TERMINAL EVALUATION AND IMPACT ASSESSMENT
OF

THE UNDP/GEF PROJECT – IND/91/G-31 – OPTIMIZING DEVELOPMENT OF SMALL HYDEL RESOURCES IN THE HILLY REGIONS OF INDIA

INDIAN INSTITUTE OF PUBLIC ADMINISTRATION
I.P. ESTATE, NEW DELHI.

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CONTENTS

Acknowledgements

ii

Abbreviations

ii

i-iv

Introduction

v

-vii

Executive Summary

vii

i-xv

Chapter I Project Concept and Design 1-
19

Chapter II Project Implementation
20-29

Chapter III Project Results
30-51

Chapter IV The Impact Assessment
52-58

Chapter V The Functioning of the Small Hydel

Demonstration Projects and trends in
Power Consumption in Target Areas
59-79

Chapter VI	The Impact of Demonstration Projects in the Target Areas	80-115
Chapter VII	Conclusions and Recommendations based on the Terms of Reference	116-158
Chapter VIII	The Lessons Learnt from the UNDP/ GEF Hilly Hydro Project	159-163
Annexure		164-193

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Dr. Anil Chandy Ittyerah

ABBREVATIONS

AHEC	**Alternate Hydro Energy Centre**
ASSOCHAM	Associated Chambers of Commerce
CEA	Central Electricity Authority
CES	Consultancy Engineering Services
CII	Confederation of Indian Industries
DPR	Detailed Projects Reports
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EC	Equipment Contractor
GEF	Global Environment Facility
GHG	Greenhouse Gas
GoI	Government of India
HHP	India Optimizing Development of Small Hydel Resources in the Hilly Regions (in short : Hilly Hydel Project)
HIMURJA	Himachal Pradesh Government Energy Development Agency
IA	Implementing Agency
IREDA	Indian Renewable Energy Development Agency
IPP	International Consultants
KW	Kilo Watt
LBS	Local Benefits Study
LPG	Liquid Petroleum Gas
MNES	Ministry of Non-Conventional Energy Sources
MoEF	Ministry of Environment and Forests
MW	Mega Watt
NGO	Non-Government Organization
NPD	National Project Director
NPC	National Project Co-ordinator
NPP	National Consultants
O&M	Operation and Maintenance

PPA	Power Purchase Agreement
PMC	Project management Cell
PD	Project Developers
SEB	State Electricity Board
SGRY	Swarnajayanti Grameen Rozgar Yojna
SGSY	Swannajayanti Grameen Swarozgar Yojna
SHPs	Small Hydro Demonstration Projects
SNA	State Nodal Agency
TER	Terminal Evaluation Report
TI	Technical Institutions
UNDP	United National Development Program
UREDA	Uttranchal Renewable Energy Development Authority
ToR	Terms of Reference
Crore	INR 10,000,000
Lakh	INR 1,00,000
1 US $	INR 45.40 (Current Exchange Rate)

EXECUTIVE SUMMARY

The UNDP-GEF Hilly Hydro Project was executed by the Ministry of Non-Conventional Energy Sources in the Himalayan and Sub-Himalayan Hilly Regions of India. This project was initiated in January 1995 and completed in December 2003. Considering the vast geographical spread of the demonstration sub-project sites, the active involvement of various Sub-Himalayan States, and the significant policy impact as well as policy implications anticipated as a result of the implementation of this project, it was decided by the sponsors to conduct an indepth Terminal Evaluation and Impact Assessment Study of the Project. The Indian Institute of Public Administration, New Delhi was requested to undertake the study. This Terminal Evaluation and Impact Assessment Study was initiated in September, 2003 with the purpose of assessing the impact of this project both at the National and Sub-project levels, and suggest measures that would help in the future expansion and development of the Small Hydro Sector in India. While highlighting the important lessons learned though the implementation of the project, the Terminal Evaluation and Impact Assessment was also expected to assist both the UNDP and the Government of India not only to assess the success of the project in meeting its objectives but to evaluate the effectiveness and impact of the project in the targeted demonstration project areas and on the beneficiaries inhabiting them, mainly in order to derive relevant policy lessons for the future.

The major conclusions reached by the study at the overall national level are that while the project was very well designed and highly relevant to the energy, livelihood, and ecological security of the hilly regions in India, it could not be fully implemented in terms of certain essential components even during its much extended time frame. This was largely due to a fairly high degree of diffusion of the formalized and accountable commitments on the part of local implementing agencies. Inspite of its rather complex and ambitious objectives the Project was very well managed at the national level. However the inadequate co-ordination at the State and Sub-project / field level may have diluted its potential impact.

The project originally intended to cover 13 Himalayan and Sub-Himalayan States. However only about half the States participated in the project and that too in varying degrees. While some States have been very proactive and responsive to the project, there are others who have only been able to utilize the project to a limited extent. The degree of pro-activity among the participating States has been closely and directly related to the technical and administrative strengths and autonomy of their respective State Nodal Agencies. Most non-participating States belong to the North Eastern Region and have kept out of the project for various reasons. Thus the geographical outreach of the project has been both non-uniform and limited. Likewise, of the three Technical Institutions that were to be developed for the project only one has been responsive while there has been no effort to either develop or replace the other two. The regional ramifications of this deficiency in the development of the Small Hydro Sector especially in the north-eastern region is quite apparent, and may have been one of the important factors that has affected the low level of participation in this region.

The Hilly Hydro Project laid a great deal of emphasis on people's participation and the evolution of ownership models in the small hydro sector. Unfortunately, this did not materialize to the expected extent. The stress on people's participation was primarily due to the fact that these demonstration projects were targeted to be set up in very remote and isolated locations and were visualized as `stand alone' SHPs requiring not only the generation of micro hydel power but also the distribution of this power through a local isolated grid. Both the generation and distribution facilities were to be set up and managed initially by the developer, with distribution being subsequently handed over to the local population mainly in order to create a sense of ownership and evolve a collective participatory model of management. It was expected that such a decentralized participative model of SHP development would evolve and grow as a consequence of the very isolated nature of these stand alone micro hydel systems. While the project made explicit provisions for the setting up of power generation facilities there was no such clear and explicitly articulated activity block designed to put the distributional facilities and related infrastructure in place. This major lacuna in the project design has led to about half of the sub-projects being based on power evacuation directly to the State grid. This revised approach has seriously affected at least 3 major categories of activities that were planned namely, the setting up stand alone SHPs and the mini grids to cater to local needs, load development and the use of low wattage devices for load management, and people's participation in the management of SHPs.

On the more positive side several activity blocks that were planned have been successfully completed, among these are Survey and Assessment, Technology Selection, Master Plan and Zonal Plan formulation, the setting up of upgraded Water Mills, and the training of manpower related to SHP development. As a result of all these activities, the relevance of the project in terms of performance, modalities of execution, and the benefits derived by recipient institutions has been satisfactory. In terms of over all effectiveness the project can be rated to have been significantly effective, while in terms of over all efficiency the project's achievements vis-à-vis its immediate objectives can only be rated as moderate at present. The project's efforts at Capacity Building and Technology Selection have been very commendable. The project has also provided a significant boost to the Government's commitments towards the small hydel sector.

In the context of the sub-projects or at the level of individual demonstration projects, the impact of the UNDP-GEF initiative has been fairly significant. Inspite of the various teething problems that these demonstration projects have faced during their initial period of operation there has been a gradual but steady improvement in the generation and capacity utilization of these demonstration plants. Though there have been numerous problems related to the proper integration and evacuation of power mainly on account of the instability and improper maintenance of the State grid, most projects visited have been functioning at fairly high levels of plant use efficiency, and have through effective tail end injection of supplementary power considerably improved and stabilized the availability of power in the target areas. As a result, power consumption in the post-project period is observed to have increased significantly in some of the target areas studied. The increased availability of power has also led to a steady increase in the use of domestic electrical appliances specially for lighting and entertainment applications leading in turn to some significant improvements in the quality of life particularly for women and children in the target areas. However, the over all profile of energy use still remains unaltered with wood and other fossil fuels being predominantly used for cooking and space heating purposes. Moreover, the expected use of electricity in various agricultural and local village livelihood applications has not yet come about. However, over time and with the stable generation and availability of power in the target areas these applications are expected to be gradually adopted by the local population in these target areas.

