OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

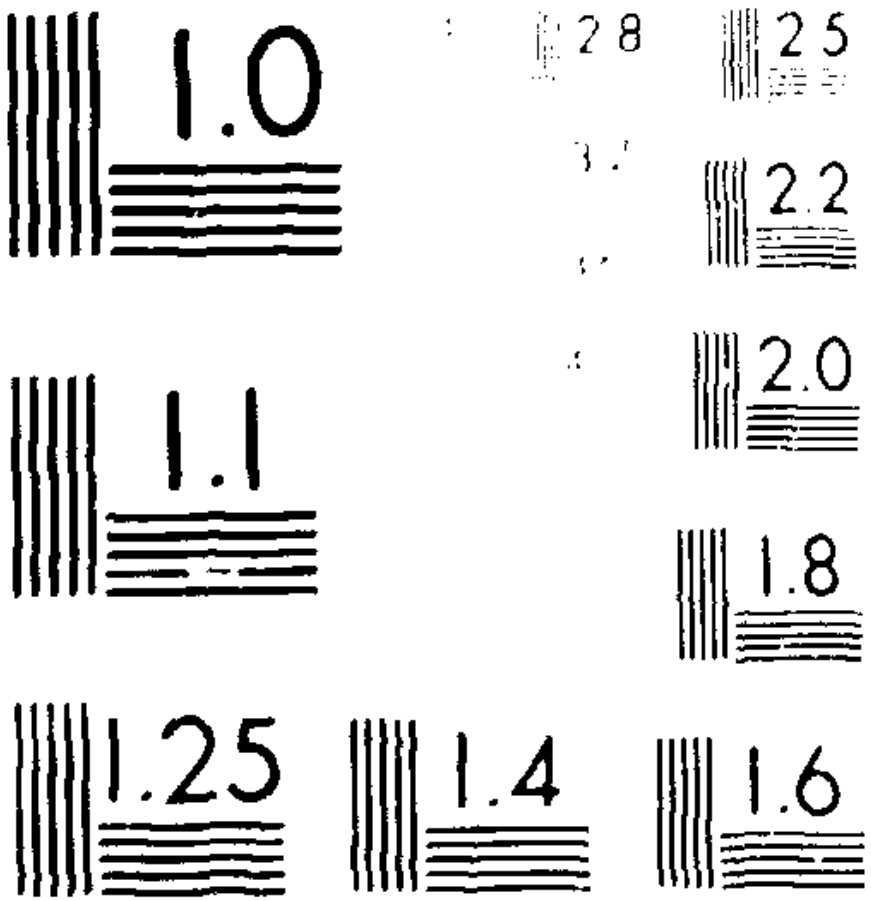
FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org


2.8
2.5
1.0
2.2
2.0
1.1
1.8
1.25
1.4
1.6

10309

Distr.
LIMITED

ID/WG.329/4
3 February 1981

ENGLISH

United Nations Industrial Development Organization

Second Seminar-Workshop/Study Tour in the Development and Application of Technology for Mini-Hydro Power Generation (MHG)

Hangzhou, China, 17 October - 2 November 1980

Manila, Philippines, 3 - 8 November 1980

REPORT *

* This document has been reproduced without formal editing.

V.81-20952

TABLE OF CONTENTS

HANGZHOU-MANILA DECLARATION ON MINI-HYDRO POWER GENERATION (MHG)[1/2/]

Accelerated rural development in the third world is an utmost universally supported objective. Such accelerated development in the rural areas must flow from increased productivity in the agricultural and small industrial sectors. The key to the increased productivity as well as improved quality of life is the provision of cheap and reliable electrical power.

Several developing nations have undertaken extensive rural electrification programmes and others are planning such efforts. The world energy crisis, set-off by escalating oil prices and heightened by unreliable oil supplies, is seriously undermining these critical programmes for accelerated rural development. Developed and other developing nations are deeply concerned with utilizing alternative energy sources particularly those which are indigenous, economical and renewable. In many cases, particularly in rural areas, mini-hydro generation can supply an inexpensive renewable source of indigenous electric power. For these reasons, it is urgent that development of MHG programmes be encouraged and assisted.

1. The developing nations of the world are called on to initiate and accelerate MHG programmes enccuraging local involvement to assure that such programmes will not remain dependent on other countries. The developed countries, international financial institutions and technical assistance groups are enjoined to assist the developing nations in this effort by providing technical and financial assistance in establishing a range of demonstration on MHG plants as well as local manufacturers of MHG equipment and machinery.

1/ Proposed by participants from Bangladesh, People's Republic of China, Jamaica, Malaysia, Norway and Republic of the Philippines.

2/ Adopted by the Seminar-Workshop/Study Tour on Mini-Hydro Power Generation in Manila, Republic of the Philippines, on 7 November 1980.

2. Although there is an existing technology of MHG, that technology is not widely available. The establishment of a means whereby ready access to this technology would be possible is encouraged. Perhaps the existing UNIDO INTIB programme could undertake the dissemination of basic technological information.

3. Finally, the delegates believe that continued information exchanges of country experiences in initiating MHG programmes would be valuable in the effective implementation of their programmes. UNIDO is requested to assist in encouraging the continued exchange of these experiences.

The participants of the Second UNIDO Seminar-Workshop/Study Tour on Mini-Hydro Power Generation (MHG) decide to underline the urgency of the needs to implement programmes for supplying cheap, reliable and renewable energy sources for the rural people particularly of the developing world, and wish this to be referred to as the HANGZHOU-MANILA DECLARATION ON MINI-HYDRO POWER GENERATION (MHG).

I. SUMMARY RECOMMENDATIONS

1. DEFINITIONS

(To Governments, UNDP/UNIDO, Financial Institutions)

The Seminar-Workshop/Study Tour recommends the following definitions of generating unit sizes for MHG:

a) Small-hydro-electric generation units are units with a rated capacity in the range twelve thousand (12,000) and one thousand and one (1,001) kilowatts;

b) Mini-hydro-electric generating units are units with a rated capacity in the range one thousand (1,000) and one hundred and one (101) kilowatts;

c) Micro-hydro-electric generating units are units with a rated capacity of one hundred (100) kilowatts and below.

2. SOCIO-ECONOMIC CONSIDERATIONS AND MULTI-PURPOSE PROJECTS

(To Governments, UNDP/UNIDO)

Because most MHG installations are run-of-the-river schemes it is recommended that:

a) Electric power be largely devoted to rural development especially in the areas of agro-industry, irrigation, cottage and forest industries;

b) Surplus power such as is often available due to seasonal increases in precipitation be harnessed and utilized for the rural production such as, for instance, chemical fertilizers, pharmaceuticals, other chemicals and metal products;

It is further recommended that:

c) UNIDO should cause to be propagated a methodology for assigning measures of merit based on socio-economic considerations for application in the evaluation of MHG projects;

d) Governments undertake mini-hydro projects as part of multi-purpose schemes for rural industrial development. Project costs should be covered by the different sectors of use according to their utilization of the power and the structures.

3. ORGANIZATION OF MHG ACTIVITIES ON THE NATIONAL LEVEL

(To Governments, UNIDO/UNDP)

It is strongly recommended that:

a) Developing countries with MHG potential set up a specific national technical team with national responsibility for co-ordinating and planning MHG development. This team should, wherever possible, have a separate identity from technical groups dealing with other hydro-power generation in the light of the fact that MHG technology is sufficiently distinct to warrant recognition as a specialized pursuit;

b) The maximum local and district level involvement in the implementation management and operation of MHG plants should be aimed at;

c) Although country-specific conditions will finally determine the optimal approaches to the studies of prefeasibility and feasibility, it is recommended that such studies on MHG projects should have a methodology appropriately developed for MHG, and distinct from the methods of evaluating larger hydro projects;

d) Where appropriate, the feasibility study on MHG plants should include detailed engineering drawings;

e) The activities of national MHG technical teams should comprise of, but not be limited to surveying, hydrology, geology, civil engineering, economic studies etc., with the purpose of conducting all phases of project planning, programming and implementation i.e. site identification and selection, pre-feasibility and feasibility studies including designing and final drawing, supervision of construction, commissioning and where required, limited operation; and

f) Involvement in the operation of pilot plants be an activity of such mini-hydro teams.

4. RESEARCH AND LOCAL MANUFACTURE

(To UNIDO, Governments, R + D Institutions)

a) With a view to reducing costs and simplifying the hardware of MHG plants, it is strongly recommended that increased research efforts be concentrated on the development of reliable, inexpensive devices and techniques for governing and/or frequency control of MHG units and associated networks.

b) In order to permit the utilization of locally existing manufacturing facilities, documentation should be made available which indicates all possible technological levels of manufacturing to arrive at the inherent components and equipment taking the various manufacturing processes and/or indigenous design alternatives into consideration. This involves the application of metalic and non-metalic materials, foundry and welding processes, etc.

5. FINANCING

(To donor agencies, banking and other financing institutions)

This meeting strongly recommends that soft loans be made available for the implementation of MHG projects.

6. THE CHINESE AND FILIPINO APPROACHES

(To UNIDO and Governments)

Based on the comprehensiveness of the mature Chinese programme and on the scope and vigor of the Philippine's initiative in MHG, it is recommended that UNIDO compile and analyse production schemes for MHG establishments in the developing countries.

7. INTERNATIONAL MHG STANDARDS AND CONVENTIONS AND AN INTERNATIONAL MHG SOCIETY

(To UNIDO)

UNIDO is commended for its welcome initiative in the drafting of standards for MHG equipment, civil works, etc., and it is appreciated by this meeting that efforts to standardize and economize on the range of unit designs must allow adequate room for innovative research and development. In the light of these facts, it is recommended that UNIDO convene an early meeting of international experts, manufacturers and other relevant parties to institute broad conventions on turbines and accessories, their ratings and sizes, test procedures, norms of construction and agreed terminology with respect to MHG.

8. CENTRES OF EXCELLENCE

(To UNIDO and other inter-governmental agencies, foundations, etc.)

The meeting strongly recommends the establishment of:

a) A Center or Centers of Excellence in Training relevant to MHG technology.

b) A Center or Centers of Excellence in Research and Development relevant to MHG technology.

9. MHG INFORMATION

(To UNIDO - Industrial and Technological Information Bank - INTIB, etc.)

For those participants from countries just initiating MHG development (the majority of participating countries), it would be of great value to have ready access to lessons learned, design guidelines, data development methods, etc., from the countries, China in particular, with experience. To comply with such needs it is recommended that UNIDO considers undertaking the following steps:

a) Establish a Center or Centres of Excellence as the focal point(s) for MHG information exchange;

b) Development of a Reference on MHG Experience and Technology:
In starting to plan installing an MHG power plant at a particular location, the inexperienced planners and designers would like to have access to the thinking of those, more experienced who faced similar situations. This information on their thinking should be in specific terms with appropriate details. We would suggest the possibility for development of a reference file as follows:

i) preparation of concise papers on fairly narrow and specific subjects. This individual paper approach is suggested so that results can start becoming available in the shortest possible times;

ii) authors for these papers should come from several countries with significant MHG experience; and

iii) the file should contain detailed information on engineering design or procedures, cost analysis and engineering rationale.

It is suggested that the reference file should cover the minimum following topics:

i) developing programme priorities
ii) hydrological data development
iii) site selection
iv) civil works development to minimize costs
v) hydro-electric equipment selection with particular reference to minimizing costs for given power demands and stream flow patterns.
vi) cost analysis and benefit analysis

It is felt that a reference file covering these subjects would be of enormous utility to the developing countries;

c) Institute an MHG newsletter, possibly through INTIB as well as publish technical material specifically concerned with MHG; and

d) Compile and disseminate inventories of institutions and expertise relevant to MHG on a regular basis.

II. INTRODUCTION

A. Background Information

The development of renewable sources of energy has become an important programme for consideration in many countries, both developing and developed. In recent years, particular attention has been increasingly paid to the development of mini- and micro-hydro power generation units specially for remote and rural areas.

Recognizing this fact, UNIDO organized a Seminar-Workshop on the Exchange of Experiences, Technology Transfer and Mini-Hydro Electric Generation Units, in Kathmandu, Nepal, from September 10 to 14, 1979.

The Seminar-Workshop adopted the Kathmandu Declaration[1/] which emphasized among other things the need to intensify action and international co-operation in this important endeavour.

The first session of the Technical Panel on Hydro-Power, organized by the Preparatory Committee for the United Nations Conference on New and Renewable Source of Energy (UNCNRSE), February 18 - 22, 1980, "... reviewed the Draft Report of the Kathmandu Workshop[2/] and agreed to adopt its conclusions and recommendations." It further "...agreed on the need for studies to reduce costs of developing mini-hydro power units, to increase their reliability and to determine better ways of their integration into large systems."

Inspite of the growing interest of many developing countries to develop mini-hydro power units, there seems to be a number of problems directly related to the planning and implementation of such MHG projects. Furthermore, inspite of the fact that a number of MHG projects are currently undertaken on both bilateral and multilateral levels through international co-operation, there seems to be definite lack of concerted effort and integrated approach towards an effective planning and implementation of project activities.

