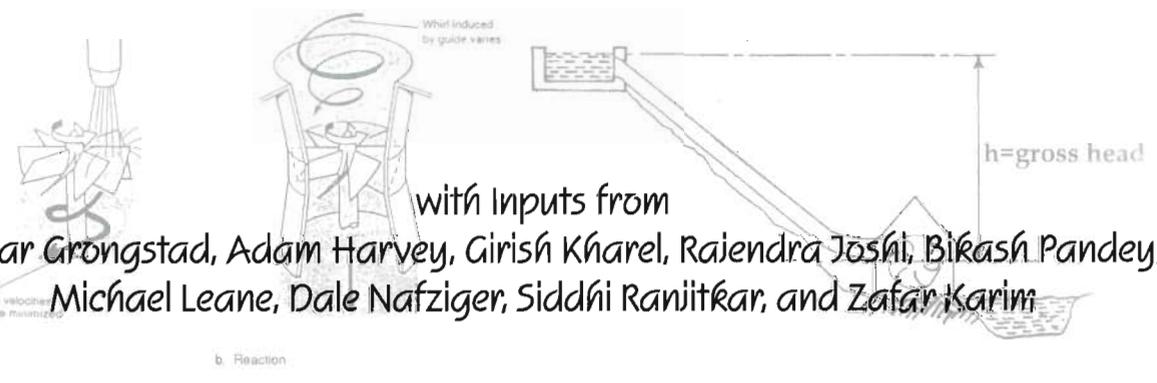


# A Manual of

# Private and Community-based Mini- and Micro-Hydropower Development in the Hindu Kush-Himalayas

Compiled by  
**Anwar A. Junejo**

with inputs from  
Steinar Grongstad, Adam Harvey, Girish Kharel, Rajendra Joshi, Bikash Pandey,  
Michael Leane, Dale Nafziger, Siddhi Ranjitkar, and Zafar Karim



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**International Centre for Integrated Mountain Development**  
**(ICIMOD)**  
**Kathmandu, Nepal**  
**1997**

# Foreword

In many of the discussions about the scale of hydropower interventions in the Hindu Kush-Himalayas and elsewhere, references are often made to mini- and micro-hydropower (MMHP), as being most appropriate for remote areas with scattered pockets of small settlements.

Over the past 25-50 years, various initiatives in this sector have been undertaken in different parts of the HKH, in particular in China, India, Nepal, and Pakistan. In several places this has been highly successful, in others, it has not been so successful. This discrepancy between the obvious theoretical advantage of using an indigenous renewable energy, appropriate for mountain areas, and the actual performance, has prompted ICIMOD to do an in-depth analysis of the scope for MMHP in the HKH. Various national and regional seminars have been organised over the past few years, out of which emerged a clear need for a comprehensive manual, on the basis of which sound judgements could be made about investing in MMHP.

The present Reference Manual on development of mini- and micro-hydropower in the Hindu Kush-Himalayan Region provides basic information on the current status of MMHP in the region and guidelines for making it more effective and sustainable. The Manual is intended for decision-makers, prospective financiers, planners, and assessors of the proposals, outputs, and impacts of such programmes. Keeping this target group in mind, the material assembled in this document is fairly wide ranging; from current status, practices, and policy support, to some specific case examples collected from the developing as well as the developed world. Basic information has also been provided regarding the implementation aspects, including project planning and feasibility, technology, financial analysis and assessment, monitoring and evaluation, and training. One chapter has also been devoted to the institutional structures needed for efficient and effective development of mini- and micro-hydropower (MMHP). Although the Reference Manual may not provide all the requisite levels of detailed information for field designers and implementers of MMHP schemes—for which some excellent manuals already exist—it attempts to provide the basic details for site survey, design, and selection of technology options.

The original version of this Manual was prepared mostly in the form of notes for individual lectures for the 'Orientation-cum-Training Programme on Mini- and Micro-hydropower Development in the Hindu Kush-Himalayan (HKH) Region', organised in 1995 for planners and decision-makers from this Region. The participants at the meeting considered the material quite original and useful and recommended wider dissemination, after some revisions and with the inclusion of a number of additional subjects. The revised draft was circulated to many experts, including the original contributors; and many valuable suggestions were received. Efforts have been made to incorporate these suggestions, as far as possible, in this final publication.