Based on the major conclusions of the impact study and terminal evaluation, our team has made some recommendations that may be taken into consideration for improving the impact and sustainability of future small hydro development in the country. These suggestions can be broadly classified under four major heads namely, measures to improve generation of power and remove supply side constraints; suggestions for proper evacuation and distribution of power in the target areas; measures that can be initiated to encourage and optimize the consumption or utilization of power by the local population; and suggestions for ensuring sustainability and active people's participation.

The major suggestions for removing supply side constraints and achieving optimum generation are, the execution of comprehensive maintenance contracts for a period of at least 3 years after the installation and commissioning of E&M equipment thereby ensuring timely repair/replacement of defective equipment, and the provision of essential spare parts. This contract should constitute an essential pre-condition for the award of E&M contracts to manufacturers. The strengthening of pre-installation testing and certification facilities should be immediately initiated in order to ensure reliability of E&M equipment and also to improve and maintain high manufacturing standards. Well established and experienced project developers should be financially supported to undertake `hands on' apprenticeship training to create a reliable pool of trained manpower for the management, operations, and maintenance of SHPs in the country. Those trained and certified under this facility should be assured placements in future SHPs. Project developers should be statutorily required to ensure proper living and working conditions for their operating staff and also to observe a stipulated minimum of pay and allowances as this is most essential to attract and retain well trained and dedicated manpower needed to sustain the operations of the SHP in such remote and difficult locations.

The measures suggested for the proper evacuation and distribution of power are, appropriate action to ensure proper sub-station based integration of grid connected SHPs and to clearly provide for local grid development for stand alone SHPs, with the cost of such integration being born equally by the Developers and the Distribution Utilities/ Agencies. The simultaneous development of such evacuation and distribution facilities are necessary for the viability and sustainability of the SHPs. It is also essential to extend the deemed energy generation facility to all the SHPs, irrespective of the type of grid available in the area. The uniform enforcement of this provision will go a long way in the proper upkeep and maintenance of the State Grid.

The suggestions related to ensure optimum consumption and the removal of critical demand side constraints are that a seasonal differential tariff structure should be introduced in the target area in order to encourage the use of electrical energy. Concerted efforts are also required to draw up a package of incentives for the adoption of low wattage and load control devices among the user population. This may be attempted by a special package of excise duty, and also sales tax relief as well as concessional import duties for such devices in order to make these devices affordable and acceptable to consumers of electricity for domestic, commercial and institutional purposes. Yet other suggestions for ensuring long term sustainability and peoples participation have also been made such as, the need for various Rural Development Programmes related to wage employment, self employment, housing, and rural infrastructure to be actively integrated with the Small Hydel Programme in order to exploit inter programme externalities and encourage peoples participation, and a strong sense of collective ownership. It is also extremely important for SHPs, to be statutorily required to incorporate explicit provisions that would meet the water requirements of local gravity based irrigation systems in the target area. This would eliminate the alienation of local water rights and resolve local conflicts that impede the development of SHPs.

It is necessary to initiate comprehensive base line surveys in areas identified for SHPs development. This would not only ensure proper impact assessments and terminal evaluation but also assist the potential developers to plan generation capacities in appropriate phases and thereby ensure techno-economic feasibility and financial viability. The evaluation team would also like to stress the need for such assessments to be undertaken only after optimum power generation and stable evacuation has been achieved, it is therefore suggested that such assessments should be initiated only two years after the commissioning of projects and should be confined to individual sub-projects.

A number of important lessons can be learned from the assessment of the Hilly Hydro Project. The project having been completed only in December 2003, the team would like to indicate that the substantial tangible results of the project are likely to take some time to clearly emerge. However, there are a number of useful lessons that the study has highlighted in the concluding chapter of this report.

The lessons that really stand out and deserve our focused attention are firstly the need for a more realistic time frame for such projects in the future and also a clear demarcation of this time frame into two distinct phases namely a preparatory phase and an implementation phase. It is also necessary to undertake comprehensive base line or bench mark studies in identified potential target areas selected for SHP development during the preparatory phase itself and which provide the basis for more realistic impact assessments. Secondly, the necessary infrastructure for effective and stable evacuation, as well as local distribution of power needs to be at least simultaneously developed and clearer provisions both financial and institutional should be explicitly spelt out and articulated in the initial project design and also incorporated into the DPRs. Thirdly, future projects need to ensure that the demand for cleaner energy and the balanced development of the load in the target areas is constantly kept in focus and encouraged through a well designed package of incentives and enabling institutional and administrative arrangements. Fourthly, future projects need to be closely integrated with other Rural Development Infrastructure, and livelihood enhancing projects taken up by other departments of the State in the target areas. This would go a long way in utilizing the significant inter-project externalities that exist and which are vital for long term sustainability and active peoples participation. Finally, our assessment indicates that future impact assessments should be conducted only after adequate time is provided for the projects to stabilize and function regularly. Any haste in this matter is likely to be deceptively discouraging in terms of the actual results of such a colossal and well concerted effort.

CHAPTER I

PROJECT CONCEPT AND DESIGN

A. CONTEXT OF THE PROJECT

India is on the forefront of the global renewable energy movement aiming towards sustainable energy security and development. Having added over 3800 MW of renewable electric capacity during 1992-2004, India has earned a place of respect in the global community. It is the only country in the world to have created an exclusive Ministry of Non-conventional Energy Sources (MNES) which has evolved a conducive and enabling environment to facilitate the accelerated development of environmentally friendly renewable energy sources.

MNES identified and initiated a project for optimizing the development of small hydel resources in the Himalayan and sub-Himalayan hilly regions of India, in order to achieve :

a) reduction in carbon emissions through use of perennial and renewable hydro energy resources,
b) protection of bio-diversity and reduction in deforestation, and
c) creating job opportunities and livelihood possibilities in the remote hilly areas.

The above proposal fitted well into agenda 21 of the Rio Summit, generally addressed all the four areas of concern to the GEF viz. Bio-diversity, Global Warming, Water pollution and Ozone depletion, while also directly or indirectly addressing virtually all the six thematic areas of priority for UNDP projects in general viz. poverty eradication and grass-root participation, environmental problems and natural resources management, transfer and adaptation of technology for development, women in development, technical co-operation among developing countries and management development.

In our opinion, the relevance of the project to the GEF concerns as of now, and to the UNDP thrust areas has been as follows ;

Relevance of the Project to GEF concerns

No.	GEF Concerns	GEF Priority weightage	Relevance		
			High	Partial	Low
1.	Bio-diversity	30%	√		
2.	Global Warming	50%		√	
3.	Water Pollution	15%	√		
4.	Ozone Depletion	5%			√

Relevance of the Project to UNDP Thrust Areas

No.	UNDP Thrust Areas	Relevance		
		High	Partial	Low
1.	Poverty eradication and grass root participation		√	
2.	Environmental problems and natural resources management	√		
3.	Transfer and adaptation of technology for development	√		
4.	Women in development			√
5.	Technical Co-operation among developing countries			√
6.	Management development	√		

Government of India is most concerned with poverty eradication, since a little over one fourth of the citizens in this country live below a modestly defined poverty line. The Government of India also realizes that growth and development cannot take place in the absence of adequate economic decentralization and peoples participation.

Private initiative, whether individual, collective or community-based, forms the essence of the development strategy articulated in the IXth and Xth Five-Year-Plans the latter being launched in the fiftieth year of independence, which will see the country not only into the next century but also into the next millennium.

