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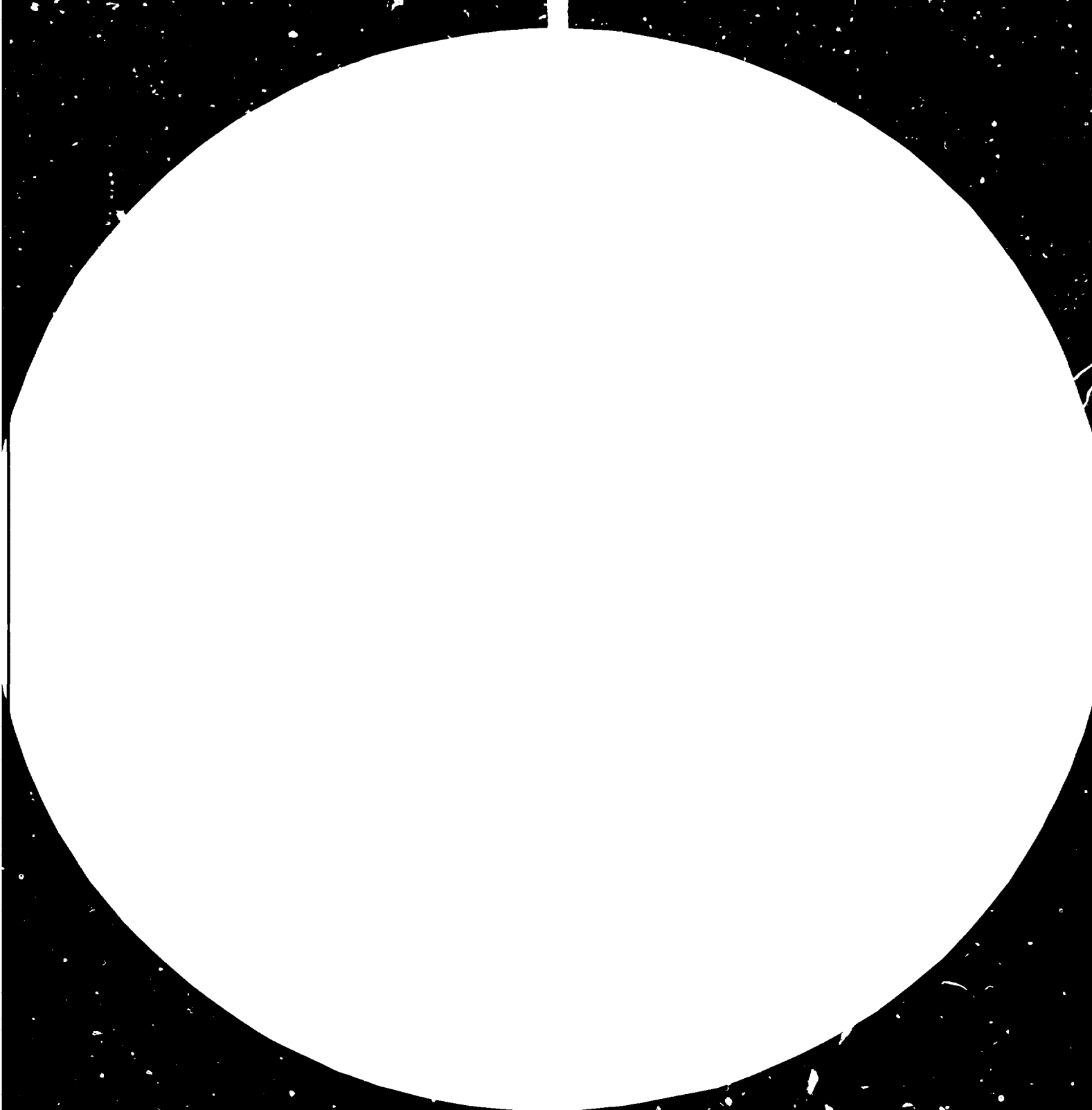

