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SMALL HYDROPOWER DEVELOPMENT IN MOROCCO*

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SUMMARY

ONE has launched a Small Hydro-Electric Power Plant (SHP) study. The aim of the SHP is to supply electrical power to rural centres, especially in remote mountain regions, isolated and more-or-less cut off from distribution networks. Current studies to index and indentify sites have already analysed 40 sites out of a possible 200.

Electrical power to be installed ranges from 50 to 500 kw for heads between 20 and 250 metres, more often, however, between 50 and 100 metres. Flows ranging from some tens to hundreds of litres per send are difficult to control and this proves to be one of the major difficulties of this study.

The expected impact of the SHPs, apart from currency savings and their contribution to the country's independence in matters of energy, are : improvement of the standard of living of local populations, promotion of new activities (touristic, the hotel trade, artisanal), the development of local industries and management training for an easily transferable technology if the program is sufficiently consistent.

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* Source : O.N.E (Office National de l'Electricité) - Hydro-electrical Equipement Service - Mr. A. EL GHORFI

1. The role of Hydroelectric Energy in the Moroccan Electricity Network

The sum total of hydro-electrical potential which Morocco can mobilize amounts to approximately 4,600 Gwh, of which 40% is effectively exploited.

These hydro-electric installations contribute, along with other means of production, to satisfy the country's demands for electricity.

At the end of 1984, power demands on the ONE inter-connected network were supplied by :

- 22 hydro-electric power stations with an installed capacity of 600 MW and producibility per average year of 1800 Gwh. Twelve of these power stations form part of major dam complexes;
- 4 thermic steam plants totalling 1,185 MW of installed capacity;
- 7 gas turbines with an installed capacity of 135 MW;
- plus a certain number of small diesel plants.

Gross power demand on the entire interconnected network at the end of 1985 amounted to 6,525 Gwh. Production break-down was as follows :

- Hydro-electric production	415 Gwh	7.4%
- Thermic production using local coal	1050 Gwh	16.1%
- Thermic production using imported fuel and diesel oil	4990 Gwh	76.5%
TOTAL	6525 Gwh	100%

Hydro-electric power, which should have counted for 1800 Gwh for an average year, dropped to 23% of its normal potential due to the persistance of drought for 5 consecutive years between 1980 and 1985.

Power from hydro-electric sources is none-the-less precious because of the fact that it comes, as far as possible, during busy periods, and, especially, at peak hours.

II) ADVANTAGES PRESENTED BY SHPs

2.1 The mobilization of resources of hydro-electric origin constitute one of the foremost priorities of both the National Energy Plan and the 1981-1985 Five-Year Development Plan.

Indeed, faced with the increasing burden of petroleum imports, the Plan earmarked two main trends as regards the choice of an Energy Production Equipment Program :

- priority utilization and mobilization of national resources of primary energy, firstly hydro-electricity
- diversification of our outside sources supplying fuel, making use, in particular, of imported coal.

The mobilization of hydro-electrical power was earmarked as a priority since it responds perfectly to the following criteria :

- mobilization of national resources with a view to reducing the country's energy dependence;
- meeting demands at the least possible cost per Kwh.

Over the past fifteen years, interest first centred on the mobilization of waterfalls formed by major multiple-purpose installations primarily built to meet the development requirements of irrigated agriculture.

Since the oil boom in 1973, certain priority has been given to the energy component of pultiple-purpose installations which allow the considerable demands for rush and peak energy to be met.

2.2. Moreover, taking into account the need to supply electricity to remote rural centers, it appears beneficial to consider the mobilization of small waterfalls.

2.3. As regards the SHP sites, priority has been granted to remote centres located in high mountain regions and valleys which are difficult to reach.

The equipment will avoid the necessity (for a certain time) of resorting to a medium-voltage hook-up to the network (extremely costly in mountain regions).

Small-scale hydro-electric installations take on their true value :

a) from the fact that they adapt to the geographical dispersion of rural mountain centres. In fact, mountain settlements tend to gather throughout the valleys in close proximity to springs and waterways, at an acceptable distance from possibly hydro-electric plant sites;.

b) due to the low power involved, the power produced by a SHP being perfectly adequate to satisfy immediate requirements. There is no surplus to be run-off or deficit to be made up by a costly line;

c) new supplies of electricity provided by SHP make no call upon imported energy sources and so do not aggravate the country's energy defecit.