While paying inescapable attention to basic infrastructure development, Government of India has also realized that economic growth even in this area has not necessarily led to commensurate improvements in the quality of life. Therefore decentralization is considered the essence for effective and responsive delivery of even the infrastructural services.

In the above context, the UNDP/GEF Hilly Hydro Project as conceived in the Project Document is highly relevant to the development strategy and priority of the Government of India. It aims at improving the quality of life of people living in remote hilly areas through private and community-based initiatives in the decentralized and responsive delivery of one of the most important infrastructural services i.e. supply of electricity at affordable prices, and in an environment friendly mode.

The Project has been equally relevant to the expectations and needs of the beneficiaries i.e. the end-users of electricity, the project developers, State nodal agencies for non-conventional energy development and the technical institutions associated with the project.

India has an assessed small hydro potential of 10,000 MW of which only about 1600 MW has been installed so far. With the systematic efforts of the MNES, small hydro power is emerging as a viable cost-effective option for providing electricity to the villages on a stand-alone basis and even as grid tail-end injection systems. A number of commercial projects are now being set up by private developers on canals as well as run-off-river sites.

Based on the strong foundations laid by this project and priority given by MNES, Govt. of India, for the development of small hilly hydro sector in the country a World Bank loan of US $ 70 million was given to MNES's financial arm, IREDA to finance 100 MW of small hydel power projects, which IREDA has successfully utilized, committing all the funds, one year ahead of schedule. Further, a second line of credit of US $ 110 million was given and stands fully utilised. Thus, the necessary lines of credit have been catalysed and are expected to provide the financial support for the rapid expansion of this vital energy sector.

The Himalayas – a vast chain of mountain ranges spanning more than 600 thousand sq. kms. of land is home to over 80 million people. The Himalayan belt has numerous perennial streams suitable for generation of hydro electric power. The project document clearly assumed that this energy, if made available in a cost-effective manner for cooking and heating, can change the deforestation trends in the region by reducing fire-wood consumption @ 1.42 tonnes per year per KW of installed capacity, even if the plants operated at 60% of their capacity and even when only 50% of the energy produced is used for cooking and heating, with the balance reserved for lighting and other uses.

With the liberalization of the economy in India during the VIII Five Year Plan, MNES has been encouraging a market orientation to the renewable energy programme with active private sector participation and with a 3-fold strategy for the development of Small Hydel Systems which is as follows :

a) Budgetary provision for demonstration projects,
b) Soft-term financing from IREDA, and
c) Fiscal incentives.

Considerable work on small hydro having already been done in China, Brazil, Australia, Finland and Sweden, it was proposed to draw on the experience of these countries and strengthen a few institutions in the Country, with AHEC, Roorkee as an apex institution. The environmental benevolence of small hydro projects, which can benignly merge in the existing fragile and sensitive environmental settings, might have been a major factor for the GEF to consider funding of the proposed project.

The Project was designed to assist the Government of India mainly through setting-up of 20 commercially viable small hydel demonstration projects, 100 water mills and upgrading the institutional and human resource capabilities from the local to national levels and finally by formulating a strategic master plan for the sector.

By developing a package of appropriate technologies and ‘management and ownership’ models which were people-centered, gender-sensitive and environmentally-sound, the project aimed at demonstrating the potential to reduce deforestation and protect bio-diversity in the eco-fragile Himalayan and sub-Himalayan region besides reducing carbon emissions. This was to be achieved by people’s participation in using electricity for cooking, heating and other purposes replacing fuel wood, kerosene, and other fossil fuels.

MNES was selected as the Executing Agency for the Project, with the National Project Director to lead the effort. He was assisted by a Project Management Cell, headed by the National Project Coordinator envisaged to coordinate the Project with technical support from AHEC, Roorkee, and IREDA as their fund managers.

B. PROJECT DOCUMENT

The Problem and the Technical Approach

(I) The Problem

i) While successive governments in India have been strongly committed to the task of rural electrification, access to electricity particularly in the remote hilly regions is very low. Even in these villages declared to be “electrified” there are a significant number of habitations that are not covered. In electrified villages too power is available for only 5-8 hours each day and the low tail end voltage which seriously affects the financially viable usage of electricity, poses a major problem. Moreover, it is both uneconomical and wasteful for the conventional grid to be extended to these remote locations. It is estimated that there are over 18,000 villages in the country mainly in remote locations that have not been effectively covered with the stable supply of electricity.

ii) Wherever some small hydro power projects exist, many of these are not efficient and cost-effective, the reason being that these are mostly scaled-down versions of large projects. While losing out on the economies of scale, simplified technology packaging not having been seriously attempted, there are redundancies and the systems are un-economical and commercially unviable and thus unable to attract Private Investments.

iii) There is a lack of awareness of the benefits of micro hydel projects among local communities.

iv) There is a general lack of testing facilities, dedicated training facilities and consultancy/ information services on Small Hydro Systems.

v) There are thousands of Water Mills operating inefficiently, requiring state-of-the-art technology inputs, for upgrading them.

vi) There are traditions in shifting cultivation in the Hilly areas – known as 'Jhoom cultivation' – which run contrary to environment-friendly land use.

vii) Cooking and heating in the remote villages is through the use of fuel wood burning. This has resulted in deforestation, affecting bio-diversity, besides leading to high levels of carbon emissions, which have detrimental effects on health and climate. With inefficient wood burning 'chullhas', a village woman can inhale smoke equivalent to 400 cigarettes a day.

In our opinion, the problems to be addressed by the Project have been very clearly defined and articulated.

[II] Technical Approach

i) The technical approach of the Project was to install 20 commercially viable demonstration projects in various Himalayan and Sub-Himalayan States that would serve as model projects for replication on a major scale throughout the Hilly regions of India. Economically optimal technology packages, tailored to local conditions, would then be available with proven methodology and implementation strategy.

ii) Zonal Plans and a consolidated strategic Master Plan was aimed at, identifying a large number of Small Hydro schemes in the entire Himalayan and Sub-Himalayan Regions, which would be ready for funding by the international donor agencies who are keen on sponsoring and enabling environmentally-sound technologies and projects.

iii) The power would be delivered to the beneficiaries around each project on a stand-alone basis, not linking them to any grid. At very few locations, where there is generation of electricity through diesel-generators, existing transmission lines, streetlighting poles and fittings would be used to the extent feasible. In other words local grids would develop around the SHPs.

iv) The main idea was to develop management and ownership models through village-level cooperatives, NGOs, people's groups etc. so that these demonstration units could be taken over by the local bodies for operation and maintenance and overall management including collection of revenue. The local personnel were envisaged to be trained in the operations, maintenance and management of these projects.

v) The aim was to prepare a Report on cost-benefit analysis, electricity tariff and revenue collection mechanism for sustainable operations of these units and use this Report for replication of these projects.

vi) 100 Water mills in different regions were to be identified and upgraded with add-on devices for electricity generation, again to serve as models for replication.

vii) Energy produced by the demonstration projects was to be used for cooking and heating etc. using low-wattage, energy-efficient appliances and with consequent reduction in deforestation. These innovative devices were to be popularised through social marketing personnel and NGOs. Agricultural pumpsets were envisaged to supply electricity for Irrigation purposes. The savings envisaged from the 20 demonstration projects were estimated to be as follows :

(a) 7,000 tons of fuel wood/ year
(b) 3,200 tons of carbon emission/ year

viii) With 500 Small Hydels totaling about 300 MW capacity deemed to be completed during the IX Five Year Plan, the following savings were envisaged :

(a) 420,000 tones of fuel wood/ year
(b) 189,000 tons of carbon emission/ year

ix) Three technical institutions in different regions were to be upgraded to a considerable extent in the field of training and consultancy/ information services on Small Hydel Projects.

x) Core competence of Key personnel associated with the Project was expected to be upgraded in the field of planning and handling of Small Hydro Projects and also in the determination and upgradation of optimal investment policies and implementation arrangements.

xi) Afforestation of catchment areas, where necessary, would be carried out by the Forest Departments of the State Governments.

xii) Towards the terminal end of the Project, a revolving fund was to be operationalized by IREDA to provide soft loans for private participation, for which the Project was expected to have catalyzed considerable interest.