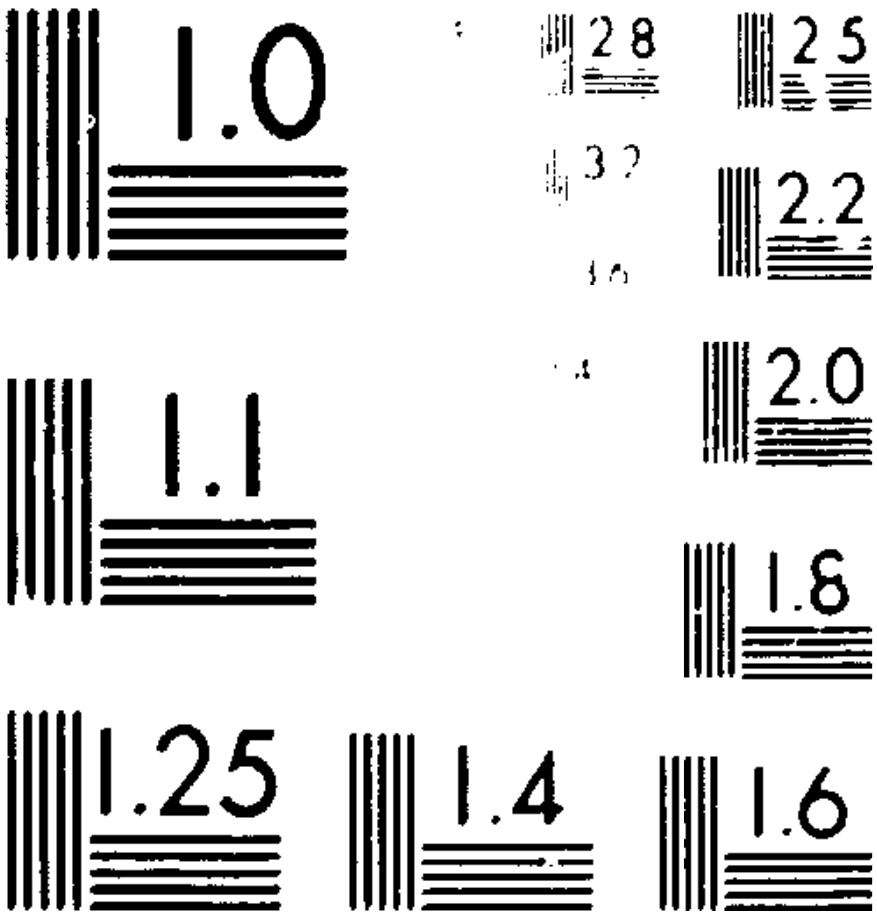
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MICRO-HYDEL GENERATION IN INDIA*

by

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1. PRESENT STATUS

Micro hydel, which could be taken as covering small capacity hydro electric projects, can be broadly categorised in Indian conditions as :

i) Small independent hydro electric projects in the hills, mainly Himalayan, where small perennial streams are available. These are mostly of medium/high head; utilising small discharge and

ii) Small installations in the plains and other regions which utilise water regulated for other purposes, e.g. irrigation canals, small dams, etc. These are usually of low head utilising larger discharges.

Schemes of both these types have been developed in the country from very early times. First micro hydel plant was installed at hill resort, Darjiling in 1897, having capacity of 200 kW. The development grew steadily over the years. With the alternative of diesel generation that became possible afterwards, small hydel generation fell into background. Also India possesses a large conventional hydro potential. Only about 10% of this conventional potential has been tapped so far. However, with the cost of fuel going up over the years, the small hydel development has received an impetus. Many more are continuing to be developed at present. A number of further ones are under investigation and formulation. At present, 88 schemes are in operation in almost all parts of the country. Detailed information in respect of

these is as follows :-

Category (i) - Hilly region

	No. of Schemes	No. of units	Installed capacity kW
In operation	62	161	78938
Under construction	27	64	17100
Under investigation/ formulation	30	43	28300

Category (ii) - Plains

In operation	26	70	495,300
Under construction	14	52	490,000
Under investigation/ formulation	22	56	314,500

Micro hydel in hilly areas

Small independent hydro electric schemes in the hilly areas are being constructed for meeting local needs of isolated areas and also for feeding into the State grids of the hilly States. Both these types of schemes exist in the Himalayan region covering States of Jammu & Kashmir, Himachal Pradesh, Sikkim, West Bengal, Arunachal, Nagaland, Manipur and Meghalaya. In the Himalayan region of Uttar Pradesh also quite a number of small hydro-electric schemes have been constructed for local needs. The unit rating installed in these regions vary from 5 kW to 1000 kW.

Schemes on canals, etc.

India has a large network of irrigation system on its rivers in the plains. Majority of the schemes are purely for irrigation purposes. However, there has been a good spurt for utilisation of small heads on the canal wherever it is economically feasible either at the head regulators or falls

in the canals. The State authorities are examining the possibilities of installation at the irrigation dams constructed earlier for power generation. Utilisation is also being considered by remodelling many canals like Western Yamuna in Haryana.

