The Electricity department of Azad Jammu & Kashmir will be undertaking six mini/small hydel schemes at Kel, Neelum, Luat, Kundel shahi, Lipa and Kathai.

iii) **North West Frontier Province**
The NWFP Hydel Development Organization will undertake several mini hydel schemes at following suitable sites:–

(i) Shishi Gole (ii) Garam Chshma (iii) Ayun (iv) Bouni (v) Thell (vi) Ashouran and (vii) Dasu.

7. **Conclusions and Recommendations**

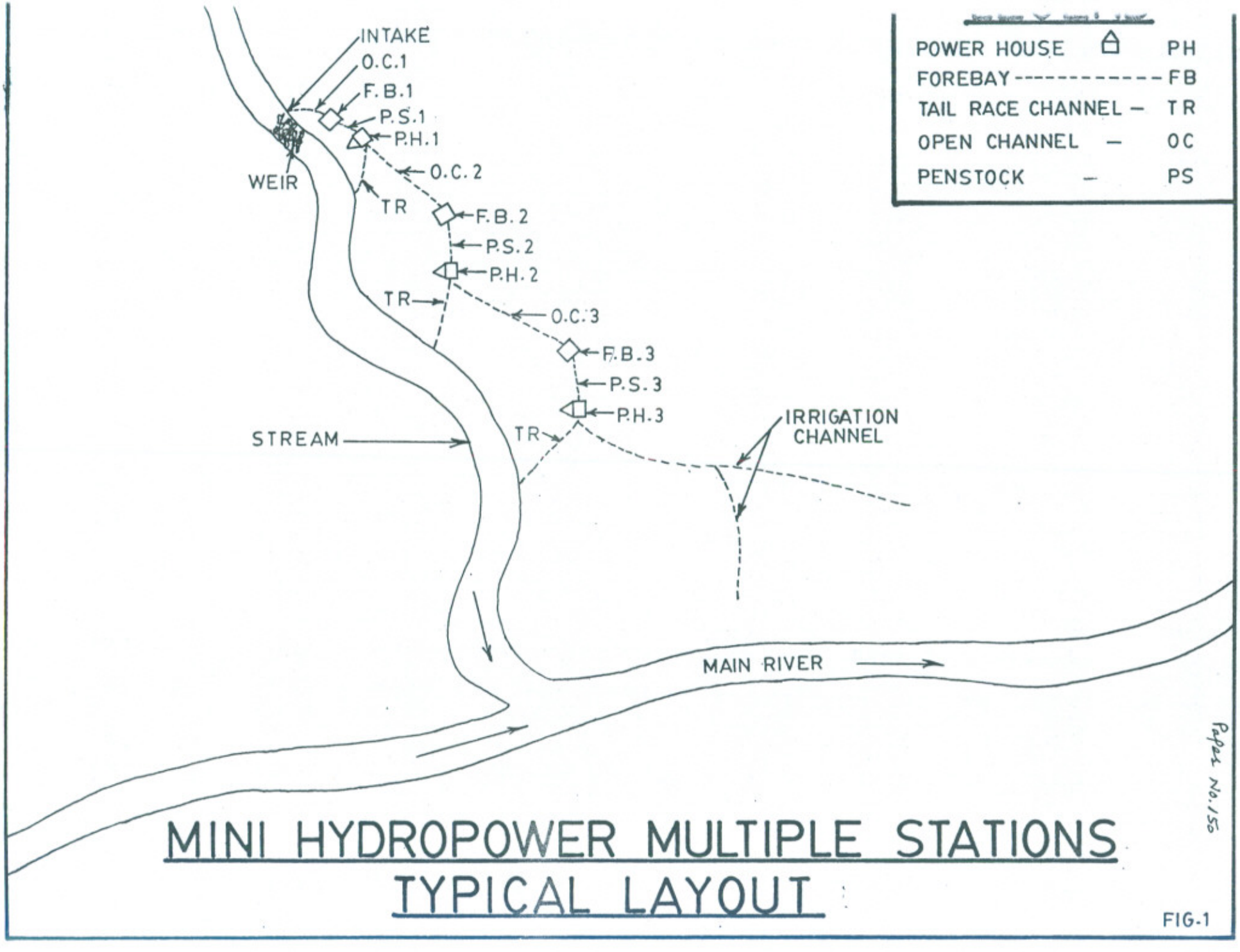
i) The Mini hydropower plants offer a source of affordable energy.

ii) They are established to maximize locally available resources, and they can be installed and maintained with a minimum of foreign exchange requirement.

iii) The depletion of trees/forests will stop because hydel power will be used for cooking and heating.

iv) The experience with mini hydropower design and construction is limited in Pakistan. Few projects have been completed with 50/100 KW capacity imported turbines by various organizations. The support of Pakistan Government is essential to establish industry to manufacture all equipment required for installing mini hydropower schemes.

v) The Government may set up an Autonomous Mini Hydel Development organization for executing/operating the schemes in the Northern parts of Pakistan. This will help in standardising the plant and equipment required for these schemes. The mass scale production of such equipment will reduce the cost of mini hydropower plants. The execution of small hydel schemes upto 10 MW in the northern parts of Pakistan may also be entrusted to this organisation.



MINI HYDROPOWER MULTIPLE STATIONS
TYPICAL LAYOUT

FIG-1

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