In our opinion, the project approach and strategy was clear and emphatically categorical.

[III] Objectives, Success Indicators and Major Assumptions

No.	Objectives	*Indicators of Success*	Major Assumptions
1.	To develop a national strategy and a master plan with detailed investment proposals for the optimum utilization of small hydel resources of the Himalayan and sub-Himalayan regions.	i) A success criterion would be the acceptance of the master plan by the MNES and its incorporation in the 9th and 10th Five Year plans, with necessary budget provisions. ii) Another criterion would be the interest evinced by potential international donor agencies by way of commitment of funds for some of the projects included in the master plan.	i) Master Plan would be ready before the onset of IX Five Year Plan, would be accepted by MNES and progressively implemented by the State Governments. ii) International donor agencies would be interested in supporting environmentally sound projects in hilly and isolated rural areas.
2.	To develop a package of commercially viable and environmentally sound technologies, on the basis of	i) A success criterion would be the adaptation and replication of these demonstration projects on a major scale throughout the hilly regions of India.	i) The demonstration project would become ideal models for replication and that all the States having hilly regions would proceed to replicate these projects.
No.	Objectives	*Indicators of Success*	Major Assumptions
2.	installation and commissioning of twenty demonstration units at various selected places, for generation and use of small hydel power and to develop appropriate models for ownership, management and maintenance of the small hydel projects through people centered and participatory approach.	ii) Another success criterion would be the reduction in the cost of installed capacity per kilowatt and in the cost of electricity per kilowatt hour compared to pre-project situation and stepped-up acceptance of end-use appliances by the people. iii) The third success criterion would be the participation of the local people in the ownership, management and maintenance including collection of revenue and expenditure of the small hydel projects.	i) Cost reduction of the order of 30 – 40% was expected to be achieved in the supply of electricity generated by the small hydro projects. People of the area would switch over from fuel wood to electricity primarily for cooking and heating, and accept low-wattage appliances. ii) Local people would participate in ownership, management, maintenance and revenue collection. Women would be largely freed from the task of collecting fuel wood and would be employed in

			small scale and cottage industries which would come up as a result of surplus electricity generated locally.
3.	To develop the institutional and human resources capabilities, from the local to national levels, needed for the execution/ implementation of the project and for sustainable development of the mini-micro hydel sector in hilly regions.	i) A success criteria would be the establishment of a 'core team' of officials at the national and state levels who would be able to handle independently the planning, design, construction, maintenance, operation and management as well as a large number of local people, in Panchayats or other local bodies, trained in the management and maintenance aspects of small hydel projects. ii) The other success criteria would be the extensive use of the three selected technical institutions, in the fields of testing, training, applied research and in the provision of consultancy and information services for small hydel projects.	i) It was presumed that training would have significant impact at the local as well as national level, and a core team of officials would be created. ii) It was assumed that the three selected technical institutions would take interest in capacity-building, so as to provide all Technical inputs for SHP development.

In our opinion, linkage among the objectives, expected outcomes and impact (indicators of success) and the major assumptions were fairly rational and logical. Anticipated risks in failure of assumptions were low.

[IV] Identification of Beneficiaries

Following beneficiaries were identified to be targeted by the Project :

i) People living in remote villages in the hilly regions, mostly tribal, poor and illiterate. [It was expected that each project would cover on an average around 200 families involving approx. 900 people].

ii) Three selected technical institutions.

iii) Implementing Agencies viz. State Nodal Agencies and Private Developers.

iv) MNES.

v) State Electricity Boards.

vi) NGOs associated with Water Mills and Demonstration Projects.

vii) Women as users/ trainers/ motivators in the load development appliances.

viii) Local 'generation and distribution' management agencies.

ix) Manufacturers of equipment and retailers of identified appliances.

x) Various NGOs and National Consultants entrusted to undertake different studies.

[V] Involvement of beneficiaries in the formulation and implementation of the Project

The beneficiaries of the electricity in the local area were to be involved with the Project right from the concept to planning & management including operation, maintenance and long term sustenance which interalia included revenue collection and overall administration. The idea was to transfer these demonstration projects after commissioning to the local bodies (Panchayats, Cooperatives and Local groups).

The users of electricity around the project were also to be involved in the use of low wattage, energy efficient appliances in lieu of fuel wood. They were to be involved in using electricity for warming of green houses for agricultural and horticultural purposes and setting-up of small-scale industries like fruit processing etc. Pump-sets were to be provided at representative locations to facilitate terrace cultivation.

The National Consultants were to work hand-in-hand with International Consultants on several issues like technology selection, Master Plan etc.

MNES, State Nodal Agencies and the Technical Institutions were to be involved with the planning, designing and implementation of the demonstration projects. The SEBs were to be involved in power evacuation arrangements and signing of the Power Purchase Agreements (PPAs) with the State Nodal Agencies/ Project Developers.

MNES was to be a focal point in organizing and coordinating all the activities through its Project Management Cell (PMC).

The Technical Institutions were to be involved in the consultancy services for preparation of feasibility and detailed project reports (DPRs), organizing training courses, testing and information services.

Manufacturers of equipment were to be involved with the Project right from the conceptual stage so as to be able to supply the right kind of technologies and products.

While beneficiaries including nodal agencies and operational partners have been clearly defined envisaging their involvement in formulation and implementation of the Project, "stakeholders" have not been explicitly identified by the Project Document. While discussing with NPC during the evaluation, it appeared to the Evaluation Team that the end-users of electricity, State nodal agencies, project developers and the Technical Institution viz. AHEC were being considered as the stakeholders.

[VI] MODALITIES OF EXECUTION

Executing Agency and Management Arrangements

MNES was selected as the Executing Agency for the Project. The Project was to be organized through a Project Management Cell (PMC) headed by a National Project Coordinator (NPC), under the overall directions of National Project Director (NPD), a senior-level functionary of the MNES. A Project Implementation Committee (PIC) was to supervise the Project with Secretary, MNES as Chairman and the National Project Director as its convener. For functional consultation and guidance besides frequent monitoring, a Project Executive Committee (PEC) was envisaged under the Chairmanship of the National Project Director, its convener being the National Project Coordinator.

Implementing Agencies/ Recipient Institutions

The implementing agencies/ recipient institutions for the Project were identified as under :

- **i) State Nodal Agencies/ Power development departments,**
- **ii) AHEC – An apex Technical Institution for the Project,**
- **iii) Private Developers,**
- **iv) NGOs, Local Cooperatives, Water Mill Association etc., and**
- **v) National and International Consultants.**

The Project Document defines in broad terms the implementation arrangements envisaged. While the modalities of corporate functioning were clearly spelt out, the networking of time-bound arrangements with numerous agencies responsible for conceptualizing, planning, designing, procuring, contracting, organizing statutory clearances, policy translation to field realities, inter-department and inter-governmental co-ordination consultancy services, involving NGOs, community leaders, women in the project formulation and implementation, etc. could have been concretized to a higher degree of precision.

Mandatory/ legal binding and formalized levels of commitment through MOUs and Agreements, in the context of the Project document, could have been put in place, to avoid the present level of diffusion of commitment to a common cause and a shared vision.