2. POTENTIAL PROSPECTS

India has a considerable potential for micro hydel generation. In the wake of uncertainities of future fuels, potential survey for schemes for low head development has been initiated. The low head canal type schemes are essentially secondary in nature and can be developed only in consonance with the development of the main systems of irrigation, etc. On preliminary data collected from the various State authorities, the potential of this nature is likely to be of the order of 3 million kW.

There is also considerable potential for micro hydel schemes in hilly regions. However, potential survey for independent micro hydel schemes in the hilly regions is rather difficult as topographical information as well as competent hydrological information cannot be found in the same manner as to the degree of fineness needed in the conventional cases. The State Authorities have been advised to launch a vigorous drive for reconnaisance and collection of field data for identification of such schemes. On a rough estimate potential of this nature would be of the order of 2 million kW.

The micro hydel schemes in the hilly region are mostly for utilisation in the local region. The generation is utilised for electrification and also for small rural industries, if they are present.

The small hydel development in the plains, however, is connected to the nearby grid as grid lines are available almost all over the plains. It is thus difficult to indicate the specific purpose for which the micro hydel generation is being utilised.

3. ORGANISATIONAL SET UP

India is a large Republic country divided into number of States. Power generation is a concurrent subject that is both Central and State Governments are concerned with the power development. The overall planning is done by the Centre in their organisation called "Central Electricity Authority". The actual execution of hydro projects for small generation rests with the State Authorities. The organisational set up for planning, investigations and execution varies from State to State. But generally speaking, it is done either by the Govt. Agencies or the State Electricity Boards which are semi-Government organisations.

The State Government Organisations are headed by Chief Engineers. There may be separate Departments for Civil works and Electrical works. On civil side there may be separate organisations each headed by a Chief Engineer for different works, such as investigations and planning, execution of irrigation projects, execution of hydro projects, etc. depending on the size of the State. On Electrical side also the Chief Engineer may be one or more.

The State Electricity Boards are headed by a Chairman with a number of Members to assist him. The organisations under them are headed by Chief Engineers. The set up below Chief Engineer may be generally same in both the cases. The Chief Engineer is in-charge of a number of circles which are divided into Divisions and Sub-Divisions. The preliminary data for planning of a power station, investigations, availability of facilities for construction etc. is carried out by civil organisations. After the preliminary

investigations the data collected by the civil authorities is discussed with electrical organisation, these two organisations have to work in good liaison. After discussions the project report is finalised by the civil authorities in consultation with the electrical organisation. Such a project report is required to be examined by the organisation in the Central Government (CEA) if the estimated cost of the project exceeds certain limit. The Centre scrutinises the scheme and gives its sanction for execution.

The construction of the project is generally incharge of civil organisation. This organisation has separate construction circles who execute the project. The equipment for the electrical works is handled by the electrical organisation. A constant co-ordination is maintained between civil and electrical organisations during execution of the project. Once the project is constructed and is stabilised for generation, it is handed over to the State Electricity Board for its operation and maintenance.

4. TECHNICAL, ECONOMIC AND ENGINEERING DATA

In the recent past about 53 units of category (i) and 7 units of category (ii) have been installed in the country. The units of category (i) are of the run-of-the-river type. The discharge in the river is maximum during summer and monsoon months which covers almost half the period of the year from April to September. The discharge in the winter months comes down substantially.

Civil works - The river waters are diverted by construction of a small dam or a weir with small intake works. The waters are taken over the water conductor

system which would have a length varying from about 1 km to 3 km depending upon the head that can be economically developed. The water conductor system would comprise of a system of tunnel, open channel, cut and cover conduit, a small forebay and head works from where small length of penstock would take off to the power house. Depending on the topography some of the features mentioned above can be eliminated. The power house building is made as simple as possible. There may be a small tail race channel for dropping the water discharged in the power house either back into the same river or some other hilly stream.

Electrical and mechanical works - The generating units installed recently in these power stations have ratings varying from 50 kW to 1000 kW. The heads utilised vary from 30 metres to 200 metres. The hydraulic turbines in these power houses are of the conventional type - either of Turgo-impulse or Francis type. The auxiliary systems in the power house are also made as simple as possible requiring less maintenance and repairs to the equipment. All the units in these power stations have been manufactured indigenously.

Of the category (ii) recently two power stations have been constructed on the canal system of Kosi and Gandak rivers in Bihar. These power stations are built on the canals taking off from the barrage itself and utilise heads as low as 3 to 4 metres. There are, therefore, no elaborate civil works required except a power house building. Bulb type of generating units are considered most favourable for such low head generation. There are also two major schemes having unit ratings of 8 MW and 15 MW under construction in the country which would utilise bulb type of units.

The complete design and engineering for all the Indian projects including feasibility reports, planning, construction and commissioning of civil, electrical and mechanical works is done by the Indian engineers.