Pursuing the recommendations of the Kathmandu Seminar-Workshop and of the Hydro-Power Technical Panel and desirous of improving the situation, UNIDO organized a Second Seminar-Workshop/Study Tour in the People's Republic of China (P.R.C.) and in the Republic of the Philippines (R.P.). These countries were chosen as Seminar venues because in the two countries Mini-Hydro Generation development is progressing quite successfully, although the methods of planning and project implementation seem to be entirely different, and that it would be most enlighting and useful if these two methods could be directly compared.

1/ Annex V
2/ ID/WG.305/22

The Seminar-Workshop/Study Tour was undertaken in Hangzhou, Shanghai and Guangzhou (all in the People's Republic of China) and in Manila (Republic of the Philippines) from 20 October to 7 November 1980, with the consent and support of the People's Republic of China's Ministry of Water Conservancy and of the National Electrification Administration (NEA) of the Republic of the Philippines. Financial assistance was extended by the People's Republic of China's Ministry of Economic Co-operation and Foreign Relations and the Ministry of Water Conservancy; and the Norwegian Government, through NORAD (Norwegian Agency for International Development). The preparation and organization of the programme was done jointly by UNIDO's Development and Transfer of Technology Branch, the Industrial Training Branch, and the Engineering Industries Section of the Division of Industrial Operations.

B. Objectives

The objectives of the Seminar-Workshop/Study Tour were:

1. To promote the exchange of information on and experience in the planning, construction and application of Mini-Hydro Power Generation Units in developing countries; and particularly, to make a comparative study of the methods of planning and programme implementation in the People's Republic of China and the Republic of the Philippines;
2. To undertake study tours of Mini-Hydro Power Generation sites, Mini-Hydro generating equipment plants, and other organizations and exhibitions directly involved in Mini-Hydro Generation;
3. To exchange views on UNIDO's work in this field, including:
   a) the preparation of a manuscript on Mini-Hydro Power Station: Manual for Decision-Makers;
   b) a discussion on standardized specifications for Mini-Hydro Power Generation system and equipment;
   c) the promotion of the manufacture of MHG equipment in developing countries;
   d) the possibility of establishing a regional/interregional development and training center in the People's Republic of China;
   e) UNIDO's technical assistance programme, particularly training programmes;
   f) technical co-operation among developing countries, as well as between developed and developing countries; and
   g) other subjects of common interest.
4. To exchange views on the programme for the United Nations Conference on New and Renewable Sources of Energy (UNCNRSE) in 1981.

C. Organization

The Seminar-Workshop/Study Tour was attended by 38 participants from 24 developing countries. Observers from four (4) developed countries and representatives of Ministries, Organizations and Institutions of the host countries also participated in the discussions. A List of Participants is attached as Annex I to this Report. The Programme of the Seminar-Workshop/Study Tour held in Hangzhou, Shanghai and Guangzhou, and in Manila; and the Schedule of Visits made during the Study Tour, are attached as Annex II. The participants had before them a set of country and background papers as per List of Documents attached as Annex III.

The opening ceremony of the Seminar-Workshop in the People's Republic of China on 20 October 1980, was honored by the presence of a number of high-level officials headed by her Excellency, Mme. Qian Zhengyeng, Minister of Water Conservancy. She welcomed the participants and officially opened the Seminar-Workshop. His Excellency, Mr. Li Fengping, Governor of Zhejiang Province; Mr. R. Ong, Minister Counsellor and Charge d'Affaires of the Republic of the Philippines in Beijing, on behalf of his Government; Mr. Yves de San, Regional Programme Adviser, on behalf of UNDP-Beijing; and Mr. W.H. Tanaka, on behalf of UNIDO, also gave welcome addresses.

At the plenary session, the participants elected the following officers:

Chairman	- Mr. Hsu Hsia-Shih (People's Republic of China)		
Rapporteur	- Mr. Ola Gunnes (Norway)		
Vice Chairman	-	Group I	- Mr. Reynaldo V. Sevilla (Republic of the Philippines)
		Group II	- Mr. Gaston Mvondo-Owoundi (Cameroon)
Asst. Rapporteur	-	Group I	- Mr. Dennis A. Minott (Jamaica)
		Group II	- Mr. Tenaji A. Deodas (India)

In addition to the discussions in the plenary sessions as well as working group meetings, the participants benefitted from the visits to MHG sites in the Jinhua and Jinyun districts of the Hangzhou Province. A Summary of the Study Tour is enclosed under Chapter VI of this Report.

The first portion of the Seminar-Workshop was officially closed in Hangzhou by His Excellency, Mr. Li Bonin, Vice-Minister of Water Conservancy. The Study Tour continued over Shanghai, Guangzhou and Conghua in the People's Republic of China before proceeding to Manila, Republic of the Philippines, where the second portion of the Seminar-Workshop/Study Tour took place.

The Seminar-Workshop/Study Tour in Manila was officially declared open on 2 November 1980, by the Honorable Alfredo L. Juinio, Minister of Public Works, who included in his address a brief orientation on the Philippine electrification programme. General Pedro G. Dumol, NEA Administrator, and Mr. W.H. Tanaka of UNIDO, also presented welcome addresses.

The participants elected the following officers for the second portion of the Seminar-Workshop/Study Tour:

Chairman - General Pedro G. Dumol
Vice Chairman - Mr. Hsu Hsia-Shih
Rapporteur - Mr. Ola Gunnes

The sessions in Manila were completed by observation visits to the Tiwi Geothermal Project in Albay and the Mini-Hydro Power Generating Unit in Cuyaoyao, Camarines Sur, as well as to local MHG equipment manufactures. It is to be especially noted with appreciation that the inauguration of the Camarines Sur Mini-Hydro Power Station in Cuyaoyao took place on the occasion of the field trip visit, and the Group was able to witness the starting up of the Station which was built within a period of four months and depending entirely on locally available technology, design, equipment and manpower.

D. Report

All participants took part in preparing various chapters and sections of the Report under the co-ordination of the Rapporteur. The Report was presented and duly adopted during the closing ceremony on 7 November 1980. The meeting recommended that the Report be presented as an input to the United Nations Conference on New and Renewable Sources of Energy (UNCNRSE) or one of its preparatory meetings. The meeting also expressed its hopes that appropriate follow-up actions be taken particularly relating to the recommendations which are summarized in the Report, and in this connexion, for those recommendations that do not relate to mandates given to UNIDO, respective U.N. or international organizations and agencies be duly informed with a request for follow-up.

Following the proposal of the participants from Bangladesh, People's Republic of China, Jamaica, Malaysia, Norway and the Republic of the Philippines, the "Hangzhou-Manila Declaration on Mini-Hydro Power Generation (MHG)", which appears at the beginning of this Report, was adopted by acclamation.

Following a summary review of the three weeks programme by General Dumol and Mr. Tanaka, Mr. Atallah on behalf of the participants, read out a Vote of Thanks to the host Governments of the People's Republic of China and the Republic of the Philippines, as well as the donor country, Norway (Annex IV).

The honorable Minister of Public Works, Alfredo L. Juinio, who graced the closing ceremony, officially declared the MHG Seminar-Workshop/ Study Tour as closed.

III. COMPARISON OF THE MHG APPROACHES IN PEOPLE'S REPUBLIC OF CHINA AND THE REPUBLIC OF THE PHILIPPINES

One of the major objectives of the Seminar-Workshop/Study Tour being the direct comparison of the methods of planning and implementation of MHG projects in the People's Republic of China and the Republic of the Philippines, two case studies were prepared and presented by representatives of the two countries. In order to enable an easier comparison of the two systems, nine specific aspects of the systems approach were selected:

A. Organization and planning
B. Local involvement in the implementation
C. Local involvement in the production of equipment
D. Multi-purpose/socio-economic aspects
E. Technology
F. Involvement of research institutes and universities
G. National/foreign technical performance
H. Financing
I. Mini-hydro versus other electric energy sources

In evaluating the two systems, it is essential to bear in mind the facts that the MHG programmes are at different stages of implementation, and that the systems are created and adopted under different political, economic, cultural and ecological conditions.

The Chinese started many years ago. They have had time to prepare their own knowledge in planning, implementation and operations. They have had time to move deliberately, if necessary, because so far they have not faced any particular energy crisis.

The Philippines is, like most other developing countries, facing the energy crisis. Their actions reflect this situation.

Other countries should evaluate their own situation and choose their own approach. In this respect the Chinese and Philippine approaches will serve only as a guidance, and not as definite concepts.

1. CHINESE APPROACH ON MINI-HYDRO GENERATION

A. Organization

1. Political Level

a.	Central Government	- Ministry of Water Conservancy	- Department of Farmland Water Conservancy
b.	Province	- Bureau of Water Conservancy	- Division of Hydropower
c.	Prefecture	- Department of Water Conservancy	- Division of Hydropower
d.	County	- Division of Water Conservancy	- Section of Hydropower

2. River Planning

To be carried out by Central Government or province or prefecture or county according to the size of the river.

3. Design

(1) Preliminary design - usually, installed capacity of $\leq$ 500 KW done by the county. The power of approving the design of SHG[1/] project is:

(i) Unit capacity $\geq$ 500 KW -approved by province level (Transmission line 35 KV or higher)

(ii) Unit capacity $\leq$ 500 KW - approved by prefecture or county level

(2) Detailed drawing - done by the county when unit capacity $\leq$ 500 KW.

4. Construction

a. County's SHG with total capacity $\geq$ 500 KW --
Organized by county and supported by the professional team from prefecture or province.

b. County's SHG with total capacity $\leq$ 500 KW --
Organized by commune or brigade, also supported by the professional team from prefecture or province.

5. Manufacturing of Equipment

Turbine unit capacity $\leq$ 500 KW - by county's manufacturer

Turbine unit capacity $\geq$ 500 KW - by prefecture's or province's manufacturers.

1/ SHG = Small Hydro Generation

6. Operation and Maintenance

Maintenance and minor repair may be undertaken by the county. Overhaul repair supported by the prefecture on some occasions.

B. Local Involvement in the Implementation

1. The implementation of SHG mainly depends upon the people, masses and according to their capability.
2. Local labour and local materials available usually are invested by the local commune.

C. Local Involvement in the Production of Equipment

Generally, for turbine-generator unit capacity $<$500 KW the machine will be manufactured by the county's factory.

D. Multi-Purpose/Socio-Economic Aspects

1. Multi-purpose:
   a) Irrigation
   b) Flood control
   c) Power generation
   d) Navigation
   e) Fishery
   f) Log passing, etc.

2. The roles of SHG in the socio-economic context:
   a) To promote water conservancy for the farmland.
   b) To develop rural small industries for the cheap power supply.
   c) To accumulate funds for the county, people's communes and production brigades.
   d) To promote the development of rural electrification and mechanization.
   e) To improve the living standard of the local people.

E. Technology

1. Civil Works:
   a) Intensive labor - adaptable to the present situation.
   b) Underground construction - by pneumatic drilling or by hand drilling. Recently, precast prestressed concrete pipes are widely used to replace steel penstocks.
   c) Standardized design of dams and powerhouse now are being compiled.
   d) Type of penstocks (pipelines):

(i) Precast prestressed concrete pipe

(ii) Welded steel plate

(iii) Timber pipe with steel rings (in the mountainous area where timber is abundant).

2. Hydraulic-mechanical and electrotechnical equipment:

a) Standardization of turbine

27 series and 85 different types. Range of head 2 to 612 meters.

b) Control system for turbine and valve

Governors - five types, i.e. hand manual, electrical, hydraulic-electrical, electronic-electrical and electronic-hydraulic - 8 series

c) Standard generators

121 types

d) Regulating and protection devices for generators.

Protection: Relay protections usually consist of differential, overcurrent, overvoltage, overload, grounding fault, buchloch protection, etc.

3. Survey technology:

a) Geological survey: Field investigation by exploration pits, trenches or adits are usually used. Sometimes boreholes are also drilled in case of an important SHG and rock samples are tested in order to give necessary data for designing.

b) Mapping: $\frac{1}{25,000}$ topographical maps are available in areas

$\frac{1}{2,000}$ maps are necessary for detailed drawing.

c) Hydrology: Generally, the hydrologic work for an SHG plant is carried out by in-site investigation as well as by necessary calculation by means of hydrologic handbooks. Handbooks have been compiled by relevant provinces or prefectures. They provide various hydrologic and statistical parameters (in tables and graphs).

F. Involvement of Research Institutes and Universities

1. Personnel training
2. Research
3. Laboratory test of hydraulic machine and hydraulic structures
4. Design works

G. National / Foreign Technical Performance

Mainly nation l technology. Useful foreign technology is also applied.

H. Financing

The source of finance (including loan) is mainly provided by local organizations at different levels and also subsidized by the central and provincial governments. The subsidy offered by the Government is about 30% of the total investment mainly used for the purchasing of machine and equipment as well as construction materials not locally available.

I. Mini-Hydro versus other Electric Energy Sources

1.	Small thermal power station	)
2.	Small diesel generation	) Mainly
3.	Extension from grid	)
4.	Biogas generation	)
5.	Geothermal generation	) Few cases
6.	Wind power generation	)
7.	Tidal energy	) Under study
8.	Solar energy	

2. PHILIPPINE APPROACH ON MINI-HYDRO GENERATION

A. Organization

THE NATIONAL ELECTRIFICATION ADMINISTRATION (NEA), assigned to the Office of the President, is responsible for planning and implementation of Mini-hydro system development as part of its rural electrification programme. The NEA is a wholly owned Government corporation receiving Government appropriations and with authority to borrow money (foreign and local).