Work Plan : Activity Blocks

The work plan was drawn for a period of 42 months dividing the project activities into 10 activity blocks as follows :

- **(i) Survey and Assessment**
- **(ii) Zonal Plan**
- **(iii) Technology Selection**
- **(iv) Water Mill**
- **(v) Load Development/ Low Wattage Appliances**
- **(vi) Project Execution : Demonstration Schemes**
- **(vii) Environment Assessment**
- **(viii) Training**
- **(ix) People's Participation**
- **(x) Master Plan**

The Major activities covered under the above 'activity blocks' were the following :

1. **Review and assess all available data including existing infrastructure facilities and untapped small hydel potential.**
2. **Prepare a zoning plan identifying different zones for different techniques of hydel generation.**
3. **Establish long term objectives and investment strategies.**
4. **Prepare development plans for development of small hydel projects in each zone.**
5. **Conduct thematic studies and prepare reports on various issues and aspects of importance to the master plan.**
6. **Prepare a master plan for optimum utilization of small hydel resources in the regions.**
7. **Identify twenty small hydel projects to serve as demonstration projects.**
8. **Prepare designs using latest available technology to improve the efficiency of small hydel projects.**
9. **Prepare drawings, specifications, tender documents, call for bids and award contracts for the demonstration projects.**
10. **Execute the demonstration projects.**
11. **Examine proof of viability of the new technologies and designs, monitor project implementation and ensure quality control, design safety, reliability and prepare completion drawings.**
12. **Prepare operation and maintenance manuals for these projects in two languages.**
13. **Provide on-the-job training to the local personnel in the operation and maintenance of these projects.**
14. **Update the master plan on the basis of experience gained through the demonstration projects.**
15. **Carry out survey on the use of electricity generated by the demonstration projects.**
16. **Carry out survey and formulate a load development programme.**
17. **Implement the load development programme.**
18. **Identify and upgrade 100 water mills through improved designs and add-on facilities for electricity generation etc.**

19. **Train villagers in different skills, to work in small scale industries and also set up their own small scale industrial units.**
20. **Set up and operationalise a revolving fund.**
21. **Prepare report and implement the management of small hydel projects.**
22. **Identify and train personnel in the planning, design, implementation, operation, maintenance and management of small hydel projects.**
23. **Develop/ upgrade the capabilities of the three technical institutions in the fields of testing, training, applied research and consultancy and information services.**

The Evaluation Team has noted that despite it being the aim of the Project and the same having been clearly stated in the Project justification (page 12 of the Project document), none of the activities listed above specifically relates to the infrastructural work of electrification of the surrounding villages to go hand-in-hand with the commissioning of the demonstration projects.

OUTPUTS

Outputs envisaged from the above set of activities were as under :

[A] Master Plan

1. **Assessment of existing Infrastructure and untapped potential,**
2. **Zoning plan,**
3. **Long-term objectives and investment strategies,**
4. **Zone-wise development plans,**
5. **Thematic studies, and**
6. **Formulation of a Master Plan comprising national strategy and investment proposals.**

[B] Demonstration Projects

1. **Identification of 20 demonstration projects.**
2. **Design with latest technology.**
3. **Drawing, specifications, tendering, award of contracts.**
4. **Execution and operationalising the demonstration projects.**
5. **Assessment of techno-economics, quality, safety and reliability.**
6. **Survey on cost-effectiveness of electricity and fuel-wood savings.**
7. **Manuals for O&M and spare parts management in English & Local language.**
8. **On-the-job training of locals in O&M.**
9. **Survey on fuel-use pattern, load development, reduction of carbon emission.**
10. **Implementation of load development appliances together with their O&M manuals.**
11. **Identification, development, upgrading, testing, add-on electricity generation and commissioning of 100 water mills.**
12. **Training villagers, including women, to set up and work in small scale industries.**

13. **Operationalize revolving fund for Equipment.**

14. **Report on management of SHPs including cost-benefit analysis, electricity, tariff and revenue-collection mechanism for implementation.**

[C] Capacity-Building

1. **53 fellows to be trained from the agencies associated with the Project.**
2. **Development of facilities in the three selected TIs, in testing, training, applied research, consultancy/ information services.**

Inputs

Government Inputs

1.	**Budget**	**:**	**Rs. 224.8 million (in kind)**
2.	**Personnel**	**:**	**NPD, PIC, PEC, PMC, TIs, Support personnel**
3.	**Training**	**:**	**Courses, Seminars, Workshops**
4.	**Equipment**	**:**	**Expendable and Non-expendable equipment**

UNDP Inputs

1.	**Budget**	**:**	**US $ 7.5 million**
2.	**Personnel**	**:**	**International Consultants, National Professionals**
3.	**Travel**		
4.	**Sub-Contracts**	**:**	**Survey, Thematic studies, EIA etc.**
5.	**Training**	**:**	**Fellowships**
6.	**Equipment**	**:**	**Expendable and Non-expendable equipment**

In our opinion, activities planned had proper linkages with the objectives and outputs delineated which, in turn, were commensurate with the inputs.

Indicators for Monitoring and Evaluation

Project review and evaluation has been described in very broad terms and we did not find well-defined indicators for Monitoring and Evaluation in the Project Document. Monitoring and Evaluation indicators could have been elaborated with early-warning signals and PERT etc.

Project Schedule

The Project was originally conceived as a 3-1/2 Year (42 months) activity. It started in Jan '95 and should have ideally been completed in June '98. Not having progressed enough, it was extended by 1-1/2 years i.e. until Dec '99 and further till Dec., 2003.

The Project being multi-purpose, multi-agency and multi-disciplinary in nature, trying to address a large development issue, hoping to make an impact in as many as 13 Himalayan and Sub-Himalayan States having their own administrative set-ups, policies, their own concerns and perceptions and political environments; should have been more realistic in its time horizon.

It could have been planned in two distinct phases,

1. **Preparatory phase, and**
2. **Implementation Phase.**

The preparatory phase of 2 years could have been devoted to the surveys, thematic studies, and preparation of inputs for Zonal & Master Plans, innovating load development appliances, sensitizing project beneficiaries, conducting EIAs, policy fine-tuning at the Central and State Government levels, identification of Demonstration Projects and Water Mills, settlement of MoUs, PPAs and Project Execution agreements. The next 3-year phase could have been utilized for execution of demonstration projects, water mills, implementation of load development appliances, Training and capacity-building, finalisation of Master/ Zonal Plans, continuing involvement of local communities (by gender) and finally the impact assessment of the Project against the perceived objectives.

CHAPTER II

PROJECT IMPLEMENTATION

A CRITICAL ASSESSMENT OF THE IMPLEMENTATION PROCESS

The UNDP-GEF assisted India Hilly Hydro Project was conceived as an activity which was to be completed in a period of 42 months ($3^{1/2}$ years) corresponding to the end of the VIIIth National Five Year Plan period so that it would provide a strong foundation for Small Hydro Development during the IXth Five Year Plan.

The project commenced in January 1995 and as such was to be completed by June, 1998. However due to its slow implementation it could be concluded only in December 2003. The project thus actually took an additional $5^{1/2}$ years or 66 months to be completed which perhaps reflects that the time horizon was not realistic. The task of effective and timely implementation within this short time horizon was particularly challenging considering that the project was not only addressing a very large and complex development issue but also hoping to make a very wide spread impact in as many as 13 Himalayan and Sub-himalayan States, spread over a vast geographical area.

We would therefore tend to agree with the views expressed by the mid term evaluation mission that the project could have been taken up in two distinct phases namely a preparatory phase of about 3 years, and an implementation phase of about $3^{1/2}$ years, with the former preparing the basic ground work for the timely and effective execution of the implementation phase. The near simultaneous execution of all the activity blocks over a very short time span seems to have led to an 'overcrowding' of several activities leading to serious constraints in the coordination and implementation process. As a result some extremely critical activity blocks necessary for the realization of the impact may have been neglected and only partially implemented. This dilution in turn may have considerably reduced the expected impact particularly at the sub-project level if not at the overall national level. It is therefore necessary for us to briefly assess the project implementation process on the basis of some broad or generalized but important parameters in order to carefully highlight the strengths as well as weaknesses in implementation that has affected the final impact of this project in terms of its basic objectives.