The original Manual was prepared by a group of experts; prominent among them were Mr. Steinar Grongstad of NORPLAN, Norway, and Dr. Adam Harvey of ITDG, U.K. A number of Nepal based experts also prepared or reviewed material for this manual; namely, Dr. R.D. Joshi (Institute of Engineering), Mr. Bikash Pandey (ITDG/Nepal), Mr. G. Kharel (Micro Hydro Consultants), Mr. Michael Leane (UMN), Dr. Dale Nafziger (BPC), Mr. Siddhi Ranjitkar (USAID), and Mr. Zafar Karim (ICIMOD). Dr. A. A. Junejo, the Project Coordinator (ICIMOD), organised and oversaw the preparation and rewriting of the Manual, in addition to writing some of the chapters himself. I am grateful to all these contributors.

Some contributors have made extensive use of materials from the Micro Hydro Manual (1993) prepared by the ITDG. Some of the data were also extracted from presentations of the participants and two guest speakers at the Orientation-cum-Training Programme. This inclusion of the material from the ITDG Manual and other papers is gratefully acknowledged. I would also like to take this opportunity to thank the Government of Norway (NORAD) for the continuous and generous support it provides to ICIMOD for implementation of the MMHP programme.

It is hoped that this Reference Manual will be of use to the planners and decision-makers associated with private or community based MMHP in the Region. ICIMOD welcomes suggestions from readers/users which may be incorporated in future editions.

Egbert Pelinck,  
Director General

# About This Manual

**A draft of this Manual was circulated to many experts, including the contributors, for comments. While these experts suggested many corrections and improvements, they also raised two pertinent issues; i.e.,**

- the manual was very long and the planners/decision-makers for whom it was intended would not have adequate time to read and assimilate its contents, and
- the above group was very diverse in terms of educational and working backgrounds and they needed particular and concise information.

**Thus a very basic dilemma arose; i.e., should the manual be made very concise and simple so that decision-makers can read it in the minimum possible time, or should it have adequate information at the risk of being too lengthy. The third possibility was to break it into two or three sub-volumes. It was finally decided to provide simple but adequate information in one volume, at the same time avoiding excessive details. Also, keeping the above issues in mind, the following breakdown suggests which chapters are useful for different groups of users.**

- (a) Decision-makers interested in learning about the advantages, achievements, current trends, and other basic information about MMHP, in order to formulate their views regarding inclusion of MMHP in the overall energy scenario, may refer to Chapters 1, 2, 3, and 11.
- (b) Similarly decision-makers who may wish to know more, particularly the relevant needs of the MMHP sector, may, in addition, refer to Chapters 4, 10, 12, and 13.
- (c) Planners and analysts concerned with the implementation and economic aspects may refer to Chapters 4, 5, 7, 8, 10, and 11.
- (d) Assessors of MMHP projects/programmes from economic and technical angles, may refer to Chapters 4, 5, 6, 7, 10, 11, 12, and 13.
- (e) Planners and implementors wishing to prepare proposals and/or execute MMHP projects may read Chapters 3 through 13.

# Abstract

This Reference Manual provides basic information and guidelines for developing and improving the performance of private/decentralised mini- and micro-hydropower (MMHP) in remote and underdeveloped areas of the Hindu Kush-Himalayan (HKH) Region. The Manual is targeted for the decision-makers, financiers, planners, and assessors of such programmes. It is hoped that the information and suggestions provided here will assist the target audience in formulating appropriate plans and implementation methodologies for using this environmentally friendly, indigenous and renewable resource to meet the energy needs of inaccessible and underdeveloped mountain areas.

The Manual contains information about the comparative advantages, current status, achievements, and impact of MMHP; and also about technology, implementation methodology, operation, management and other relevant aspects leading to optimising the benefits of MMHP programmes. The overall inference is that, for those remote areas in which grid extension is not viable and the water resource is available, small-scale, isolated private MMHP schemes may be introduced with appropriate supporting interventions, using the local manpower and technical base.

In addition, the Manual contains guidelines regarding the selection of appropriate technology choices, management systems, institutional arrangements, and other necessary inputs; which may be in the form of funding, training, or repair and backstopping facilities. Material on the financial analysis/assessment and monitoring of MMHP has also been included.