In implementing the rural electrification programme the NEA sponsored the establishment of member-owned rural electric co-operatives. These co-operatives are governed by member elected boards. NEA acts as financing agent in providing the co-operatives with funds required for construction. Along with the financing NEA provides technical assistance and policy guidance. NEA also monitors the fiscal performance of the co-operatives.

In the Mini-hydro programme the NEA provides funding for the co-operatives by borrowing (foreign and domestic), it establishes policies and in the initial years will guide and assist the co-operatives in design and construction of mini-hydro plants.

Co-operatives borrow from the NEA the funds required to construct the power plants. The co-operatives are responsible for planning power use and for overseeing design and construction. When the power plants are completed, the co-operatives will manage them and sell the power to repay their loans from the NEA. As the programme matures it is expected that the co-operatives will assume more and more of the responsibility for execution of the programme to include site selection, routine design, contracting for needed design services and for construction (by force account or contract). The NEA's role will approach that of a development banker.

Pre-feasibility studies will be initially conducted by NEA staff assisted by private engineering firms (under contract). The design work (again initially) will be performed by private (local) engineering firms with initial efforts receiving technical review

by Foreign Consultants reporting to the NEA. The co-operatives (100 in number) are now federated into a national organization. Ultimately this national federation will provide technical assistance to the co-operatives in the design phase.

Initially, construction will be done by either private contractors or by force account, with force account becoming the dominant approach as experience is developed.

Equipment manufactures will for the first two to four years be done by various foreign suppliers. Local manufacturing capability will be developed in the private sector and probably at the co-operative (federated perhaps) level, as well.

B. Local Involvement in the Implementation

The electric co-operative has as members all persons receiving electricity. The co-operative is member-owned and controlled (through an elected board). The co-operative will, as the capability becomes firmly established, be almost fully responsible for implementation although the implementation will be in line with NEA established policies and targets.

C. Local Involvement in the Production of Equipment

There are, as yet, no final plans for local equipment production. One co-operative has already fabricated a turbine, mated this with a generator and installed the equipment. It is expected that further development along these lines be encouraged.

In addition, the private sector is undertaking to develop a manufacturing capacity. One manufacturer has already supplied, for a pilot plant, a turbine manufactured to a local design. The electrical equipment for this pilot project was also locally supplied.

The private sector is also expected to form joint ventures with foreign manufacturers to produce equipment locally using imported technology. One such venture, with China, has been agreed on. The NEA expects that local manufacturing will account for most equipment by 1984 to 1985, at least in the 500 KW and below range.

D. Multi-Purpose/Socio-Economic Aspects

The Philippine Government has established a national policy of full electrification of the rural areas. This policy is well on its way toward implementation and full coverage will be achieved before the end of this decade. Electricity is being supplied from whatever generation source appears appropriate for the particular locality. The provision of electricity is viewed as necessary:

(a) for quality of life
(b) for agricultural production
(c) to encourage rural industries

The Mini-hydro programme is viewed as a means of helping to free the Republic from its dependence on imported oil and as a means for supplying the cheapest practical power to the rural sector.

Generally speaking, the next few years will see a predominance of single purpose (electricity generation) mini-hydro sites.

E. Technology

The Philippine programme is in its formative years and its technology is heavily imported from a wide variety of sources (China, the UK, France, Norway, Japan and others). This technology will be assimilated and synthesized with local knowledge to evolve a Philippine technology. This will not occur prior to the mid-1980's.

F. Involvement of Research Institutes and Universities

At this time, there is a considerable reliance on imported technology. Therefore, the involvement of local research institutes and universities is rather limited. The private manufacturers and engineering firms do rely on local universities for assistance on technical problems beyond the capabilities of their staff. This involves the participation of individual professors and/or university sponsored technical institutes and consulting firms.

The University of the Philippines provides a very strong engineering consulting and financial analysis service available to assist as requested.

G. National/Foreign Technical Performance

The NEA is borrowing money, for tied equipment purchases, from a variety of countries (cited above). In each case technical consultants are assisting in initial site selection, preliminary design and equipment specification. Foreign consultants will provide more assistance in the construction and installation processes. These services allow the NEA to mount an accelerated programme while local personnel gain experience on-the-job and are exposed to the best technology available from all over the world.

H. Financing

Currently, the NEA has concessional or semi-concessional financing for the foreign exchange costs for over half the programme planned through 1987. Local costs will be covered from appropriated funds and from local borrowings with the NEA acting as banker. Financing will not be a constraint for the next few years.

I. Mini-Hydro versus other Electric Energy Sources

Currently, the Philippine relies heavily on oil to generate electric power. There are many locations in the Philippines at which Mini-hydro generation (MHG) power plants can be developed to supply power at costs well below those of oil fired thermal plants. The Philippines has a crash programme to free itself from a dependence on foreign oil for the generation of electricity. The MHG programme is an integral part of this national effort at energy independence. MHG supplied electricity because of modest scale of operations and scattered potential sites is particularly suited to meet the power needs of the rural electric co-operatives. It is for this reason that MHG development falls to the NEA.

Much of the power needs of the rural areas are supplied from the national grid. Although the country is now dependent on oil-thermal plants there is a large potential for generation electricity from alternative sources. Within the next decade the Philippines will generate its electricity primarily from large hydro, geo-thermal, coal-thermal and nuclear plants all of which will provide electricity at prices below that of oil-thermal.

Thus, the proposed MHG plants must be competitive with these power sources. For this reason the emphasis is on low-cost site selection in areas to be supplied by the grid.

It is true that significant areas will not receive grid coverage in this decade. In these areas MHG must be competitive with other local power generation alternatives. These include small geo-thermal sites, wood fired-thermal plants, possibly producer gas fuelled diesels and oil fired diesels. In these areas, the MHG sites which are less (than is required in the grid areas) economically attractive will be developed but still the requirement is to provide electricity at rates equal to or less than those possible from alternative sources.

There are large possibilities for MHG development given these criteria even when more expensive imported technology and equipment are employed. As local technology and manufacturing ability evolve it is expected that power plants costs will decline and MHG will become even more competitive.

Over-all the national Government has established the following targets for power generation by the co-operatives:

(a) By 1982 the co-operatives are to generate from indigenous and renewable resources, 20% of their power requirements
(b) By 1987 they are to generate 50%
(c) By 2000, 100%

It is expected that more than half of this local generation will come from mini-hydro power plants.

IV. SUMMARY REVIEW OF COUNTRY PAPERS

1. BANGLADESH

The Bangladesh Power Development Board is responsible for the planning and initiation of all hydro and mini-hydro programmes. In doing this, it works in collaboration with the Bangladesh Water Development Board. The Rural Electrification Development Board is responsible for the operation and maintenance of all proposed sites. Co-ordination is facilitated because all three statutory organizations fall under the purview of the Ministry of Power, Water Resources and Flood Control.

At present, there is no local manufacturer of MHG machinery but infrastructure is in place which can, with assistance, be adapted to the production of runners and shafts.

All mini-hydro will have to be part of multi-purpose projects. These projects will benefit the rural regions with better irrigation, improved power delivery to husking mills, aid cottage industries and supply lighting for domestic uses.

2. BURMA

The Electric Power Corporation of Burma which is an agency of the Second Ministry of Industry is responsible for the generation, transmission and distribution of electric power in the country. Operating under a clear policy on mini-hydro from the central Government, it has directed its MHG initiatives primarily to areas and communities in the north of the country which are remote from the national grid.

Machinery for large hydroelectric installation has to be imported at present, but an experimental programme has commenced for the local manufacture of electric and mechanical equipment, particularly of turbines. It is intended that this pilot operation should spread out to involve other manufacturing enterprises.

The present MHG programme of Burma will reduce the degree of deforestation now taking place due to the cutting of fuelwood. Its explicit purposes are to supplement existing electricity supply, stimulate economic activity and

spread social welfare, substitute for fossil fuel wherever possible and conserve on the use of petroleum products in rural areas.

3. ETHIOPIA

The Ethiopian Electric Light and Power Authority (EELPA) has overall responsibility for MHG and other hydropower in Ethiopia. That agency's Research and Feasibility Division is charged with the specific responsibility for conducting surveys and doing pre-feasibility and feasibility studies related to MHG projects. Projects considered feasible are transmitted to the Engineering Department for construction, electro-mechanical engineering or are contracted out to local or other enterprises. Ownership, operation and maintenance is by EELPA.

There are no local facilities for manufacture of equipment at present. The need for technology transfer is keenly felt in respect to MHG machinery.

Multipurpose projects involving power generation and irrigation are underway and some are already operational. The propagation of MHG plants in the rural areas is seen as a priority especially in the production of minerals and in assisting small scale gold mining enterprises.

4. EGYPT

The paper "Hydro-Electric Energy in Egypt" is, as its title suggests, a broad presentation on hydro power in general throughout Egypt.

For MHG, the paper points out that the new policy is to refocus attention on this source with concentration on the rural Fayoum and Delta region.

5. GUYANA

The statutory authority responsible for electricity generation, transmission and distribution has set-up two groups working on MHG and large hydro projects. Three nearterm projects are in the pipeline and MHG development is planned for much of the country utilizing local materials of construction and for equipment fabrication.

Experimental work on the local manufacture of crossflow turbines has been going on for some time and it is intended that Guyana should be self-reliant in all matters of design, machine building and construction for MHG plants as early as possible.

MHG is considered vital in the further development of rural saw milling for Guyana's vast timber resources, in fostering and cottage industry, improving irrigation and the facilitating of small mining outfits especially with respect to the production of gold.

6. INDIA

The Central Electricity Authority (CEA) which is an organ of the central Government bears overall co-ordination responsibility for MHG development throughout India. However, the state governments are responsible for the execution of MHG projects for which sanction must come from the CEA. CEA also maintains its scrutiny during the civil and electrical work, stabilization, commissioning, running and maintenance of such plants by the State Electricity Boards.

India is engaged in the indigenous manufacture of all electrical units in the 50 to 1,000 KW range. All designs and engineering are done locally. For turbines, one public sector enterprise is engaged in producing 5 to 15 MW units. Two private sector firms specialize in producing high head equipment, one of which concentrates on units of below 3 MW capacity.

MHG projects are usually integral to wider projects involving irrigation and are designed to promote the development of rural communities and areas. In the Himalayan region, MHG development is considered to be crucial to the development of remote villages and areas.

7. JAMAICA

All work on renewable energy sources is co-ordinated through the Ministry of Mining and Energy. Site investigation and prefeasibility studies are conducted by the Renewable Energy Development Division (REDD) of the Scientific Research Council and by the Petroleum Corporation of Jamaica (PETROJAM).

For larger hydro-sources work is contracted out to local and foreign private consultants from the developed countries. MHG project implementation is both PETROJAM and the Jamaica Public Service Company - the state's electric power company. Operation and maintenance of plants is now done by this utility but it is planned that some micro-and mini-hydro plants should be owned by private enterprise. These latter plants will be owned and operated by private concerns in conformity with the national standards.

There is no local manufacture of turbines at present. However, the REDD is engaged in development work toward this goal. Penstock materials, switchgear and some electric machinery are already in production for local and overseas consumption. The infrastructure for work on various types of pumps already exists widely and, with technical assistance, can be upgraded to handle the manufacture of prime movers for Jamaica and the wider Caribbean market.

MHG is, by Governmental policy, to reduce the almost total dependence on foreign fossil fuels for the generation of electricity and to increase the range of activities and the social welfare of rural communities by facilitating agro-industries, light industries, cottage industries, food preservation and tourism.

8. KENYA

The Government of Kenya is presently in a bilateral arrangement with the Government of Finland which directly provides for the development of MHG in Kenya and the necessary transfer of technology. In this initial stage, it is necessary to import turbines and other machinery but pipework and other metal work is done locally.

Rural development in Kenya is beset by the problems of vast distance between population centres. The MHG programme is specifically designed to provide power for market centres and other service centres such as hospitals, etc., in the rural areas.

9. LIBERIA

The Government of Liberia through the Liberia Electricity Corporation is now engaged in the implementation of mini-hydro schemes. Private consultants have so far performed the bulk of the work.

In this new programme, it is planned that the rural communities shall own and operate their MHG plants.

The paper does not mention local manufacturing capabilities but it is stressed that MHG development is being concentrated in rural communities with a view to improving village industries, agricultural productivity forestries and potable water supply. The MHG programme is also designed to assist in the literacy drive by providing lighting for night-time adult education classes and generally uplift the living standards of the rural poor.

10. MALAYSIA

The National Electricity Board of Malaysia are the implementors of the MHG programme for the country. The Board sets standards of engineering, construction, operation and maintenance for MHG plants. Within the Research Department of the Board is the Mini-Hydro Team (MHT) which consists of twelve (12) engineers and fifty-two (52) supporting staff divided into three sectors responsible for the surveying of sites and feasibility studies, design and construction of plants; and for electro-mechanical engineering. The MHT issues specifications, invites bidding extenders, does plant machinery selection and design assessments, negotiates and recommends the award of contracts by central Government, supervises contractor's activities and monitors MHG plants for the first year after commissioning. The Team also does the construction of some of its plants.

Since the early 1900's there have been many founderies in Malaysia. As a consequence, the foundation already exists for the local propagation of MHG machinery manufacturing technology. The endogenous production of all MHG equipment is seen as a medium to long-term goal.

