Economic Analysis and Application of Small Micro/Hydro Power Plants

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Abstract. The increase in oil prices and subsequent worldwide energy crisis in 1973, prompted many countries to search and develop renewable sources of energy. Since each year costs increase and supply of fossil fuels diminishing, non-conventional energy sources installation, development is taken as prime consideration. Much of the small hydro potential is in the hilly and remote, inaccessible areas of India, where generation from other sources or transmission of power over long distance would not be feasible. Development of this local potential meets a long felt need. Energy Production has become highly expensive world wide & its shortage has led to intensified research studies for developing alternate sources of energy. Mini/Micro/Small Hydro Power are some of the alternative sources whose proper utilization can improve the overall energy picture of the world. These are the clean, pollution free, eco-friendly energy sources. Integrated generation and distribution for rural area on fuel availability, small hydro capacity on run of the river, shall improve the availability and reduce energy cost. Since there is a parallel between energy consumption and economic development and because prices for imported energy mainly oil, are always increasing, the yearly energy bills and consequently the balance of payment deficits are growing. Though we possess major natural resources in the form of water power, that have to a large extent remained untapped. Some big and medium scale hydropower schemes a few to hundreds of MW capacity exist. But a small portion of the existing potential is used thus, and high grade energy in the form of electricity is produced in such installations. The large quantities of electricity produced require complex transmission and distribution networks. Bringing electricity to the consumers is therefore a costly affair and economically only possible where large load centers exist. These are usually to be found in urban areas where population density is high, thus creating a high domestic demand in a relatively small area. In addition, most large-scale and energy-intensive industries are near urban areas. This too, represents a large demand. In rural areas, where a majority of the people live, the population density is very often low, settlements are frequently far apart and the prevalent simple life style requires less high-grade energy per capita compared to city dwellers. Industrial energy demand is generally confined to small-scale activities such as agro processing and cottage industry. Thus, electricity demand per unit of area is low and the reason why supply from large generating sites often over long distances and difficult terrain-and distribution to many low-demand consumers scattered over a large area, is not economically feasible. The consequence of this unfavorable situation regarding electricity supply to rural areas is that a great proportion of the population of these areas has so far not benefited from the amenities of electricity. Up to and sometimes more than 90 % of energy consumed is in the form of biomass which is used mainly for thermal energy requirements such as cooking and heating in households and in agro-processing. Moreover, scientifically speaking, it is bad practice to use high grade energy such as electricity for such low-grade thermal applications as cooking. Lastly, besides high generating costs, electric cooking also involves high costs on the part of the consumer for necessary equipment. Small and very small hydropower schemes combine the advantages of large hydro on the one hand and decentralized power supply, as with diesel sets, on the other. They do not have many of the disadvantages, such as costly transmissions and environmental issues in the case of large hydro, and dependence on imported fuel and the need for highly skilled maintenance in the case of diesel plants. Moreover, the harnessing of small hydro-resources, being of a decentralized nature, lends itself to decentralized utilization, local implementation and management, making rural development possible mainly based on self-reliance and the use of natural, local resources. There are in fact many thousands of small hydro plants in operation today all over the world. As far as costs are concerned, sophisticated technology tends to be very expensive. Again, it is in the big schemes where economic viability is possible. Small installations, for which the sophisticated technology of large hydro is often scaled down indiscriminately, have a much higher capital cost per unit of installed capacity, without either the advantage of economics of scale or a significant increase in capacity compared to simpler technology. This paper