INSTITUTIONAL ARRANGEMENTS FOR PROJECT IMPLEMENATION:

At the overall level the project has been well managed. This has been particularly visible at the level of the Apex Executing Agency which is the MNES. The regular monitoring of the project by the National Project Director (NPD) with the assistance of the Project Management Cell specially created in the MNES for this purpose, has in turn been regularly evaluated by the Project Execution Committee (PEC). The project has also been monitored and occasionally evaluated by the Project Implementation Committee. The project has also been audited annually by UNDP since its inception. However, it needs to be mentioned that the one key functionary the NPD (who is the Member Secretary of the PIC) mainly responsible for the effective implementation of the project was changed several times creating discontinuities that may have in more ways than one, led to the slowing down of the implementation process.

As provided for in the Project Document a Tripartite Review Meeting is reported to have been held once in a year. The frequency of these meetings could have been increased on noticing delays and time overruns in the implementation process. This would have put the necessary pressure on all parties to speed up the implementation process. Though the UNDP/GEF National Coordinator and his team did visit the project sites occasionally to assess the ground level situation relating to different activity blocks, these visits could have been more frequent and purposive while also leading to necessary and timely follow up initiatives particularly in relation to those activity blocks where progress was slow or inadequate. These critical activity blocks, which suffered neglect would ultimately dilute the expected impact of the project. However, the overall financial support extended by the UNDP country office seems to have been both adequate, and timely.

The general commitment of the Government at least in principle has been very significant however in actual practice it has varied at different levels. At the level of the Central Government the involvement and material support provided by the MNES has been substantial. The National Project Director has right through the project-enjoyed adequate delegated powers for effectively carrying out his tasks, however the same cannot be said regarding the National Project Coordinator whose tasks and responsibilities were equally essential for the effective monitoring and implementation of the project. As for the State Governments the level of commitment has certainly varied over the different participating States. While States such as Himachal Pradesh and Uttaranchal located in the Western Himalayas and with relatively greater geographical access to the Central Government in Delhi, have demonstrated a fairly high degree of commitment, others who are located in the Eastern and North Eastern Himalayas have shown little or at times no commitment to the project, with perhaps the exception of West Bengal and Assam. This varying commitment may have been conditioned by the relatively greater access and interaction with the Central Executing Agency as well as the locational and logistic support received by some of them from the only Technical Institution namely the AHEC, Roorkee that was located closer to these two States. Moreover the State Nodal Agencies (SNA) in the more committed States were also relatively more developed and supported by the respective State-Governments as compared to others. Due to these reasons the Project has generally failed to make a significant impact in most of the Eastern and North Eastern States though most of these are substantially endowed with small hydel potential.

It may be important to mention here that even in these States where the commitment towards the project was high or substantial the Nodal Agencies in these States have lacked the administrative strength to resolve various problems at the local level with other State Government Departments and Agencies. In most cases the State Nodal Agencies have been left to fend for themselves without much support from the State Governments who have to nurture and strengthen them in order to effectively enable them to function and deliver outputs for which they have been set up. The weaknesses of the SNA in terms of both manpower and physical and financial resources is perhaps the clearest reflection of the commitment that each State Government has had towards this project in particular and mini and micro hydel schemes in general.

The State Governments have also neglected the need to dovetail and coordinate this project with other development activities in the area. Had there been a serious attempt at dovetailing programmes related to employment, entrepreneurship development, water supply and sanitation, village infrastructural asset creation programmes, horticulture and minor irrigation programmes, with these Hilly Hydro Projects the impact on the ground or on the beneficiaries in the targeted area would have been substantial in terms of achieving the employment, livelihood and regional development objectives of the project.

It was also observed that even though the Project Management Cell did establish mechanisms for monitoring and reporting with the various field level agencies actively engaged in the implementation of the project, they did seem to have faced several difficulties in obtaining and timely gathering of relevant information and feed back from these various sources. This was mainly on account of the absence of a State Level Project Coordinator who could be made clearly responsible and empowered with adequate powers and facilities for providing this information to the NPC.

The 'Stakeholders' of the Hilly Hydro Project who participated actively in the management of the project were the SNAs, the State Power Utilities, AHEC a few NGOs and some private developers. However the local population and their representative organizations in the sub project areas particularly women, for whom a major stakeholder role had been visualized and clearly articulated in the project document were hardly involved in the management or monitoring of the sub projects and therefore never really developed a sense of ownership and stake holding in the project. This non-involvement and neglect of the local population has been a major set back for the timely and effective implementation of the project and has diluted the actual and effective impact of the project.

THE EFFICIENCY OF THE PROJECT IMPLEMENTATION PROCESS:

At the overall national level it may be said that the project has utilized most of its resources in achieving its targeted outputs. This is particularly reflected in the creation of a comprehensive Master Plan by the CES and detailed Zonal Plans by the AHEC. However greater interaction and coordination between the CES and the AHEC could have helped in achieving these outputs in a shorter period of time as well as gone a long way in improving their quality and depth.

The active involvement and development of only one out of the three National Technical Institutions for capacity building, testing, research and consultancy which were considered to be vital ingredients for the success and sustainability of the project has been a major drawback for the project and has constrained the development of the Small Hydel Sector in many of the participating States and considerably slowed down the pace of implementation of the project.

As regards the national and international personnel deployed in the project their efficiency and effectiveness has not been as significant as desired. A larger number of competent national consultants could have been identified and involved particularly those who had high competencies and capacities in ensuring greater peoples participation and more effective social marketing specially in relation to women beneficiaries of the targeted areas.

The training component and related inputs in the project were of fairly high quality. Several training fellowships and national training programmes and workshops are reported to have been organized. The rather hasty and casual identification of persons to be trained may have affected the end results of this activity. Moreover while training inputs were substantial for those posted in senior positions in the implementing agencies more training inputs could have been provided to those at the middle and lower levels who would ultimately operate and maintain the sub projects. It is also felt that several persons who benefited from training were not retained in the sector for long enough to make any visible or tangible impact. Ensuring an adequately long tenure for those trained under the project in appropriate posts and positions within the States Small Hydel sector could have gone a long way in achieving faster and more efficient implementation as well as optimal resource utilization.

The desk equipment procured under the project was both appropriate and of good quality, it was also observed that most of this equipment was fairly well maintained and utilized productively. It may however be emphasized that adequate equipment related to testing and rating of Electro-Mechanical

Devices and Control Systems should have been procured and installed in the Technical Institutions at an early date. This would have provided the appropriate and much needed facilities for initial scrutiny and testing of equipment before final installation and commissioning as most indigenous manufacturers supplying various components were deficient in terms of in-house testing and rating facilities. The electro-mechanical and control equipment finally procured for the demonstration sub-projects was observed to be wanting in several respects. The problems of frequent breakdown and the non-availability of spares and replacements has been significant at the sub-project level as we shall be seeing in some detail when we discuss the functioning of the sub-projects. It may be mentioned that equipment related problems have been more frequent in the case of larger sub-projects in the capacity range if 400 KW to 1 MW. However, the quality of equipment and techno-economic efficiency of smaller stations in the range of 50 KW to 200 KW has been very good as also reflected in their performance. This perhaps indicates that in most cases a phased expansion of generating capacities would have led to better and more stable performance and higher techno-economic efficiency.

As regarding the important issue of project outputs and the achievement of immediate objectives the overall progress has been slow but significant. The timeliness of various inputs has differed as between various project activities. The weakest area of project implementation has been the participation of local people particularly women as also the evolution and development of ownership models for the sustainable and participative management of these projects. As regards project benefits the SNAs, the Developers from the public, private and NGO sectors and the only Technical Institution which is the AHEC, and to some extent the State Power Utilities have benefited both in term of capacity building as well as other spin offs from the project. The local communities have also benefited in several ways indirectly if not directly. These benefits have been realized particularly in those areas where sub-projects have started to supplement power availability and thereby bringing about tangible improvements in the quality of power supply and also the general quality of life specially in regard to lighting, communication, and media facilities. We shall attempt to analyze and assess these significant changes on the basis of our sample survey later in the report.