The paper emphasizes the role of MHG (in integration with the supplying of potable and irrigation water), as a catalyst for rural development through the facilitation of modern services and cottage industries.

11. NEPAL

The Kingdom sees the national exploitation of its hydro-electric potential as the basis for development growth. MHG is perceived as a cornerstone of this policy especially as it relates to rural development. This is because the construction of MHG plants is relatively inexpensive and obviates the need for costly transmission line systems.

In the hilly and other rural areas, electric power produced from MHG plants is being and will be used for room heating, the provision of power to village bazars and Everest camps, and to foster village industries generally.

12. NORWAY

The co-ordination of hydro-electric power and water resource conservation and development is the responsibility of NVE (Norwegian Water Resources and Electricity Board). MHG has, for many years, been a significant component of power production for far flung rural localities in mainland Norway and on some of that country's islands. NVE also plans designs, constructs and operates about 30% of the country's total potential, but the majority of MHG plants are planned, financed, constructed, operated, maintained and owned by municipalities. The use of local consultants is widespread.

Norway has both the capability and capacity for all aspects of MHG work and equipment production. There are industry standards that facilitate Norwegian and other producers and buyers of electro-mechanical equipment.

The extent of electrification in Norway has been a major factor in that country's development - both urban and rural. MHG and small hydro have allowed the development of small industries, handicrafts, etc., and greatly enhanced agricultural activity. This effect has been at play since early in the 1900's.

13. PAPUA NEW GUINEA

The Papua-New Guinea Electricity Commission plans and co-ordinates the supply of electricity throughout the country. The Commission's Development and Operations Departments perform system planning and design, award contracts and manage the generation, distribution and transmission of power.

Much of the work so far performed with respect to MHG has been performed by private consultants. This pattern is expected to continue for a while yet. The present programme requires the replacement of rurally located diesel units in the range 600 to 3,000 KW by MHG plants wherever the hydrological conditions so warrant.

The paper does not mention local manufacture of MHG equipment but points to the development objectives for all areas of Papua New Guinea especially with respect to agriculture, village industries, the decentralization of economic activity and the promotion of small-scale craft-work and artisanship.

14. PERU

The "National Plan for Small Hydro-Electric Plants" recently promulgated through the Ministry of Energy and Mining of Peru, has articulated the policy of the National Government to MHG. The plan calls for the construction of fifty (50) projects in the period 1980-85 at an expenditure of US$ 10.5 million. This Ministry issued norms on MHG plant operation, manages, co-ordinates, promotes and controls the MHG programme. The Office of the Programme for Applied Technology (OPTA) performs a supervisory and co-ordinating function.

ELECTRO PERU, the national electric power company, is responsible for executing these MHG projects. This is done through five regional units.

Local manufacture of equipment is co-ordinated through the Ministry of Industry and Tourism, by means of the Institute of Industrial Technology Investigation and of Technical Normalization (ITINTEC), which develops or recommends methods of plant design and equipment manufacture. To aid in the dissemination process, ITINTEC has produced and published a handbook for designers and users of MHG. Private industry and the National Engineering University (UNI) through its professional theses programme are deeply involved in the application of the technology and in advanced training relevant to MHG. There is over twenty years of experience in the manufacture of turbines and other related machinery.

15. ROMANIA

This Report on the MHG programme of Romania is thorough in its presentation of up-to-date achievements and of the near- and long-term objectives up to the year 2000.

The Institute for Hydroelectrical Studies and Designs (ISPH) performs engineering designing for the Ministry of Electrical Power which is the Ministry responsible for planning, financing and implementation of MHG projects.

Standardization of all the main features such as civil works, electro-mechanical equipment and maintenance procedures has been achieved. The paper summarizes these standards. All manufacturing is done locally. Civil works planning is often undertaken by the Regional Water Works Management bodies (OGA's) while electro-mechanical engineering on such plants is conducted by the Regional Electrical Enterprises (IRE's).

From an existing twenty-four (24) installations and ten (10) plants under construction the overall MHG development plan directs that 600 plants be completed in the 1981 - 85 period and, thereafter, 1,800 plants in the fifteen ensuing years.

The approach to MHG lays stress on multipurpose utilization of the water resource wherever possible. Although some plants already operate in isolation and several of those planned will not be within the grid network, it is a matter of policy to link MHG plants, dispersed across the country, in the national network wherever practicable in order to entrance the stability of the electrical system.

16. THAILAND

His Majesty, The King, has officially supported the full development of the mini-hydro potential of Thailand. In the Master Plan for MHG the Government has set out the task of identifying this effort as a long-range package of projects to be implemented with assistance from China, Finland, Norway, Switzerland and the United Kingdom.

All potential sites are to be investigated; preliminary site surveys, prefeasibility studies on both an individual and overall basis are to be done; comparisons are to be made between MHG power and power supplied by diesel or from the natural gas fuelled grid supply; a priority listing of project components for feasibility and implementation is to be compiled with a view to making specific recommendations for project implementation within the one-year and longer five-yearly planning cycles.

17. TURKEY

Turkey has been one of the greater users of MHG in the world. At one time, there were over 40,000 generating units of this capacity dispersed across the country. Most work on MHG is now co-ordinated through the Bank of Provinces. There are four national bodies engaged in plant planning and a similar number engaged in the planning of networks. Three of the first group do detailed plant design and two of the latter groups are concerned with the design of lines.

For construction, there are two bodies engaged in plant construction and two on line construction.

However, there is no organized manufacturing of turbines. TEMSAN, the Turkish Electrical Machinery Industry, a government-owned agency, has begun the production of two types of machinery in the 50 to 20,000 KW range.

MHG has played a pivotal role in the development of rural Turkey. Present realities in Turkey dictate that many of these smaller plants should be phased out as it becomes feasible to tie more communities in the countryside to the national grid.

18. YUGOSLAVIA

It is the function of the central Government to co-ordinate all power source development on the federal level. In the reconstruction of the country following the physical destruction of the Second World War, small and mini-hydroelectric plants played a vital role alongside the development of larger sources.

As a consequence, there is much expertise available in Yugoslavia on MHG. There are six (6) organizations engaged in the design of MHG plants and equipment, among other things, while four manufacturing organizations produce equipment applicable to MHG.

In Yugoslavia small plant projects are usually one component of a multi-purpose scheme. Often this scheme involves some or all of the following features: irrigation, electrical power generation, improvement of the

water regime, the promotion of tourism and, often, the facilitation of the fisheries resource.

19. ZAMBIA

The development of MHG in Zambia is being financed by the Government through grants to the publicly owned Zambia Electricity Service Corporation (ZESC). The National Energy Council advises the relevant ministry on policy and on decisions related to programmes and priorities. ZESC now manages the MHG programme.

The possibility for local manufacture of turbines and alternators is at this time, remote.

The National Plan stresses rural agriculture and industry to minimize the imbalance between rural and urban areas and, very significantly, has the goal of reducing Zambia's dependence on copper exports. In about sixty (60) rural districts, the feasibility of MHG in conjunction with irrigation for the development of special crops and large scale agriculture is being studied. At present MHG sources supply just over 8,000 rural consumers. This is planned to rise steeply within the near - to medium-term.

V. REPORT ON SEMINAR-WORKSHOP/STUDY TOUR DISCUSSIONS

1. THEME I - Systems Approach to the Establishment of MHG Projects

Summary of Discussions

As a basis of the discussions at the Seminar-Workshop, UNIDO presented an Issue Paper 1/ which was intended to serve as an expanded agenda.

It was decided to have this Issue Paper as a main guide for the discussions. However, the wide spectrum of problems included were regarded as too comprehensive to be given sufficient attention on all points within the time available. Therefore, the discussions had to focus on selected problems of priority only.

Another prerequisite of the Seminar-Workshop was the statement and recommendations from the Kathmandu Seminar-Workshop in September 1979. The Kathmandu Declaration is attached as Annex V to this Report.

The plenary session covered Theme I of the Agenda: "Systems Approach to the Establishment of MHG Projects", which is a primary concern to the policy - and decision-makers who must accomplish, inter alia, the following tasks:

(a) Setting the objectives and priorities;
(b) Identification of present capacities and capabilities;
(c) Planning and programming of action;
(d) The socio-economic benefits of MHG stations.

These four subjects were regarded as the main topics to be dealt with by plenary.

A. Setting the Objectives and the Priorities

Nature of the problems

Five points were emphasized during the discussions as follows:

1. "The economies of scale". Initially low demand, therefore, electrification often not feasible at pre-planning stage:

1/ ID/WG.329/1

In rural areas the inital demand for electricity is usually very low, particularly in remote and isolated areas in many countries. This problem causes high costs per consumed unit of electricity, which again is effected by the problem of the "economies of scale".

2. Shortage of resources. Priority on food as basic needs instead of on electricity:
In many developing countries, particularly those with large population, shortage of food and other basic needs call for giving top priority to the production of food, and in certain cases, shortage of financial resources could become an obstacle for promoting the electrification programme of the country.

3. Migration from rural to urban areas:
It was pointed out that the migration of rural population was a common problem for many countries. While it would be difficult to convince people not to move to urban areas, it would attract the people to remain in their original surroundings if an appropriate environment could be provided. Accordingly the need for decentralization was emphasized.

4. Often conservative attitudes among decision-makers:
The decision-makers often have a conservative attitude towards how electrification is to be performed, and it seems to be rather difficult in many countries to break through this situation.

5. Lack of an overall and integrated rural development policy and planning including socio-economic/cultural aspects:
A common problem in many countries is how to convince the government and the decision-makers about the benefit of electricity, and in particular MHG, for the interest of the population in the rural areas. The necessity of bringing electrification into the rural development plans and programmes including due recognition of the socio-economic/cultural aspects was emphasized.

The lack of appropriate development planning was also pointed out, and in some cases the governments were not even able to provide information on the needs of the rural areas.

Recommendations

(a) It is highly recommended that the governments set-up a clear-cut policy on rural development planning, including the socio-economic/ cultural development aspects. An electrification plan should be integrated into the overall rural development planning, which could contribute to solving several problems to a certain degree, i.e., the possibility of creating rural centres which would counteract the "economies of scale" problem; counteract the urban migration problem; and possibly contribute in utilizing limited resources in a most beneficial way. The implementation of such plans should be the responsibility of the local authorities in close co-ordination and co-operation with the central government.

In this respect, it is recommended that the UNDP and UNIDO strengthen their efforts in supporting the activities of the developing countries with required expertise and resources.

(b) The electrification plans of the rural areas should be carried out step-by-step, in accordance with the growth of demand for electricity. The development of MHG would be a suitable means of achieving this objective, since it is by far the cheapest alternative in such areas where the initial demand is low. This fact should be expressedly noted and emphasized in the rural development plans.

(c) The need for irrigation is outstanding in many countries, especially form the view-point of the need to increase agricultural and food production. It is particularly emphasized that Mini- and Small-Hydro Power Projects should be planned in combination with irrigation, flood control etc., if and where this is possible. Such multi-purpose projects would better meet the expenses of the river development. Multi-purpose projects should be treated as an integral part of the overall socio-economic planning. The responsibilities should be carried by the central as well as the local authorities, possibly with appropriate support from UNDP and UNIDO.

(d) In connexion with the overall planning of rural development and electrification, it is recommended that the Chinese and the Philippine approaches be studied since it represents two different concepts which could be used as a guidance for other developing countries to develop their own plans (see Chapter III of this Report).

(e) It was strongly recommended that MHG projects be started on a pilot basis since this would provide information and experience for convincing the decision-makers about the feasibility of MHG projects and its contribution. For promoting such activities, the developing countries often require technical and economical guidance and support which could be an area for developed countries to offer assistance and contribute to the needs of the developing countries.

B. Identification of present capacities and capabilities

Nature of the problem

The discussions focussed on the following three problems:

1. The availability of funds for construction and operation:
   It was reconfirmed that quite often, the development of MHG has to rely heavily on financing through foreign loan. In this respect, it was recalled that MHG was a typical "capital formation" investment, where most of the expenses were connected with the construction, while the cost of operation was comparatively inexpensive. As compared to the initial costs of installing a diesel generating unit, the initial capital requirements for some MHG could be relatively large, however, savings would be made during the operation time through savings on the cost of oil.

2. The cost burden on rural consumers:
   The problem was raised that the people in rural villages have little or no possibilities for paying for the power they consume, and thus could hardly pay for the connexion to the grid. This problem seems to be in many developing countries.

3. Loans from international development banks/cost-benefit problems:

It was pointed out that the loan conditions of international development banks often had special requirements giving considerations to the rentability of the investments which were found to be a cause of concern for implementing some MHG projects. This was especially the case since the real benefits from electrification as part of an infrastructural development problem would be difficult to assess.

Recommendations

(a) It is quite obvious that the development of rural areas is the way of promoting self-reliance in most developing countries. Since electricity is of outstanding importance for such development, it is strongly recommended that if development is to continue, it is a necessity that due consideration be given to electrification programmes for the rural areas. Keeping in mind the international energy crisis, hydro-power as a renewable resource should be considered as a unique energy potential, and MHG as a suitable solution for the rural areas.