## Some Local Terms

- Bijuli Dekchi* (Nepal) A low wattage cooking pot with an electrical heating element and a thermostat designed to heat-cook various foods in a hot water medium
- Dhiki* (Nepal) A foot-operated device used for dehusking paddy through pounding
- Gharat* (India, Pakistan) A traditional vertical axis, wooden water mill used mainly for grinding grains  
*Ghatta* (Nepal)
- Lokta* (Nepal) An indigenous tree which grows widely in the middle hills of Nepal. Its bark is used for making traditional Nepali paper
- Kol* (Nepal) A traditional manually-operated pestle-mortar device for expelling oil from seeds through a crushing action
- Okhal* (Nepal) A hand-operated pestle-mortar device used for dehusking paddy through manual pounding

## List of Abbreviations, Acronyms and Local Terms

ACAP	Annapurna Conservation Area Project (Nepal)
ADB/N	Agricultural Development Bank (Nepal)
AKRSP	Aga Khan Rural Support Programme (Pakistan)
BEW	Butwal Engineering Works (Nepal)
B/C	Benefit/Cost Ratio
BTI	Butwal Technical Institute (Nepal)
BYS	Balaju Yantra Shala (Nepal)
CRT	Centre for Rural Technology (Nepal)
DCS	Development and Consulting Services (Nepal)
ELC	Electronic Load Controller
FAKT	Association for Promotion of Appropriate Technology (Germany)
GEF	Global Environment Facility
GIS	Geographic Information System
GTZ	German Agency for Technical Cooperation
GATE(GTZ)	German Appropriate Technology Exchange
HDPE	High Density Polyethylene
HKH	Hindu Kush-Himalayas
HMC	Heavy Mechanical Complex (Pakistan)
HMG/N	His Majesty's Government (Nepal)
HRC-SHP	Hangzhou Regional Centre (Asia-Pacific) for Small Hydropower (China)
ICIMOD	International Centre for Integrated Mountain Development
IGC	Induction Generator Controller
IREDA	Indian Renewable Energy Development Agency Ltd
IRs	Indian Rupees (US\$ 36 IRs)
IRR	International Rate of Return
ITDG	Intermediate Technology Development Group (U.K, Nepal & Sri Lanka)
KMI	Kathmandu Metal Industry (Nepal)
kVA	kilo Volt-Amperes
kW	kilo Watts
kWh	kilo Watt-hours
L/S	Litre per second
LEDG	Ladakh Ecological Development Group (India)
MCB	Miniature Circuit Breaker.
MDPE	Medium Density Polyethylene
MHP	Micro-Hydropower
MHPPG	Mini Hydro Power Group (An Association of Europe-based agencies associated with development of mini and micro-hydropower)
MMHP	Mini and Micro-Hydropower
MNES	Ministry of Non-Conventional Energy Sources (India)
MOM	Management Operation and Maintenance
MPPU	Multi Purpose Power Unit (Nepal)
MW	Mega Watt
NA-PWD	Northern Areas-Public Works Department (Pakistan)
NEA	Nepal Electricity Authority
NMHDA	Nepal Micro Hydropower Development Association
NORAD	Norwegian Agency for Technical Cooperation
NPV	Net Present Value
NRs	Nepal Rupees (1 US\$=57 NRs)
NWFP	North Western Frontier Province (Pakistan)
NYS	Nepal Yantra Shala
O&M, O+M	Operation and Maintenance
OM&R	Operation Maintenance & Repair
O&T	Orientation and Training

PCAT	Pakistan Council of Appropriate Technology
PCSIR	Pakistan Council of Scientific and Industrial Research
PRs	Pakistan Rupees (1 US\$ = 36 PRs)
PTC	Positive Thermal Coefficient
PV	Photovoltaic
PV	Present Value
RONAST	Royal Nepal Academy for Science and Technology
SCECO	Salleri Chialsa Electricity Co. (Nepal)
SDC/SATA	Swiss Development Cooperation/Swiss Agency for Technical Assistance
SEB	State Electricity Board (India)
SELUP	Salleri Electricity Utilisation Project (Nepal)
SHP	Small Hydropower
SHPD	Small Hydropower Department (Nepal)
SHYDO	Sarhad Hydel Development Organisation (Pakistan)
SKAT	Swiss Centre for Development Cooperation in Technology and Management
TWh	Tera Watt hours
UMN	United Mission to Nepal
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation
USAID	United States Agency for International Development
UPVC	Unplasticised Polyvinyl Chloride
VDC	Village Development Committee (Nepal)
W	Watt
WAPDA	Water And Power Development Authority (Pakistan)

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