is presented with an objective to study detail Economic Analysis of Mini hydel schemes as the cost is most important issue of development of small hydel schemes. This is one of the techniques for generating electric power using non conventional energy technology, an important area for research and development. Run-of-the-river micro-hydro scheme requires no water storage but instead diverts some of the water from the river which is channelled along the side of a valley before being 'dropped' into the turbine via a penstock**.** Hydropower is a well-proven technology, relying on a non-polluting, renewable and indigenous resource, which can integrate easily with irrigation and water supply projects. This study would facilitate to take effective measures for reducing the cost which are also given in the paper. Analysis of two mini hydel schemes, Bhimgarh small hydel project and Chargaon-Jatlapur Mini hydel project in India, constructed on dam toe and canal fall respectively is given mentioning the total cost of schemes. Parameters like cost of Civil work for power house, by pass canal, intake structure and cross regulation has been worked out. Cost benefit ratio and Annual return is also calculated. The estimate for electrical and mechanical equipments is prepared. Economics of stand alone and grid connected system is explained. Any system of promoting renewable energy should give incentives to reduce the cost of production for the capital equipment required. To assess the suitability of a potential site, the hydrology of the site needs to be known and a site survey carried out, to determine actual flow and head data. Hydrological information can be obtained from the meteorology or irrigation department usually run by the national government. This data gives a good overall picture of annual rain patterns and likely fluctuations in precipitation and, therefore, flow patterns. The site survey gives more detailed information of the site conditions to allow power calculation to be done and design work to begin. Flow data should be gathered over a period of at least one full year where possible, so as to ascertain the fluctuation in river flow over the various seasons. The constraints and problems arising in development of power hydel schemes are known. Improvement of technical and economics viability of low head small hydro requires reduction of capital and maintenance costs of equipment. The major cost of a scheme is for site preparation and the capital cost of equipment. In general, unit cost decreases with a larger plant and with high heads of water. The costs of micro hydro power can be kept low by avoiding some of the more costly aspects of large hydro power. Some measures to reduce cost are given. Comparing with other alternative sources of energy, economics of Non-Conventional energy schemes is given considering environmental aspect also which is very important. Governments have recognized the environmental benefits of renewable, and provided subsidies to stimulate their growth against the less costly conventional energy sources, such as thermal and nuclear plants in electric power systems. The Clean Development Mechanism (CDM) under the Kyoto Protocol to United Nations Framework Convention on Climate Change (UNFCCC) provides an opportunity for the Indian power sector to earn revenue through the reduction of greenhouse gas emissions (GHG), particularly carbon dioxide (CO_2). The mini/micro hydro schemes can play a critical role in rural development since the returns are immediate and the gestation period is shorter. However because of limited availability of coal and other fossil fuels and for total upliftment of country, growth of remote places is a must. Whereas to transmit power to such remote places is very costly. This problem gives rise to Pico-hydro Power Plant that does not require construction of dams and hence considered as run off river. The major difference between high capacity and Pico-hydro plant is that the later does not require any construction of dams and hence it is considered as run-off-river plant. Hence, a simplified model with turbine, Generator and Mechanical Coupling as the major equipments has been demonstrated and its working is been explained. The output of the model has been tested and usefulness of this research is highlighted. Small, Mini and micro hydro power stations are conceptually different from major hydro power plants because they are small in capacity i.e. low head and they are decentralized, so that wherever the situation is favorable they can be constructed. Common sites are falls from mountains, irrigation canal drops, and small rivers, etc. These power stations are gaining wide importance nowadays because we are having number of such sites which are scattered round the country. So a comprehensive study and analysis of these power stations is a timely need, including aspects like reliability, economical operations, maintenance and protections. This paper gives the foremost important information pertaining to cost, and its comparison with other Non-Conventional energy sources. The demonstration model represented gives a simplified and basic concept for young students, and also for upcoming researchers to proceed ahead with further implementation of the project at major level. Overall economy will be the main objective than mere energy production. Marginal reduction in energy will be acceptable in view of simplicity of the system and economy. There is ample scope for reducing Civil engineering cost and also total cost by adapting certain suggestions mentioned in the paper. The demonstration model promoting the incremental energy that can be supplied by hydro power can become a boon for local people in combination with other small scale local sources. Any increase in energy supply from these clean renewable sources gives reduction in demand on our other non renewable and more hazardous fossil fuel and nuclear sources. With these analysis results and suggestions new technologies can be developed so that overall cost will reduce, efficiency will increase, and such schemes will be attractive especially for stand alone applications. It can help to conserve the conventional energy sources like coal/oil and such others. This economic analysis and demonstration model can be good reference for those who are beginners in this area so that with these studies, they will get further insight in this very important area worldwide.