(b) It is recommended that an intensive sensitization campaign be carried out vis-à-vis the politicians and decision-makers in the developing countries, in the donor country as well as among the agencies and organizations of the UN system. This sh uld include a recommendation for the financing of MHG projects to be taken into the development programme and financial aid for the developing countries.

(c) When promoting the electrification and the MHG development in rural areas the central as well as local authorities should bear in mind that the cost burden put on the consumers be assessed according to the paying capabilities of the consumers, and it is desirable that this specific situation be taken note of and accepted by international development banks when considering such investments for rural development.

(d) It is further recommended that international development banks accept MHG as a basic factor for promoting rural development, and consequently, to consider the rentability requirements for MHG projects as an integrated part of rural development activities.

C. Planning and programming of action

Nature of problem

1. Insufficient knowledge of hydro-power potentials: lack of maps and hydrological data:
   The lack of maps and hydrological data is often hampering the possibilities for carrying out prefeasibility studies effectively and efficiently. Prefeasibility studies are the only way of getting needed knowledge of the power potentials in an area.

2. Insufficient capacity for planning, designing, construction and operation:
   Many developing countries still lack required technical capacities and capabilities, mainly due to the educational system as well as insufficient training and experience.

3. Organization of MHG development:
   Many developing countries still lack or have inappropriate institutional set-ups for implementing MHG programmes.

4. Legal procedures:
   There are two aspects concerned with the legal problem, namely,
   (a) the water rights (ownership of the river); and
   (b) legal procedures regarding the approval of plants.

5. Lack of planning and design criteria:
   In most developing countries there seems to be a lack of criteria for the planning and the designing of MHG projects, which has its root in the problem of insufficient technological capabilities.

6. Too many standards:
   The manufacturers of turbines and other MHG equipment have standard designs. The main problem for developing countries is that caused by the plural number of technical assistance sources – there are too many standards of equipment which result in difficulties in repair, maintenance and management of spare parts.

Recommendations

a. It is recommended that after formulating the strategies and policies of hydro-power development, hydrological measurements and investigations be initiated starting from those areas where the largest hydro-power potentials exist. In the case of MHG, the preparation of topographical maps are regarded as too big an investment for merely preparing a prefeasibility study. In case proper maps do not exist, aerial surveys could be recommended for identifying possible MHG sites. Field visits and measurements would be necessary for further in-depth investigation.

At the initial stage of planning, it is strongly recommended that a number of prefeasibility studies be carried out in order to substantiate the strategies and policies of hydro development, and with the aim of obtaining an overall view of the hydro potentials in the country. These studies could be carried out with the assistance and support of donor countries, preferably with specific emphasis on the on-the-job training effects.

b. In view of the growing importance of hydro-power and especially MHG, it is recommended that developing countries initiate and/or intensify the national system of education and training of technical personnel required at different levels.

It is further recommended that UNDP, UNIDO and other U.N. agencies give special attention to this problem and formulate and implement appropriate programmes of education and training of MHG technicians.

c. In order to plan and implement MHG projects, developing countries should create the necessary institutional infrastructure to support the required activities. In this respect, it is recommended that the responsibility for developing MHG projects be decentralized to the regional and district authorities provided that appropriate bodies are created for performing the tasks.

It is further recommended that a central body be given the responsibility of co-ordinating all activities on MHG development at the national level,

which could also serve as a focal point of contacts between the local bodies and the various technical and financial organizations and institutions. Although there are a number of outstanding experiences in many developed as well as developing countries on organizational matters, it is still strongly recommended that each developing country should adopt its own organizational system in a flexible manner that suits the country's existing circumstances. There is no one single model that can be recommended for all.

It is further recommended that UNDP, UNIDO and other U.N. agencies as well as donor countries should include a programme of assistance in promoting the development of MHG projects.

d. The efforts being made on the part of UNIDO to develop standard specifications for MHG equipment and for MHG civil-engineering works, has been duly taken note of. In this respect, it is recommended that the standardization of specifications of MHG should not be considered in too strict a manner, since this would seriously hamper the technological development and individual savings on different projects.

D/ The Socio-Economic Benefits of Mini-Hydro Generation Stations

Mini-Hydro Generation is, in a real sense, for the rural areas. It is not uncommon to find that villages close to large hydro stations are not being vested with the benefits of electrical energy. This is because the cost of conversion of the high voltage generated to domestic requirement is very high and the technical requirements rather complicated. As such, the introduction of Mini Hydro Generation Stations in the rural areas with abundant water energy potential may contribute considerably to the uplifting of the socio-economic standards of the areas. There may also be a reduction in rural-urban migration with the coming of rural development, as the presence of electricity creates small industries and at the same time offers job opportunities to the rural population.

The Mini Hydro Generation Stations can also be on existing irrigation dams, or be entirely new schemes. There is no removal of water from existing rivers or streams as most of the Mini Hydro Generation Stations are of the run-of-the-river type. If ever storage is required, the amount of storage is normally of 4 hours or 12 hours duration and therefore does not contribute to the reduction of irrigation requirements, if any. Also the risk of bursting dams is non-existent.

The benefits of Mini Hydro Generation apart from the production of electricity can be several. As an example, electricity in the home improves the comfort and education standards, perhaps increase the general knowledge of the rural population through the mass media of radio and television.

The contribution of Mini Hydro Generation to rural development is rather wide and apart from the above can be as follows:

1) Industries

The existence of electricity in the rural area can be a means of moving cottage and artisan industries to the rural area and this would, in fact, reduce the rural migration as mentioned earlier. The industries that can participate in the use of electrical energy from the Mini Hydro Generation Stations includes small fertilizer industries, workshops and saw mills which will definitely augment the income of the rural population.

2) Agro-Industries

Agro-industries would definitely gain from the electric energy supplied by the Mini Hydro Generation Stations in terms of processing industries for agricultural products as well as refrigeration. Energy for this type of industry, except for refrigeration, should be used during the day-time when the rural population works in the fields and as such the maximum utilization of the energy is realized.

3) Irrigation

The water available from the tail-race of the high and medium head Mini Hydro Generation Station is normally of sufficient head and is available for diversion into irrigation systems which would otherwise require a certain amount of energy for pumping to areas where the water is required. Another aspect of irrigation is the pumping of water from canals onto an agricultural area. Release of water from dams or irrigation systems can generate sufficient amounts of electrical energy which can then be conducted through transmission lines to the pumping house thereby eliminating the need for diesel-fuelled water pumps.

4) Drinking Water

At the weirs or mini dams, it is usual to make provisions for a small pipe to be fitted for drinking water purposes. The rural population close to the Mini Hydro Generation Stations then have sufficiently untreated drinking water made available to them. For areas where deep wells exist, the electrical energy which is produced in excess during the day may be used to pump water into large tanks with pipes for distribution to rural households.

5) Fish Farming

The building of weirs or mini dams for a Mini Hydro Generation Station may be good enough to create ponds for fish farming and sufficient facilities can be provided for spawning of fish of a migratory nature.

6) Health

The establishment of clinics with proper facilities only available through the existence of electricity, e.g. small operating rooms with proper lighting, refrigeration for storage of medicine, compressors, etc., can contribute greatly to the health of the rural population.

7) Recreation

With the coming of Mini Hydro Generation Stations to the rural areas there will be an opening in areas suitable for recreation. Places which were once isolated and void of facilities can now be an attraction to tourists.

8) Conservation of Fuel

In the light of increasing fuel prices the establishment of MHG cuts down the utilization of fuel in the rural areas which would otherwise be costly for the development of the area. The transport of diesel fuel itself is costly and cases of prolification are not unusual. Economic evaluation of Mini Hydro Generation as against diesel fuel in electricity generation have indicated the advantages of Mini Hydro Generation.

9) Flood prevention

In certain instances where cascaded Mini Hydro Generation Stations have been established for both electricity generation and irrigation, there has been a considerable effect on the control of flooding.

In electric energy generation, it is always wise to establish a demand prior to the extension of long transmission lines to an area. The created demand which may be well established after the ongoing of Mini Hydro Generation may make it more economic to extend the transmission line from the grid to the demand area and thus establish better security of supply by virtue of a dual source. When this stage of progress has been achieved the extra energy available from the Mini Hydro Generation Station (output of the Station may be increased by adding extra turbines), can be transmitted to the grid and further justify the Mini Hydro scheme. The total energy from the stream at the power station site is then fully utilized.

SCORE SHEET OF SOCIO-ECONOMIC BENEFITS
OF PROPOSED MHG INSTALLATION

	3	2	1	0	-1	-2	-3
1 Industries 2 Agro-industries 3 Irrigation 4 Drinking Water 5 Fish Farming 6 Health 7 Recreation 8 Fuel Conservation 9 Flood Prevention 10 Tourism							
TOTAL SCORE							
11 Number of Beneficiaries							

2 THEME II - Local Manufacture and Construction

Specific Technical and Economic Aspects of MHG (Group I)

Summary of Discussions

The discussions of this Group were characterized by an exceptionally high-level participation by its various members. The following is a list of the issues dealt with in the order in which they were examined:

1. Technical and economic aspects of initiating the manufacturing of turbines, especially their runners, in developing countries. Various cross-flow turbines such as the Mitchell-Banki and Turgo devices were considered in the light of their ease of fabrication, cost, efficiencies and durability under operational conditions.

2. The Chinese participants presented an overview of and insights into their organization, methodology and developing MHG plants and equipment. Based on this presentation, various participants outlined their procedures and described their manufacturing and construction approaches.

3. The need for laboratory testing of runner models was next highlighted. Of the developing countries present, China, Peru, Malaysia and Guyana, gave descriptions of their ongoing efforts in laboratory testing and/or overall research and development.

4. The issue of the cost of automatic control equipment as a component of overall MHG costs was examined in considerable detail. Specific note was taken of the new developments in frequency control by "electronic load dumping on ballast loads" involving constant loading on units in the range below 500 KW. Participants from two countries described their work in this field and drew attention to parallel efforts elsewhere and to novel products on the market for this type of control. Much discussion ensued on the system operating characteristics under this kind of automatic control regime.

Arising out of this discussion, experiences were exchanged on the problems and methods of maintaining synchronization and stability on networks comprised of small equivalent units operating on minigrids isolated from main national grids.

5. A new, efficient and low-cost turbine called the "Lift Translator" was described by one participant. This machine was reported to be operatable in the head range 0.5 to 20 meters, is relatively easy to fabricate (there are patents issued on it) and is said to be suitable

for the range of unit capacities 3.5 to 4,000 KW.

6. The Group examined various methods of training in MHG technology, ranging from the training of operators, plant engineers and maintenance crews to the training of programme managers. Several participants led the discussion and set out various approaches to this problem based upon their national experiences.

7. The operation of the Filipino Electric Cooperatives was examined in considerable details.

8. In connection with the necessity of promoting the flow and exchange of information on technologies and equipment for MHG application, the Industrial and Technological Information Bank (INTIB), established by UNIDO, was discussed, and considered to be a suitable mechanism to serve the requirements of the developing countries.

9. Discussions were carried out in connection with the desirability of establishing an international society promoting the technology of MHG and linking technologists and groupings of persons involved in this destinct field. In this respect the initiatives by UNIDO were considered to be highly welcome.

Recommendations

1. Note was taken of UNIDO's welcome initiatives in the drafting of standards for MHG equipment, civil construction work, etc. In continuance of this, it is recommended that UNIDO convene a meeting of international experts, manufacturers, and other relevant individuals, organizations, and agencies, to set-up international standards on turbines and accessories, their ratings and sizes, test procedures, norms of construction and agreed terminology with respect to MHG.

2. Prefeasibility and feasibility studies on MHG projects should have a methodology appropriately developed and unique to MHG, and distinct from the methods of evaluating larger hydroelectric projects, in the light of the fact that the technologies are different.

3. It is strongly recommended that whenever and wherever possible, local consultants and engineers should be utilized to the maximum.

4. Bearing in mind the significant differences in the technological approaches to MHG and to other hydroelectric generation of power, it is strongly recommended that the technical groups working on MHG be distinctly identified from those technical groups dealing with hydro-power generation.

5. The meeting recommends the following definitions for generating unit sizes for MHG:

a. Micro-hydro-electric generating units are units with a rated capacity of one hundred (100) kilowatts and below; and

b. Mini-hydro-electric generating units are units with a rated capacity in the range one hundred and one (101) and one thousand (1,000) kilowatts.

6. The meeting recommends the establishment of:

a. a Center or Centres of Excellence in training relevant to MHG technology

b. the establishment of a Centre or Centres of Excellence in Research and Development relevant to MHG technology;

c. the establishment of a Centre or Centres of Excellence to provide technical and other information relevant to MHG.

It is further recommended that UNIDO give due consideration to the eventual combination of the activities in training, R and D, and information gathering and dissemination into single institution at the global, regional and sub-regional levels as appropriate.

7. With a view to reducing the cost of MHG plants and machinery, it is strongly recommended that increased efforts on research be directed towards the development of reliable, inexpensive devices and techniques for governing and/or frequency control of MHG units.

8. In order to promote the interchange of information on MHG, UNIDO is requested to set-up, possibly as an activity of INTIB, an MHG Newsletter, as well as the publication of technical documents and reference material, specifically concerned with MHG.

9. In order to promote the necessary and desirable exploitation of resources for MHG, UNIDO is requested to compile and desseminate on a regular basis, inventories of institutions and expertise relevant to MHG.