Economics - The cost of micro hydel installation ranges from Rs.5000 to Rs.10,000/kW installed (Rs.100 = U.S.$ 12.5). The power stations have been constructed either by the State Government Authorities or by the State Electricity Boards and are financed as well as owned by the Government. After the commissioning of the units, the operation and maintenance of the power stations is entrusted to the State Electricity Boards. The responsibility for the management, revenue, etc. also rests with the State Electricity Boards.

5. SALIENT TECHNO ECONOMIC FEATURES

The construction of the micro hydel projects has been made as simple and economical as possible. The design of the civil features is so chosen that maximum scope for utilisation of local men and material is possible. Some of the novel features of construction are as follows :-

If the discharges are small a drop-type weir is ideally suited for diversion structure. The drop-type weir consists of reinforced concrete trough constructed just below the bed level on the stream with trash rack bars fixed at the top. The trough is given longitudinal slope so that the required discharge is drawn into the intake and also to flush out the heavy silt deposited by the water during the monsoon.

For water conductor system wooden flumes or galvanised iron sheet flume or even pre-cast concrete flumes have also been adopted. The topographical and geological condition sometimes preclude adoption of open flume particularly in steeply falling hilly terrain. This may also be subjected to occasional land slides. In such cases it is advisable to adopt pre-cast concrete pipes which are comercially available. These pipes can be embedded in the trenches and back-filled. Such pipes also help in preventing formation of ice at high altitude of hilly regions.

For penstocks, use of electric resistance welded steel pipes has been found economical. Circumferencial joints are made at site. Expansion joints in the penstocks can be eliminated altogether when they are buried.

If a forebay structure is required in the water conductor system pressed steel tank can be provided with adequate support without resorting to excessive excavation in the hill slopes.

In the small head installations of category (ii) also economies are achieved by simplification of intake and gate structures. The power house civil structures required for bulb type units is significantly less than that for conventional Kaplan unit. This is one of the reasons why bulb type units are preferred for low head installation apart from their higher efficiency.

Standardisation - Attempts are being made for standardisation in as many features as possible. This is possible in civil works, layouts of the power station; gate arrangement and auxiliary and ancillary equipment utilised in the power house.

Economic considerations: - The conventional hydro power stations which are being constructed in large number and also utilising a large rating of the generating units have an installation cost varying from Rs.3000 to Rs.7000/kW. The cost of the micro hydel generation schemes considered economically feasible varies from Rs.8000 to Rs.15000/kW. Of course there are no hard and fast rules of economic feasibility as other factors such as urgent need as well as resources of a particular State also play an important part in taking up the scheme. The figures mentioned in this paper hold good for the present time.

6. CAPABILITY OF MANUFACTURING FIRMS

There are three indigenous firms who have been in production for quite some time. Out of these, one is in the public sector and two in the private sector. The firm in the public sector has been manufacturing equipment for small hydro generation of comparatively bigger rating (5,000 kW to 15,000 kW). The equipment manufactured by this firm is in operation quite satisfactorily for number of years. The firm has so far manufactured units of conventional type, i.e. Kaplan and Francis. The firm is presently developing manufacture of bulb type of construction of the generating units. It is envisaged that requirement for future bulb units would be met by the firm.

The two firms in the private sector have specialised in the manufacture of equipment required for installation for Category (i). The design of the turbine is of Turgo-impulse or Francis. One of these firms have manufactured quite a large number of units having rating upto 3,000 kW. The other firm has come up recently and has supplied comparatively less number of generating units.

There is one more firm in the public sector which is planning to take up manufacture of small turbines for micro hydel generation. The plans, however, are in the initial stages and the actual manufacture is likely to take some time.

The three firms who are in production depend entirely on the local facilities for manufacture of the generating units except specialised stainless castings know-how for which is being developed in the country. All the components required for generating units and auxiliary equipment are also manufactured in the country. In fact, the country is self-sufficient in the production of hydro generating equipment of almost all categories.

Design and Engineering for the micrc generation projects as well as the equipment is available in the country.

7. PROGRAMMES FOR DEVELOPMENT AND TRAINING

The C.E.A. who is the organisation of the Central Government is responsible for overall planning for power development in the country. The CEA has been encouraging States to go in for construction of small hydel as much as possible. With the availability of generating equipment for low head, the programme is expected to get greater impetus. The future programme envisages installation of small units at the existing irrigation dams and also remodelling of canals for utilisation of head wherever possible. In the Himalayan region, development of M.H.G. is governed by the urgent local needs as this would be the only source of generation in these regions.