POTENTIAL INSTALLATION OF SHPs

A pres-study site inventory has allowed ONE to map two hundred sites, the scope of the study being limited to sites :

- cut-off from any medium-voltage distribution network (remote areas or those with no agglomerations of sufficient importance) or which will not be included in the network for some time (at least during the life of the SHP to be set up).

- with power inferior to 500 kw. These sites, having a unit power ranging between 50 and 500 kw represent a global installed capacity of 20 MW and a 60 Gwh producability factor.

This potential corresponds to the electrification of more than 300 remote sites in mountainous rural areas.

III) PRESENT STATUS OF STUDIES

The study has already covered 40 sites which have been indexed and are the subject of studies and surveys in varying phases of progress.

Work is to begin imminently at the TABANT site in the Aït Bouguemez valley (Azilal Province) which was one of the first to be selected as a pilot-project. It will have an installed capacity of 200 Kw and will supply electricity to 4 villages.

Detailed studies have been made of other sites such as :

- TINKHAR N'IFNI (Taroudant Province)
- AGHBALOU N'KERDOUSS (Er Rachidia Province)
- ABACHKOU (Azilal Province)
- ZERWALT (Azilal Province)

IV) LOCATION AND CHARACTERISTICS OF THE SHPs

1) Site Location:

- In the Atlas and the Rif, in valleys which are particularly inaccessible during the winter when snow can cut-off traffic for several weeks or even months;
- at high altitudes between 600 and 2000 m NGM in the Atlas and between 400 and 1000 NGM in the Rif;
- where the distance from the last antenna of the network is between 30 and 50 kilometres.

2) Climate Type :

Semi-arid mediterranean-type climate in the Rif and in the Central Atlas, arid on the Saharan flank of the Atlas. Rainfall is:

- 300 mm on the western flanks of the Atlas
- 100 mm on the Saharan flanks of the Atlas
- 500 mm in the Rif.

3) Hydrological conditions of springs and water-ways :

The flow of the springs and water-ways surveyed vary from some tens of litres per second to some hundreds of litres per second.

Sites are located in the uppermost parts of the water-ways, well up-stream from hydrological plants.

Little survey data is available except such as ONE agents were able to gather by various methods during their trips. The scarcity of rainfall statistics constitutes one of the main difficulties of the SHP study.

Obviously, data provided by observation stations can be used and the following studies made :

- correlation with downstream areas of the catchment areas which are better-known
- rain-flow correlation
- in addition to public surveys and assessment of water-level traces.

A flow control section was set up almost two years ago at Tabant n'Aït Imi and this provides daily flow readings. Current metre measuring has recently been put into operation at other sites.

4) Equipped output - Daily load curve

In particular, the output must be collated against constraints imposed by vested rights (irrigation) and the possibilities of output modulation (which can, in certain cases, be provided for).

The basis for hypothesis of daily turbine volume is generally taken as 1 to 1.5 times the volume of summer inflow.

An SHP should be able to supply its local network without interruption, summer or winter, and without recourse to other sources. It has, therefore, a looad curve identical to that of the local network.

Determination of this curve necessitates economic and socio-economic studies and forecasts of the potential use of electrical power (current and future) at sites which are not yet familiar with this form of energy.

These studies, which often go into great detail, relate to :

- Population growth at the site
- The possibility of creating industrial or other activities (hotel trade). This is, obviously, the final objective of the SHP project.
- The evolution of the purchasing-power of potential subscribers.

The regions in question are generally the least populated and the poorest. In many cases, local purchasing power is still insufficient to pay for branch pipes (costs covered by the State) and water rates.

5) Heads :

Generally averaging between 50 and 100 metres but can range from 20 to 250 metres.

Capital outlay will, in general, be less for a low flow rate and greater head.

6) Centres to be supplied - Distribution networks :

In general, the sites are in the vicinity of small centres (in the case of springs) or at a distance of not more than 5-6 kilometres.

When more than one kilometre, it becomes necessary to resort to medium voltage (5.5 or 22kv).

Villages to be supplied have populations ranging from 200 to 3000.

7) Zoning for the purpose of Inventory Surveys :

To facilitate on-the-spot identification studies, the following classification has been adopted - taking into account climatic and hydrologic criteria :

1) the Atlantic flank (centre)
The Oum Er Rbia catchment area and waterways of the Atlantic flank of the Atlas south of the River Oum Er Rbia;

2) the Atlantic flank (north)

The Bou Regreg-Sebou catchment area;

3) the catchment area of the Mediterranean waterways;

4) the Sarahan flank of the Atlas.