10. In view of the significance which MHG has in the promotion of rural industrial development, it is recommended that UNIDO give intensive consideration to initiating the establishment of an international professional society or association which will devote itself to the development of MHG technology and promotion of international co-operation in this field.

11. It is recommended that each developing country should form its own technical team which is to be responsible for all matters relevant to MHG development. The activities of such MHG teams should comprise of, but not limited to, the following: surveying, hydrology, geology, civil engineering, electro-mechanical engineering, economic studies, etc., with the purpose of conducting all phases of project planning, programming and implementation, i.e. identification and selection of sites, prefeasibility studies, feasibility studies, designing and final drawings, supervision of construction, commissioning and/or operation, including repair and maintenance.

UNIDO should organize a programme of assistance in setting-up such teams by providing training of the cadres in appropriate ways and in suitable institutions, with a view to strengthening capability and fostering complete national or regional self-reliance in MHG technology, in the shortest possible time.

3. Theme III - A) MHG for Industry
B) Cost Reduction Scheme in MHG Installations (GROUP II)

Summary of Discussions

A. MHG for Industry

In the last UNIDO Seminar-Workshop at Kathmandu it was recommended that it is imperative that developing countries, while planning and implementing programmes for establishing MHG, should pay ample attention to the problem of establishing industries in the neighbourhood of their stations. The discussions were characterized by a consensus that industries, especially of the small-scale, are essential for utilizing the energy of MHG.
The manyfold benefits derived from MHG are summarized below:

1. Irrigation

This is one of the prime considerations in many of the countries such as China, India, Egypt, Thailand, etc., for planning of the mini-hydro stations. The power generated is also utilized for agricultural purposes, such as pumping, drainage, etc.

2. Industries:

As a large portion of the energy is still available industries do and can utilize it. The various industries for which MHG is utilized are given below:

2.1 Utilization in China

(i) small-scale workshops mainly for repair purposes
(ii) cement factories
(iii) fertilizer factories
(iv) timber/saw-mills
(v) rice mills
(vi) flour mills
(vii) chemical factories - These utilize surplus energy available in three seasons of the year and which have a production of over 27,000 tonnes per annum for production of:
a) ammonium solution, b) tetra-hydrochromate,
c) ingredients of vitamine B + C, etc.

2.2 Utilization in other countries:

(i) Cottage industries, workshops for agricultural appliances, basket making, etc.
(ii) Saw mills
(iii) Rice mills
(iv) Tea-coffee gardens
(v) Food processing plants
(vi) Sea-food preservation plants
(vii) Ginning machines
(viii) Oil-seed extraction plants
(ix) Fertilizer plants
(x) Rubber plantation

2.3 Domestic and other uses:

(i) Rural electrification
(ii) Rural hospitals/health centres
(iii) Educational institutions
(iv) Training centres
(v) Domestic use - lighting, cooking, ventilation, etc.
(vi) Breeding of live-stock

2.4 Quite a few countries want to establish MHG specifically to substitute for their present diesel generation to save on the foreign exchange bill for oil imports and conserve this valuable commodity.

2.5 In most of the developing countries the energy is to be utilized in the rural areas. This should help to prevent migration to the urban localities.

B. Cost Reduction Scheme in MHG Industries

The last Seminar outlined broad measures for reducing the costs of the MHG. Valuable information was gathered from the Chinese experience in this field. This is briefly summarized below:

1. Multipurpose utilization - MHG is a part of county prefecture and province level planning. The benefits from MHG include irrigation, flood prevention, navigation locks, log passing, development of fisheries. Some portion of the cost of the MHG is allocated to these benefits as a result of which the cost of pure generation is very much reduced. Their present cost are of the order of 1000 - 1300 Yuan/KW.

2. Economy in planning, design - The counties have their own expert teams who carry out reconnaissance work, preliminary designs, detailed construction drawings, erection and commissioning. They already have contour maps of the scale 1:50,000. They also possess necessary skilled/semi-skilled workers and the labour force for carrying out construction and erection activities.

3. Economy in civil works - Civil works constitute about 45 to 60% of the total cost of MHG. Site selection is done in such a way that structures such as dams, water conduit systems, powerhouse buildings required, are set up as simply as possible. Though designed individually, civil design criteria have been established and this is applied as far as possible. Structures for MHG plants of capacities less than 100 KW are standardized. Extensive use of local materials is being made. The rocks found in the neighbourhood are used for masonry work. For penstocks use is being made of prestressed concrete pipes, which are used up to heads of 160m. In order to save on transport costs pipes with a diameter larger than 3300mm are cast on site. Also the infrastructural facilities are made as simple as possible.

4. Economy in manufacture of equipment - China has already developed 86 designs of generating sets. The new MHG plant utilize some of these machines, thus giving scope for mass production and effecting saving. This may mean slight sacrifices in the efficiency of the hydraulic equipment, but it is not considered so important as long as it can save the capital cost and reduce the time of manufacture and construction of the project. Use of pressure relief valve has been developed which helps to eliminate the surge tank and reduce pressures in the hydraulic elements and thus effecting saving in the total material costs.

5. Adoption of R+D effort - Research and development activities are also undertaken simultaneously which help in bringing out economies in materials and designs.

Recommendations

1. The Group stressed that UNIDO should encourage and promote further MHG establishments for the development of rural industries in the developing countries, such as:

   Agro-industry
   Cottage-industry
   Forest-industry

2. Maximum utilization of surplus power of MHG due to seasonal variation of water availability for other industry such as pharmaceuticals, chemical and metal mechanics, etc. should be encouraged to other developing countries.

3. The Group recommended that UNIDO should compile and analyse reduction schemes of MHG establishments of the developing countries, based on the Chinese experiences.

4. MHG planning should be a part of national development plans for rural areas.

5. Appraisal of MHG schemes should not always be considered along the usual lines as for other power generation projects. The criteria for evaluating these projects should, where appropriate, be different from purely commercial ones since MHG can have multi-purpose utilization.

6. The Group felt that UNIDO should develop a methodology of proper evaluation prior to the carrying out of MHG projects, which should include socio-economic aspects.

VI. REPORTS ON STUDY TOUR/VISITS[1/]

1. People's Republic of China

Eight (8) mini-hydro sites and two (2) factories were visited in the Jinhua and Jinyun counties located south and west of Hangzhou. The visits covered cascade development of three (3) small river basins. In each case, hydro-stations were erected to capture most of the potential energy available in the mainstreams, that is, aggregate heads of the hydro-power plants were close to the total drop in the river basin. The river basins were the Shuanlong and Meixi in Jinhua county and the Panxi in Jinyun county.

The visited power plants ranged from 12KW to 2400KW with heads ranging from 3.5m to 220m. The power plants were as new as 1978 and as old as 1955, thus, there was great diversity and useful in enabling the participants to obtain a general understanding of the range of approaches used in China. However, it is hard to be specific as to what was learned that should be relevant to the respective programmes of the Group members. The tour is preliminary valuable in a familiarization sense.

China has undertaken massive efforts to provide the maximum possible irrigation water to its rural areas. This is demanded and made economical by its very high population density and by its large number of underemployed rural people. A large percentage of the costs of developing these irrigation systems have been borne by the rural population. Because opportunity costs for rural labor and materials are quite low, these irrigation works appear to have low economic costs.

The small hydro programme has been an add-on to the irrigation programme. Because the water is collected and canalized by the irrigation system, it becomes relatively economical to install the hydro-electric units. The electricity is used, in the first instance, to support the irrigation system, by pumping, where it is needed. Secondly, the electricity is for rural industries and finally, for home consumption. The latter use is extremely modest (one figure cited was 40KWh per year, per household) and rates are quite high (around US$ 0.14 to US$ 0.16 KWh). Rates for industrial and agricultural sales are about 40%, to 50% less than the household rate. Because irrigation is the controlling factor in water use, perhaps for other reasons, the power plant load factors appear to be low (2000-3000 hours per year).

1/ Detailed reports issued as Addendum to this Report.

For most of the participants representing countries just starting their MHG efforts, the Chinese approach of full cascade development is not likely to provide an appropriate model. This is true for several reasons but perhaps the most salient is that a country just starting will probably wish to concentrate its activities on the most economically attractive possible sites. Most likely, this would mean for several years, only very partial development of the potential head on any one stream. However, the civil works and development approach on some of the individual visited stations certainly provide models which will give ideas to the participants.

Obviously, there is a very large capability in China to manufacture mini-hydro equipment. At the same time, the field visit demonstrated that there is an apparent rather large variance in sophistication and perhaps reliability between manufacturers. Some equipment appeared very much better made and designed than did others. The Group, however, received little information on specific costs, reliability and on efficiency of the equipment. There is much to be gained from Chinese experience in the equipment area; but it would appear that the user should be quite selective and careful in seeking to apply directly for their own use.

The better equipment, at least on a visual basis, appeared quite well designed and made.

On the civil works side, the impression on the Chinese approach (it must remain as an impression in the absence of better analysis) obtained was that there was an insufficient economic concern in civil works design and probably also in site selection. It is speculated that the local leadership may be motivated to have impressive statistical records in terms of such parameters as largest fraction of potential head captured, KW of installed capacity, meters of tunnel, etc.
If this speculation is at least partly correct, this factor combined with the absence of a rigorous cost efficiency consideration in the design stage could account for what was an apparently common overdesign and occasional apparently non-economic plant development.

Generally, for example, penstocks even for modest heads were of steel. There was a 12KW plant placed immediately adjacent to a 500KW plant. Tunneling was used rather lavishly to, from appearances, capture the lost meter of potential head. Power houses quite massive.

This observation is less a criticism of the Chinese approach (overall, the accomplishments of the Chinese small hydro programme are enormous and impressive) than a caution against too rigid a copying of the Chinese model. The approaches must be adapted to the needs and circumstances of individual countries and it may be that most countries sending participants are going to wish to develop more appropriate their contexts, costs criteria in civil works design.

The factory tours were useful in providing an overview as to the general manufacturing capability in the People's Republic of China. The factories visited had a wide range of equipment and manufactured a very wide range of hydraulic and electrical equipment. The rather subjective impressions obtained in the factories are of use in understanding what is possible in Chinese production. Unfortunately, the time was rather too limited to obtain enough details.

There were some issues raised on the Study Tour about the experiences of China which questions could not be answered due to the brief time available:

a. From a view of minimizing generation costs, was there a general tendency for the civil works to be overdesigned?
b. Why were steel penstocks used so extensively (instead of the lower cost reinforced concrete pipe alternative)?
c. What is the precise type of economic criterion used by China? Is it an overriding criterion and can this approach be applied elsewhere?
d. What is the rationale for attempting to develop close to 100% of the potential head on a given cascade?
e. What was the rationale for the extensive tunneling accomplished on the Panxi cascade development?

2. Republic of the Philippines

In spite of the limited time available, arrangements were made for the Seminar-Workshop/Study Tour to visit one MHG site, one geo-thermal plant, a potential dendro-thermal plant site and the Albay Electric Co-operative Inc., as well as local MHG equipment manufacturers.

The MHG plant at the Cuyaoyao, Camarines Sur IV, which was constructed within a record speed of four-months and a designed capacity of 350 KW, was purely a result of joint collaboration of the technical circles in the Philippines in this field, and the project starting from the conceptual and practical planning and designing of the power system, equipment manufacturing, installation, civil works and up to the management and operation of the Station was implemented by local personnal only, under the policy guidance, support and co-ordination of the National Electrification Administration (NEA). It is also significant in that it was the first MHG project where the mechanical and electrical components were completely manufactured and installed by domestic technology and enterprises, namely, the AG+P (Atlantic Gulf and Pacific) and PHILELEC (Philippine Electric Corporation). The equipment include two turbine units, vertical Francis type each with a rated capacity of 175 KW, some 250 M long of steel penstock, as well as corresponding electrical components. The Cuyaoyao Station will be capable of meeting the needs of some 3,000 country-side families and will save the country of some 6,000 barrels of imported oil a year. It was reported that whereas a diesel generating plant would cost ₱ 0.70 to generate KWH of electricity, the MHG would cost only ₱ 0.28 to generate the same amount of power. Needless to say, the MHG has a 50 years life-span and is powered by an virtually inexhaustible energy resources, which proves to be another positive edge over diesel generation.

The Seminar-Workshop/Study Tour Group was honoured by the fact that commemorating the occasion, the Cuyaoyao Station was officially put into operation during the visit.

One of the potential renewable sources of energy, namely, geo-thermal energy, is being practised in the Philippines through the use of steam to spin the turbine blades connected to generators. The Group visited the Tiwi Geo-thermal Power Plant in the vicinity of Legaspi City, which has a capacity of 110 MW and which had its trial operation in January 1979. In view of the successful records, other areas in the country with geo-thermal potentials are presently under study. The geo-thermal development in the Philippines, more practically in Luzon, with its rich resources, is very promising and further studies are being undertaken to utilize it substantially to supplement requirements of the Luzon grid.

The local capabilities to manufacture MHG equipment in the Philippines, is still limited. A new step, however, is being undertaken as demonstrated by a signing of a co-operation agreement between the Philippines and the P.R. China. The AG+P is acquiring technologies to manufacture MHG turbines under licence from China, whereas PHILELEC has initiated activities for the production of power transformer, distribution transformer, switchgears and other electrical appliances to meet the requirements of the vast MHG programme drawn up by the NEA. The visit to the two equipment manufacturing plants of PHILELEC and AG+P was very interesting, particularly from the view point that they had entered into technical co-operation agreements with the Hangzhou Machine Tools Work and the Hangzhou Electrical Equipment Works visited by the Seminar-Workshop/Study Tour Group in P.R. China.