THE EFFECTIVENESS OF THE HILLY HYDRO PROJECT :

On the whole the effectiveness of the project as assessed on the basis of the results achieved so far have been significant if not substantial. The input mix of the project has been fairly economical and there were really no alternatives which could have produced the results so far obtained with fewer resources. From the progress made by the project so far it can be said that the outputs that are being delivered at this stage are marginally contributing to some of the immediate objectives. However one may hasten to add that as the sub-projects have still to achieve stable generation of power in most cases it could really take some time may be another year or two till the outputs significantly contribute to some of the immediate objectives particularly those related to GHG emissions deforestation and protection of bio diversity as well as employment generation and better livelihood possibilities in the target areas covered by these demonstration sub projects.

In the sphere of capacity building the enabling environment as well as the facilities developed in the sole Technical Institution has been satisfactory. However the situation could have been far more effective if all the Technical Institutions envisaged under the project had developed, this would have dispersed the enabling environment for capacity building more widely over the entire range of participating States. The Institutional Development and related Human Resource Development can thus only be said to be satisfactory and partially successful as implementation regarding this aspect has been quite slow. The training inputs provided under the project seems to have benefited a fairly narrow range of project personnel as these have been concentrated on a certain selected category of senior trainees. The range of training could have been much wider, if it was also extended to larger number of project personnel at the middle and lower levels dealing with field level management, operation, and maintenance. Supplementary efforts are still needed to develop the remaining Technical Institutions in the Eastern and North Eastern Sectors so that the vast small hydro potential that exists in other areas *can be effectively exploited with greater participation by private developers and others in these regions.*

Though the overall impact of the project can only be described as being partially successful mainly because the benefits due mainly from stable operations of the sub-projects is yet to reach the larger population living in the target area, however other direct beneficiaries such as the SNAs and Developers have significantly benefited from the project. However, it should be stressed that as power generation from these demonstration projects stabilize and supplement the grid over the next few years there is all likelihood that the utility of project outputs would certainly come about. So will the gender differentiation in the utility of outputs become more apparent and visible. However, this is a slow and complex process and any expectation of a fast and spectacular transformation of the environment and livelihoods should be avoided. On the environmental front the impact of the project has been very insignificant so far, however in the long run there could be some impact in terms of lowering of emissions particularly those related to the consumption of diesel and kerosene oil. Though in the case of fuel wood very little substitution exists at present and no significant changes can be expected in the long run as well, unless financial incentives through the provision of subsidized cooking and heating appliances, as well as lower seasonal differential electricity tariffs are seriously considered.

As far as financial effectiveness of the project is concerned the entire project was partially subsidized. At the present stage the project has not reached the self financing stage however with improved management and maturity of the projects they are likely to generate their own resources and in all likelihood become viable self financing entities. However a lot depends on the enabling conditions provided for financial viability by the State Governments and even more significantly on the pace at which load development takes place in the target areas.

Summing up briefly, the major factors that have affected the implementation process and thereby the production of outputs and the consequent impact are as follows :

1. Inadequate coordination between the state and field level functionaries and agencies.

2. The very partial or inadequate development of Technical Institutions.
3. The complete lack of mobilization of local communities and their lack of involvement in the project.
4. Substantial delays in the completion of certain critical actively blocks.
5. Inefficient and ineffective monitoring of the project due to substantial delays in the receipt of information from the field.

CHAPTER III

PROJECTS RESULTS

In this section we briefly but critically assess the progress made in relation to each of the 10 broad activity blocks envisaged in the project at the time the project was concluded in December, 2003. Our comments in this section are based on discussion we had with various project personnel in the MNES as well as the State Government, AHEC, the Developers and key persons in the project impact area (during our field visits), we have also extensively referred to the Status Reports produced by the MNES as well as the Mid Term Evaluation Report for the project. This assessment of the progress made in terms of activity blocks is followed by a brief presentation of the positive results achieved by the project.

1. ACTIVITY BLOCK : SURVEY AND ASSESSMENT

This activity of Survey and Assessment was taken up in the initial period of the project in order to assess the institutional capabilities, infrastructure and the status of small hydro development in all the 13 participating states. The responsibility of conducting this study was given to the Tata Energy Research Institute, New Delhi. Information related to Small Hydro Development in all these States was collected through a series of interaction with the State Power Departments/ SEBs, State Nodal Agencies for Renewable Energy, Agencies connected with the development of Small Hydel Projects, some NGOs and Technical Institutions. Information regarding the existing energy scenario, the institutional structures which were in place for implementing these projects, the existing status of small hydro power development and projects under execution and survey were compiled for the 13 participating States. The study was completed in March, 1996 and laid out the ground work for proceeding further with the project. It may however be mentioned that information related to the existing transmission and distribution infrastructure and existing loads specially in remote locations where the SHPs were likely to be set up was not attempted, this would have provided for some special initiatives for strengthening the transmission and distribution systems around the sub projects and also to frame more effective load development strategies in the sub project areas. The information compiled was however utilized to some extent in the preparation of the Zonal Plans and the Master Plan, planning of various activities, and strengthening of human resources in the participating States. The absence of proper base line or bench mark exercises as a part of this activity block seems to have been a missed opportunity for enabling subsequent impact assessments in the target areas.

2. ACTIVITY BLOCK : ZONAL PLAN

This activity block involved the zone wise assessment of potential of small hydro power in the participating States and the identification of potential sites (up to 3 MW) using remote sensing and computer modeling. The work was assigned to the Alternate Hydro Energy Centre (AHEC), University of Roorkee, which subsequently was made the IIT, Roorkee. The International Consultant for this activity was M/s. Mead & Hunt, USA. This work is reported to have been completed in a period of three years with the active involvement of the National Institute of Hydrology, Department of Earth Sciences and Centre for Remote Sensing, University of Roorkee. It was also reported that the work involved close interaction with the State Agencies and that comments and suggestions were regularly received by the AHEC from the International Consultant.

This exercise of assessing the hydro potential and potential sites in different zones was started with the collection of some basic information from each participating State. It is reported that around 600 topographical maps of the Survey of India related to the Himalayan Region were comprehensively scanned and the Maps prepared by the National Thematic Mapping Organisation, Calcutta were also used for this purpose. With this basic information suitable catchment areas were delineated and watershed boundaries identified and drawn. The discharge data for various catchments thus identified were compiled for the development of Regional and Sub-Regional flow duration curves. Related and relevant information regarding vegetation cover, geology and seismology was also incorporated to identify potential sites for small hydro projects. The zonal plan also relied on the study conducted by the Central Electricity Authority on the identification of potential hydro sites up to 15 MW, which had clearly identified 2162 SHP sites with a potential of 3827 MW.

It is also reported that the draft zonal plan report prepared by the AHEC was circulated to all the participating States for comments. Two training workshops were also organized by the AHEC on GIS based identification of small hydro sites. The final draft report was discussed with the participating States in June, 1999 and the report was revised and reoriented after incorporating several comments made by the Mid-term Evaluation Mission. It has been claimed that the report has been printed and circulated widely to the State Governments, Private Developers and other stake holders, however in several areas visited by our team it was felt that the circulation and dissemination of this document to lower levels among the stakeholders was inadequate, particularly among NGOs and CBOs active in various zones. However it needs to be mentioned that the zonal plan has been widely consulted by a number of participating States and has also provided the basis for the development of a countrywide information base related to small hydro potential. It is noteworthy that some States like Himachal Pradesh have improved and developed additional software which provides full details of sites as well as choices in the selection of technologies to set up SHP projects. The State of Himachal has also offered over 400 sites identified as part of the zonal plan to private and NGO developers for setting up SHPs. It is also reported that the newly formed States of Jharkhand and Uttaranchal are also actively utilizing the information provided in the zonal plan and also making their own attempts and refining and improving the zonal plans for their respective States. The commendable work done under this activity block has been widely appreciated and stands fully completed and its overall impact on enabling and catalyzing small hydro power development has been significant and substantial, this is amply reflected by the MNES plan to extend this exercise to all the States in the country during the 10^{th} Plan Period.