V) PROJECTED STRUCTURES AND INSTALLATIONS DESIGN :

The installations identified involve, in general, fairly average falls and the designs under consideration are for equipment by water diversion. The main advantage of this type of design is the fact that it does not require major structures to raise water levels nor to afford protection against flooding, flood rate in these high, mountainous sites being relativelv low.

As far as possible, the design of civil-engineering structures will be kept fairly simple so as to avoid encumbering installation costs with high study-costs, on the one hand, and to enable the greater part of construction work to be entrusted to regional firms and, if at all possible, to local sub-contractors.

As regards major hydro-mechanical and electrical equipment, this too should be of sofficiently simple design for it to be built locally even at the expense of a drop in certain performance standards and quality of service.

Manufacturing of this kind can only be considered if the program is sufficiently vast and Moroccan industries guaranteed a minimum volume of orders.

For these reasons, an overall site index study and implementation plan is of great importance.

VI) The economic aspect of the SHP program

To be able to assess the direct benefits of the SHP program (in terms of direct financial returns) the project must be compared with alternative means of energy production capable of rendering the same services. In the case of the SHP program, it can be compared with either the Diesel groups or expansion of the network.

A simplified comparison of cost price per Kwh follows :

	SHP	Diesel	Network Expansion
- Amortization of initial investment costs	Very high: 85-95%	Average: 15-20%	High: 50-79%
- Fuel		High: 60-90% according to specific consumption	
- Purchase of electric energy			High: 30-50%
- Maintenance costs (heavy maintenance)	High: 5-10%	Average: up to 30%	Low: 10%
- Operation, management, overheads and miscellaneous costs	3-5%	4-6%	2-3%

It is evident that the producibility of a SHP depends largely on the life of the installed power.

To clarify, under economic conditions prevailing at the end of 1985, the cost per Diesel Kwh produced (before distribution) in remote mountain regions ranged from 2.30 Dhs to 3 Dhs.

If 2 Dhs/Kwh is taken as a reference cost, for a SHP to be advantageous, the cost per Kva should not exceed 40,000DH/kva if the guaranteed life of the installed power is higher than 4,000 hours.

VII) ECONOMIC AND SOCIAL IMPACT OF THE SHP PROGRAM

In addition to the direct financial profitability aspect, the advantages of the SHP program are linked to :

1) Global economy :

a) a source of renewable energy, therefore offering security of supplies, it is particularly appreciable in regions which may be isolated during the winter;

b) it is alocal resource thereby providing a certain saving in foreign currency (in so far as currency savings are made at the time of investment);

c) the equipment of this resource has a local involvement aspect which provides considerable opportunities for local industries and firms.

2) Social Development :

(this is not specific to the SHP progrqm but to electrification in general).

a) Thanks to electricity supplies, communities can attain a satisfactory level of equipment (schools, dispensaries, utilities.....)

b) Creation of small local industries thus providing job opportunities and a certain 'revalorization'.

c) Improvement of individual and social standards of living which could help to curtail rural population drift.

VIII) TECHNOLOGICAL IMPACT

The SHP program includes a major part of "soft technology" which lends itself to a greater transfer and more wide-spread diffusion of technology.

1 - At survey level :

a) technical studies :

Participation of Moroccan groups and engineers, aided at the onset by their European counterparts.

b) economic and socio-economic studies :

economic and socio-economic usefulness to the community itself (as reference and data for other surveys).

2 - At implementation level :

a) local enterprises

b) local industries

- manufacturing under license, on condition that the program is sufficiently vast and that industries are guaranteed a minimum volume of orders.

- local design (extremely high levels of performance are not sought for the SHPs. This does not, however, preclude the search for a well-adapted technology).

  It will leave the field free for innovation.

3 - At operational level :

a) Electrification of rural areas : creation of small industries (mentioned above).

b) Operation - Maintenance

   Training of specialized local work force, technology diffusion.

IX) <u>DIFFICULTIES ENCOUNTERED - FUNDING</u>

The difficulties encountered are tied to the importance of required investments which exceed the budgets set aside for rural electrification.

In the domaine of budgetary allocations, the SPH program has not yet managed to impose itself over classical rural electrification programs which are achieved by limited expansion of the medium voltage network (less costly) and which, moreover, concern relatively large centres which can claim a certain priority as regards electrification.

The SHP program, whether in the sphere of studies or realisations, has sofar been in quest of funding within the framework of international bilateral cooperation.

Certain conventions have been signed in this sense and are currently in the process of implementation.