The dendro-thermal plant, presently being promoted as a pilot project by NEA, will be a three-MW wood-fired steam power plant. Experiments are being undertaken for the supply of wood from a tree plantation of 1,000 hectare of Ipil-Ipil tree which will be sufficient to provide electricity for 15,000 rural houses. This tree was considered most suitable, as within three years' time it grows to a size that would provide effective raw material. An Ipil-Ipil plantation site was visited.

One observation noted was the active involvement of the Electric Co-operatives established under the guidance of NEA. The members of the Electric Co-operatives are not only participating financially in the form of membership fees but substantially in various service areas. Some 120 co-operatives have been established so far, and in order to encourage effective contributions, the co-operatives are being encouraged to conduct seminars and programmes for education of their members, in order that they may undertake their duties and responsibilities properly. According to the requirements, NEA provides guidance, support and assistance in this respect. It was recognized that the co-operatives were not necessarily composed of engineers or technicians with electrical background, and it was felt that such local participation was an important element for successful activities in MHG promotion including the use and application of the generated power.

VII. International Technical Co-operation in Mini-Hydro Generation

Summary of discussions

a. Mini-Hydro Power Stations - Manual for Decision-Makers

The representative of UNIDO explained the activities undertaken by UNIDO in the preparation of an MHG Manual, with the financial support of the Swedish International Development Agency (SIDA), and with the collaboration of the Organization for Latin American Energy Development (OLADE). A skeleton outline of the Manual was presented with the further clarification that the Manual was not to cover too many technical details. The main objective is to provide a general outline of considerations to be given by decision-makers at the top and medium levels. It was further explained that the first edition of the Manual was not expected to be perfect, that it would be subject to regular modifications and improvements, based upon suggestions from the users. The first draft of the Manual was expected to be available by the end of 1980 or the beginning of 1981 and the publication is set for in Spring 1981.

b. Establishment of a Regional/Interregional Research Development and Training Centre

Activities undertaken since May 1980 on this matter were explained by the representatives of the People's Republic of China and UNIDO. The project document prepared by the Chinese authorities was described in which the four main objectives were (a) scientific research and technical development, (b) exchange of technical information, (c) technical training, and (d) technical guidance, all in the field of MHG. Plans have been drawn up and preparatory actions initiated to establish the Centre at Hangzhou, the construction work and part of the activities are expected to be started in 1981. It was further explained that in the initial stages the major activities would be mainly for the ASEAN and Pacific regions, and participants would be given the opportunity of working on the planning, designing, construction, installation, operation and management of small-hydro power stations in their own countries.

The UNIDO representative supplemented the explanations by referring to the concept of his Organization in creating Centres of Excellence in selected developing countries, which could function as sub-regional, regional and global focal points of international co-operation on the selected subject and industrial sectors. He expressed his feeling that the Centre in China could be one of a series of similar centres in other regions of the world, which all together could form the backbone of a global network in the field of MHG. The participants made various comments relating to the anticipated role and functions of such regional centres, particularly in the field of training, information exchange, technology adaptation and publication, as well as its being a co-ordinating point for promoting international co-operation. In general, the participants welcomed the initiative taken by UNIDO/UNDP and the Government of the People's Republic of China, and while requesting that the project be duly followed up to put the project into operation as early as possible, urged that UNIDO take similar steps in other regions for the benefit of those countries that are not in the ASEAN/Pacific region.

c. Information Exchange on MHG - INTIB

In connexion with the need to increase the flow of information on MHG at the various stages of project planning, programming, implementation, operation and management, the representative of UNIDO explained about the Industrial and Technological Information Bank (INTIB), which was in the position of acting as a focal point for exchange of information. He referred to the specific characteristic of INTIB, which is not to be a mere computerized data bank, but be more oriented towards servicing the needs of government organizations and institutions, depending largely upon the interlinking and networking with other existing information systems throughout the world. He expressed his feelings that each country should create an information centre of their own at the national level, which could be interlinked with the activities of INTIB. The head of the delegation of the Philippines responded immediately by nominating the department of Philippine Rural Electrification of NEA as the contact point of information on MHG in his country.

In complimenting such activities of INTIB, the participants expressed their strong interest in UNIDO initiating activities for:

- a periodic publication "MHG Newsletter"
- an MHG bibliography, possibly with abstracts, which information could be disseminated in the MHG Newsletter or other suitable means.

d. UNIDO's technical assistance programmes

UNIDO's representative explained the activities of UNIDO's technical assistance programme in general and outlined the procedures to be followed in submitting official requests through proper channels. This technical assistance includes activities such as carrying out of prefeasibility and feasibility studies, preparatory missions, project establishment and execution and technical information dissemination, etc., as well as in formulating and executing training programmes for the strengthening of man-power capabilities required in the implementation of MHG programmes.

ANNEX I

LIST OF PARTICIPANTS

Bangladesh

Mr. AKHTAR Ali
Deputy Secretary, Ministry of Power and Water Resources
Covernment of Bangladesh Secretariat, Dacca-2

Mr. MAHMOOD Syed T.S.
Director, Project Planning, Power Development Board
Wapda Building, Motijheel, Dacca-2

Burma

Mr. RALLIAN SANG B.
Assistant Engineer, Electric Power Corporation
197-199 Lower Kemmendine Road, Rangoon

Cameroon

Mr. MVONDO-OWOUNDI Gaston
Directeur de l'Energie et de l'Eau
Ministere des Mines et de l'Energie, Yaounde

China, P.R.

Mr. HSU HSIA-SHIH
Director of Bureau of Water Conservancy
Zhejian Province, Hangzhou

Mr. BAI Lin
Chief of Division of Hydro-Power, Ministry of Water
Conservancy, P.O. Box 2906, Beijing

Mr. DENG Bingli
Deputy Director, Bureau of Farmland Water Conservancy
Ministry of Water Conservancy, P.O. Box 2906, Beijing

Mr. GUO Ruizhang
Associate Chief Engineer, Shanghai Water Conservancy
Bureau, Tongren Road, Shanghai

Mr. LI Chengshi
Chief, Division of Foreign Liaison, Ministry of Water
Conservancy, P.O. Box 2906, Beijing

Mr. LIANG Jian
Deputy Director of Foreign Affairs, Ministry of Water
Conservancy, Beigon Road, P.O. Box 2906, Beijing

Ms. TSOU Youlan
Interpreter in Ministry of Water Conservancy
P.O. Box 2906, Beijing

Mr. ZHANG Wenzheng
Engineer, Research Institute of Water Conservancy and
Hydropower, P.O. Box 366, Beijing

Mr. ZHU Xiaszhang
Associate Chief Engineer, Ministry of Water Conservancy
P.O. Box 2906, Beijing

Egypt	Mr. ATALLAH Abdel Hakam Ahmed Vice President, Qattara, Hydro-electric Renewable Energy Authority, P.O. Box 304, Cairo
Ethiopia	Mr. HAILU G. Mariam Senior Engineer in Planning and Studies Department Ethiopian Electric Authority, P.O. Box 1233, Addis Ababa
Guyana	Mr. O'LALL Joseph Nathaniel Specialist Engineer Electrical/Mechanical, Hydropower Division, Ministry of Energy and Natural Resources Brickdam, Georgetown
India	Mr. DEODAS Tanaji Apparao Director, Central Electricity Authority Ministry of Energy, New Delhi 110022
Jamaica	Mr. MINOTT Dennis Audley Head, Renewable Energy Development Division; and Regional Co-ordinator, Caribbean Alternative Energy Program, Scientific Research Council, Box 350, Kingston
Kenya	Mr. WAGANA Gerald Mukuha Deputy Chief Electrical Engineer, Electrical Department Ministry of Works, P.O. Box 41191, Nairobi
Liberia	Mr. SONII Baseeru M. Generation Manager, Liberia Electricity Corporation P.O. Box 165, Monrovia
Malaysia	Mr. HOESNI Bin Nasaruddin Senior Research and Development Engineer National Electricity Board, P.O. Box 1003, Kuala Lumpur
Nepal	Mr. CHATURVEDI Shatrughna Nath Superintending Engineer, Department of Electricity Darbar Marg, Kathmandu
Norway	Mr. GUNNES Ola Director, Water Power Research Division, Norwegian Water Resources and Electricity Board, Middelthunsgate 29, Oslo 3, P.O. Box 5091 MAJ
Papua New Guinea	Mr. MANIKUAIE Gabriel Valentine Acting Chief Engineer Generation, Papua New Guinea Electricity Commission, P.O. Box 1105, Boroko
Peru	Mr. COZ Andres Federico Lecturer at the National University of Engineering (U.N.I.), P.O. Box 1301, Lima

Philippines	Mr. DUMOL Pedro G. Administrator, National Electrification Administration 1050 Quezon Avenue, Quezon City
	Ms. SANTOS Zenaida Adriano Deputy Administrator for Engineering and Materials National Electrification Administration 1050 Quezon Avenue, Quezon City
	Mr. DENTON Frank Hardy Consultant, National Electrification Administration 1050 Quezon Avenue, Quezon City
	Mr. FAVOREAL, Percival F. General Manager, Camarines Sur IV Electric Coop.Inc. Tigaon, Camarines Sur IV
	Mr. GUANZON Jovencio A. Cost Engineer, National Electrification Administration 1050 Quezon Avenue, Quezon City
	Mr. SEVILLA Reynaldo V. Director for Engineering, National Electrification Administration, 1050 Quezon Avenue, Quezon City
Romania	Mr. PARHOTI, Eugen Chief Engineer, Institute for Hydroelectrical Studies and Designs, 2P-Republicii Bulevard, Bucharest
Sri Lanka	Mr. THILLAILINGAM Sanmugalingam Electrical Engineer, Ceylon Electricity Board P.O. Box 540, Colombo
Thailand	Mr. CHULLAKESA Chulapongs Director, Office of Rural Electrification Provincial Electricity Authority, Interior Ministry, Bangkok
Turkey	Mr. TUMER Timucin General Director of State Hydraulic Works, Ankara
Uganda	Mr. KAGGA Michael Mwanje Assistant Chief Generation Engineer, Uganda Electricity Board, P.O. Box 7059, Kampala
Yugoslavia	Mr. HUMO Dzemal Technical Manager, Hidroelektrane na Neretvi, 79.000 Mostar
Zambia	Mr. CHANDA, Johannes Kalolo Principal, Ministry of Power, Transport and Communications Box 50065, Lusaka

OBSERVERS

France	Mr. VANDAME Etienne Consulting Engineer, Petite Production Electrique En France, 16 Avenue Albert I, 60300 Senlis
Japan	Mr. TAKANASHI Hisashi Acting Director, Engineering Consulting Firms Association (ECFA), Kasumigaseki Bld. 327 III, Kasumigaseki, Chiyodaku, Tokyo
Norway	Mr. SAETERSMOEN Gjermund Consulting Engineer, Norconsult A.S., Box 9 1322 Movik
U.S.A.	Mr. MILLER Douglas Llewellyn Area Manager, Hydro-Turbine Division, Allis Chalmers Corporation, Box 712 York, Pennsylvania 17405

UNITED NATIONS

UNIDO	Mr. TANAKA, William H. Head, Development and Transfer of Technology Branch Vienna International Center, P.O. Box 300 A-1400 Vienna, Austria
	Mr. PACK, Han-Woung Industrial Development Officer, Development and Transfer of Technology Branch, Vienna International Centre P.O. Box 300, A-1400 Vienna, Austria
	Mr. SEIDEL, Hans H. Industrial Development Officer, Engineering Industries Section, Division of Industrial Operations Vienna International Centre, P.O. Box 300 A-1400 Vienna, Austria
	Ms. WEISSENBOCK, Anita Secretary, Development and Transfer of Technology Branch Vienna International Center, P.O. Box 300 A-1400 Vienna, Austria

Annex II

A G E N D A

17-19 October 1980		Participants arrival and transfer to Hangzhou
20 October (Monday)	8:00- 9:00	Registration of the participants
	9:00-10:00	Opening ceremony in P.R. China - Inauguration address and opening of the Seminar-Workshop/Study Tour (Mme. Qian Zhengying, Minister of Water Conservancy) - Welcome address (Mr. Li Fengping, Governor of Zhejiang Province) - Welcome address (Mr. Romualdo A. Ong, Minister-Counsellor and Charge d'Affairs a.i., Philippine Embassy, Beijing) - Welcome address (Mr. Y. de San, UNDP Regional Programme Adviser, Beijing) - Welcome address (Mr. W.H. Tanaka, Head Development and Transfer of Technology Branch, UNIDO)
	10:15-10:30	Election of the Chairman, two Vice-Chairmen, the Rapporteur and two Assistant Rapporteurs. (The vice-chairmen and assistant rapporteurs will be in charge of Working Groups I and II)
	10:30-12:30	Plenary Session Presentation of case study of China (Part 1) "Chinese Experiences of Small Hydro Power Generation", by: Mr. Guo Ruizhang, Associate Chief Engineer, Shanghai Water Conservancy Bureau
	14:00-15:00	Presentation of case study of China (Part 2) "Development of Small Hydro Power in China", by: Mr. Zhu Xiaozhang; and "Multi-purpose Development of the Jinjiang River Basin", by: Mr. Zhang Wenzheng
	15:15-18:00	System approach to the establishment of MHG projects (Theme I)
21 October (Tuesday)	8:30-10:15	Plenary Session Systems approach to the establishment of MHG projects (Theme I) - continued
	10:30-12:30	Plenary Session (Theme I) - continued

	14:00-15:15	Plenary Session (Theme I) - continued
	15:30-18:00	Plenary Session (Theme I) - continued
22 October (Wednesday)	8:30-12:30	Concurrent Sessions Group I - Local manufacture of MHG equipment in developing countries (Theme II) Group II- MHG for industry/Cost reduction scheme (Theme III)
	14:00-18:00	Group I - continued Group II - continued
23 October (Thursday)	-	Preparation of Report
24 October (Friday)	6:00-10:05	Leave for Jinhua County by train
	11:30-12:00	Briefing on MHG in Jinhua County
	13:30-18:00	Study Tour Turbine factory Generating equipment factory Fourth power station of Meixi cascade Dongkou power station Youth power station Double-dragon station
25 October (Saturday)	7:30-18:00	Cascade development of MHG in Panxi River, Jinyun County
26 October (Sunday)	8:00-12:00	Study Tour in Jinhua County
	14:53-19:15	Back to Hangzhou by train
27 October (Monday)	8:00-12:00	Hangzhou generating equipment plant
	14:00-16:00	Equipment fair
28 October (Tuesday)	8:30-12:00	Review and discussions on study tour in China
	13:30-14:30	Closing session by his Excellency Mr. Li Bonin Vice Minister of Water Conservancy
	16:30-19:30	Leave for Shanghai by train
29 October (Wednesday)	-	Visit to People's Commune (rural industries)
30 October (Thursday)	-	Shanghai industrial exhibition
	17:15-19:15	Fly to Guangzhou

31 October (Friday)	8:30-12:00 14:00-16:00	Kantong Fair Drive for Conghua County
1 November (Saturday)		Study tour in Conghua County
2 November (Sunday)	8:30-10:30	Conghua County to Guangzhou City by bus
	13:20-15:30	Departure for Manila
3 November (Monday)	9:00-9:30	Opening ceremony in Rep. of Philippines - Welcome address (Brig. Gen. Pedro G. Dumol, Administrator, National Electrification Administration - NEA) - Welcome address (Mr. W.H. Tanaka, Head of Delegation, UNIDO) - Inauguration address and opening of the Seminar-Workshop/Study Tour (second part) Hon. Alfredo L. Juinio, Minister of Public Works and Communications
	10:00-10:15	Election of Chairman
	10:15-12:30	Review and discussions on the Study Tour in the People's Republic of China
	14:00-18:00	Presentation and discussions of case studies of the Philippines
4 November (Tuesday)	9:00-12:30	Plenary Session
	13:30-18:00	Study Tour Plant visits: AG+P and Philippine Electric (PHILEC)
5 November (Wednesday)	8:30-10:15	Presentation and discussions of the work of Group I (Theme II): "Local manufacture of MHG equipment in developing countries".
	10:30-12:15	Presentation and discussions of the work of Group II (Theme III): "MHG for industry/Cost reduction scheme in MHG installations".
	14:00-18:00	Technical co-operation: - MHG Guidelines for Decision-Makers - Information Exchange Systems on MHG - Formulation of a "MHG Club" - Compilation of a MHG Bibliography - UNIDO Training Programmes - UNIDO Technical Assistance Programmes - TCDC (Technical Co-operation among Developing Countries) - Possible establishment of a regional/ interregional Development and Training Centre - other programmes of common interest.

6 November (Thursday)		Study Tour to BICOL
	11:30	Depart for airport
	12:30	- Leave for Naga - Proceed to Cuyaoyao Mini-Hydro Plant - Proceed to Legaspi City
7 November (Friday)		- Visit to Tiwi Geothermal Plant - Pass-by Cobo Bliss site - Briefing/lunch at Albay Electric Co-operative, Inc. (ALECO)
	16:00	Leave for Manila
	19:30	Adoption of the Draft Report Closing session by his Excellency Hon. Alfredo L. Juinio, Minister of Public Works and Communication.

Annex III

LIST OF DOCUMENTS AND COUNTRY PAPERS

1. Aide-Memoire

2. UNIDO Issue Paper (ID/WG.329/1)

3. Prospect of Small-Scale Hydro Power Development in Bangladesh
by: Syed T.S. Mahmood
Power Development Board, Wapda Bldg., Motijheel, Dacca-2
Bangladesh

4. Mini-Hydro Power Development Program in Burma
by: B. Rallian Sang
Electric Power Corporation, Rangoon, Burma

5. The Utilization of Seasonal Electric Energy from Small Hydroelectric Stations
by: Wang Mengzhao
Bureau of Water Power, P.R. China

6. The Rural Electric Power Network, Planning and Operation in Dayi County, Sichuan Province
by: Lu Hua, Fang Xinhin
Hydroelectric Department, Sichuan, P.R. China

7. Multi-purpose Development of the Jingjiang Basin
by: Liu Rudong
P.R. China

8. Integration of Small Hydroplants of Yongchun County into the Small Local Grid
by: Department of Water Conservancy and Electricity
Fujian, P.R. China

9. China's Small Hydroelectric Machineries
by: Ministry of Water Conservancy
P.R. China

10. Application of Relief Valves in Small Hydroelectric Stations
by: Ministry of Water Conservancy
P.R. China

11. Earth Dam Projects in Small Hydro-Power Construction in Hubei Province
by: Ministry of Water Conservancy
P.R. China

12. Small Hydropower in China
by: Ministry of Water Conservancy
P.R. China

13. Planning for the Small Hydro-Power Station and Network in Tungcheng County, Hubei Province
by: Ministry of Water Conservancy
P.R. China

14. The Application of Prestressed Concrete Pipes
in Small Hydro-Electric Stations
by: Ministry of Water Conservancy
P.R. China

15. Report on the Study Tour to Norway, Finland,
West Germany and Switzerland (Small Hydropower)
P.R. China

16. Chinese Experiences in Small Hydro Power Generation
by: Guo Rui-Zhang,
P.R. China

17. Hydro-Electric Energy in Egypt
by: Abdel Hakam Ahmed Atallah
Hydro-Electric Renewable Energy Authority, P.O. Box 304, Cairo
Egypt

18. Country Paper on Ethiopia - Medium- and Small-Scale Hydro Power Plants
by: G. Mariam Hailu
Planning and Study Department, E.E.L.P.A., Addis Ababa
Ethiopia

19. Micro-Hydropower in Guyana
by: Joseph Nathaniel O'Lall
Ministry of Energy and Natural Resources, Brickdam, Georgetown
Guyana

20. Micor-Hydel Generation in India
by: T.A. Deodas
Central Electricity Authority, New Delhi
India

21. Mini-Hydro Electric Generation of Electricity in Jamaica
and other Countries of the CARICOM Region
by: Dennis Audley Minott
Renewable Energy Development Division,Scientific Research Council
Box 350, Kingston 6
Jamaica

22. A Case Study on the Mini-Hydro Power Development in the Philippines
by: Takiji Yasuda and Noboru Murata
ECFA
Japan

23. Paper on Mini-Hydro Electric Plants in Kenya
by: Gerald Mukuha Wagana
Ministry of Works, Nairobi
Kenya

24. Mini-Hydro in Malaysia
by: Bin Nasaruddin Hoesni
National Electricity Board, P.O. Box 1003, Kuala Lumpur
Malaysia

25. Micro-Hydel Project in Nepal
by: Shatrughna Nath Chaturvedi
Department of Electricity, Darbar Marg, Kathmandu
Nepal

26. Small-Scale Hydroelectric Power Technology
by: Ola Gunnes
Norwegian Water Resources and Electricity Board
Oslo 3, P.O. Box 5091 MAJ
Norway

27. Power Development in Pakistan
by: Syed Mahmood
Ministry of Water and Power, Islamabad
Pakistan

28. Micro-Hydro Generation in Papua New Guinea
by: G.V. Manikuaie
P.N.G. Electricity Commission, Port Moresby
Papua New Guinea

29. Small Hydropower Generation in Peru
by: Andres Federico Coz
P.O. Box 1301, Lima
Peru

30. Mini-Hydro Application in the Philippines
by: P.G. Dumol and F.H. Denton
National Electrification Administration (NEA), Quezon City
Philippines

31. Lighting Up the Countryside - The Story of Electric Cooperatives in the Philippines
by: Frank H. Denton
National Electrification Administration, Quezon City
Philippines

32. Small-Scale Hydro Power Programme in Romania
by: Eugen Parhoti
ISPH
Romania

33. Small-Hydro in Sweden
by: Thovild Persson
Swedish Power Association, Stockholm (ID/WG.329/3)
Sweden

34. Summary on Mini-Hydro Project
by: Chulapong Chullakesa
Office of Rural Electrification, Provincial Electricity Authority
Miristry of Interior, Bangkok
Thailand

35. Mini-Hydropower Generation (MHG) in Turkey
by: Timucin Tumer
General Directorate of State Hydraulic Works, Ankara
Turkey

36. Small-Scale Hydro-Power Plants in Yugoslavia
by: Dzemal Humo
Hidroelectrane na Neretvi, Mostar
Yugoslavia

37. Development in Mini-Hydro Power Generation in the Republic of Zambia
by: Johannes Kalolo Chanda
Ministry of Power, Transport and Communications, Box 50065, Lusaka
Zambia

38. Low-Head Hydroelectric Unit Fundamentals
by: Howard A. Mayo Jr., P.E.
Manager, Market Development, Hydro-Turbine Division
York, PA 17405 U.S.A.

39. Mini-Hydro Development in Lyberia
by: Baseeru M. Sonii
Lec, Liberia

40. Yugoslav Experiences, Achievements and Possibilities of Co-operation with Developing Countries in the Area of Mini Hydro-Electric Generation Units
by: Darko Bekić

41. Hydropower Developments Projects in the Provinces of Bohol and Actique
by: Gjermund Saetersmoen
Philippines

42. Micro-Hydroelectric Project for Rural Development in Papua New Guinea
by: Ed Arata
Papua New Guinea

43. Seminar-Workshop/Study tour in Development and Applications of Technology for Mini Hydropower Generation to be held in China and Philippines
by: Prof. Dr. M. Abdullah
Pakistan, Islamabad

ANNEX IV

VOTE OF THANKS

Mr. Chairman, Ladies and Gentlemen,

On behalf of my colleagues, delegates from different countries of the world and myself, I have the honour to thank the Chinese and Philippine people and their Governments for hosting us during the Second Seminar-Workshop/Study Tour in the Development and Application of Technology for Mini-Hydro Power Generation. I wish to thank the Norwegian Government for the financial support they extended. I would like to take this opportunity to admire the great effort which UNIDO has exerted to make our meeting feasible. If these authorities and governments are mentioned for their support, it is actually greatly appreciated the individual efforts exerted by Mr. Hsu and his colleagues in China. Also General Dumol and his assistance who made all arrangements in the Philippines. The leadership of Mr. Hsu and General Dumol is a great key tool in the success of this Conference. Mr. Tanaka and his colleagues from UNIDO have been following very closely the details and progress of the Conference trying to reach unanimous resolutions by explanation and through tedious patient discussions.

I am sure there are many other people who have served and assisted us in the success of this meeting. To all the above-mentioned people I would like to express our deep gratitude. Whatever we say cannot meet the great efforts exerted, but I hope other conferences shall follow which will be the best appreciation for the efforts exerted to hold this conference.

Thank you all very much and best wishes to all who have participated in this conference.

7 November 1980, Manila, Republic of the Philippines

Abdel Hakam Ahmed ATALLAH
Vice-President
Hydro-electric Renewable Energy Authority
Cairo
Egypt

Annex V

KATHMANDU DECLARATION ON INTERNATIONAL CO-OPERATION IN THE FIELD OF MINI HYDRO ELECTRIC GENERATION*

Proposed by representatives of Nepal, People's Republic of China, Colombia, Norway, Sweden and Tanzania.

The Seminar-Workshop on the Exchange of Experiences and Technology Transfer on Mini Hydro Electric Generation Units organized by UNIDO/ESCAP-RCTT in co-operation with the NCST and the RECAST of Nepal from 10 - 14 September 1979 in Kathmandu has demonstrated the interest in and the importance of this subject.

Exchange of information, knowledge and experience is felt to be of basic importance for promotion of this technology, not only between developed and developing countries, but also among the developing countries themselves.

In this respect, parties carrying out activities in this field: governments and official and private institutions, as well as UN agencies and other international and bilateral organizations are invited to increase their supporting efforts to accelerate the electrification of rural areas by means of small scale power production including micro and mini hydro generation within the framework of rural development plans.

The participants of the Seminar-Workshop therefore decide to underline the need for the strengthening of international co-operation in a systematic, efficient and effective manner, and want this to be referred to as THE KATHMANDU DECLARATION.

---

* Adopted by the Seminar-Workshop on the Exchange of Experiences and Technology Transfer on Mini Hydro Electric Generation Units at Kathmandu, Nepal, 14 September 1979.