3. ACTIVITY BLOCK : TECHNOLOGY SELECTION

This activity was initiated on the basis of a comprehensive survey of existing World literature and experience for selecting the most appropriate technology mix for use in the demonstration projects to be set up under the Hilly Hydro Project. The AHEC Roorkee was assigned the responsibility as the National Consultant for this activity block while M/s. Mead & Hunt of the USA was appointed the International Consultant. A very comprehensive technology survey is reported to have been carried out wherein the most appropriate technologies with the state of the art low cost civil, mechanical and transmission and distribution works for each project were identified. These technologies having been selected are now used in the demonstration projects. The technologies selected were incorporated in the tender documents and thus realized in the civil and E&M components of each sub-project. The significant state of the art concept like COANDA screen intake structures, SCADA system for automatic control and monitoring, and load diverters to replace mechanical and other governors specially in smaller sized projects were adopted and has to a considerable extent been seen by and created significant interest among many private developers. However it is felt that some more International Consultants could have been involved in this activity to provide a wider range of choices through greater international exposure within this critical activity block. It is felt that a few more International Consultants having experience in working with and in other developing countries could have improved the choice of appropriate technology to a much greater extent. We would like to reiterate this point which was appropriately raised by the Mid-Term Evaluation Mission. And though this activity block was completed it would still be worthwhile updating future choices in this ever expanding sector.

4. ACTIVITY BLOCK : WATER MILLS

This activity aimed at improving and upgrading the design of traditional water mills in order to make them mechanically efficient and also to generate electricity for local needs. The project envisaged the installation of 100 such upgraded water mills spread over several participating States. The National Consultant for this activity was the AHEC, Roorkee for the States of J&K, U.P. (now Uttaranchal), Himachal Pradesh, and Bihar while the Tata Energy Research Institute (TERI) was made responsible for this activity in the North Eastern Region.

In all it is reported that 143 water mills with new designs were installed, these were largely mechanically upgraded mills as only three of these could be further upgraded for electricity generation. This clearly shows that the water mills as a means of localized generation and usage of power was not able to achieve any significant impact. It was also reported that of the 143 water mills upgraded under the project only 23 were installed in various locations in Himachal Pradesh, 20 were upgraded and installed in J&K, 50 were installed in Uttaranchal and 50 were upgraded and installed in Arunachal Pradesh. The remaining States do not seem to have participated in this activity block, as use of water mills in these States is not prevalent. The upgradation of water mills seems to have progressed more in those States where the State Nodal Agencies were active. A great deal of effort went into the designing and testing of upgraded watermills at the AHEC, Roorkee. While on the spot training was said to have been provided by the installation teams, training programmes were also organized at the AHEC involving local bodies, NGOs and water mill owners. However as observed during our field visits it was clear that adequate follow-up and monitoring after installation was deficient in many areas specially in Uttaranchal and Himachal. During our discussions with water mill owners in selected sites we got the general impression that the careful *screening and selection of beneficiaries was not given adequate attention, these selections seemed to have been carried out in great haste which may have been one of the basic reasons for the dilution of the possible impact and demonstration effect. Our teams visit to one such area revealed that of the seven upgraded water mills installed in the Juthed Sub Project area in H.P. as many as three were not functioning while in two cases the owners had reverted back to the traditional models as they were not convinced about improved performance, and also dissatisfied with the technical support received from the Nodal Agency. At the same time it was also observed that the response regarding water mills was very encouraging in parts of Uttaranchal, and largely based on these encouraging responses the MNES has launched a fresh revamped scheme for the up-gradation of water mills. It is also reported that apart from two manufacturing facilities one at Saharanpur (UP) and the other in Guwahati (Assam) which have developed for the manufacture of water mills based on the new design, there are other indigenous manufacturers who have shown an active interest in this activity. A few NGOs in Himachal Pradesh, J&K, Uttaranchal and Arunachal Pradesh have started to get actively involved in motivating water mill owners to take up this work, while also disseminating and propagating the utility and possible multiple applications of improved design. The multipurpose unit of water mills which generates electricity have not only enthused villagers and water mill owners in several parts of the country but has also attracted a few small entrepreneurs who are now keen on promoting localized electricity generation through such village based units particularly in small and isolated habitations. A Bangalore based and a Varanasi based entrepreneur have further improved and modified designs and installed power generating units in several locations. Such commendable effort should be supported through well designed incentives in order to encourage private entrepreneurship in this field.*

It may also be mentioned that while operation and maintenance manuals and brochures have been prepared and distributed to the users and motivators, UREDA the SNA for Uttaranchal has taken a significant lead in this activity by publishing a detailed manual in the local language which contains valuable information on diverse field applications possible through the upgraded mill. It also highlights the various incentives offered to water mill owners for up-gradation and *provides an outline on the financial implications of up-gradation. While this activity block stands completed and the target set forth in this project achieved, a lot more needs to be done by the SNAs in all the participating States in order to maintain and sustain the momentum gained in water mill up-gradation during the project.*

5. ACTIVITY BLOCK : LOAD DEVELOPMENT/ LOW WATTAGE APPLIANCES

The availability of uniform load for decentralized power projects poses a major challenge affecting their power load factor as well as economic viability since the project was clearly visualized to cater to the power requirements of remote areas through 'stand alone' SHPs. Uniform load development during non peak hours and load limitations during peak hours was an essential condition for the techno-economic sustenance of the plant. The project therefore envisaged development of Low Wattage Appliances for the development and utilization of uniform load specially during the day and during late night hours. These appliances were developed as prototypes which would then be tested in project sites around three already existing

SHPs functioning in a decentralized set up. The experience gained from these tests and trials would then be used for improving the appliances as well as utilizing those that were found suitable for utilization in the demonstration projects.

The National Consultant for the development of Low Wattage Appliances was M/s. Tide Technocrats, Bangalore, while the International Consultant for this activity block was M/s. SKAT of MHPG Group, Switzerland. The National Consultant for load development were Consulting Engineering Services, New Delhi.

On the basis of a World wide survey of appliances and user experience several proto type appliances were either imported or developed with the help of local manufacturers. These included low wattage water heating systems, low wattage cookers, night storage room heaters, load limiters and load limiter managers as well as dual tariff meters. These low wattage devices were reported to have been tested in three project locations namely Jankichatti in Uttaranchal, Nindighagh in Bihar and Bazgo in Ladhak, J&K. The testing of these devices and the exposure and public dissemination of the utility of these devices were undertaken by CES who in turn involved local NGOs in these areas for the purpose. The feed back from local users is reported to have been far from encouraging it is said that while water heaters were very well received other devices such as cookers and storage heaters did not evince much interest among local users. It was also revealed during discussions with concerned persons and officials that the very delayed funding of NGOs for their services in this regard led to their progressive withdrawal and as a result since no firm orders for these devices materialized the manufacturers also lost interest and motivation for the further production and supply of these devices.

It was anticipated that the experience gained from the three pilot locations would be subsequently utilized in load development and management in the demonstration project areas. However this did not happen as seen during our teams visits to various projects. However in Titang Demonstration Project developed by the Sai Engineering Foundation attempts were made to distribute conventional regular wattage appliances such as room heater, cooking heaters and immersion rods, these were accepted though not used as freely mainly due to erratic availability of electricity and the lack of affordability due to the present tariff structure. It was also revealed to us by the local population that though wood is still the preferred fuel for cooking and heating in most households more persons have started to use conventional electrical devices specially in the severe winter months when wood is substituted by electricity and in summer months persons tend to substitute wood by LPG as this is more easily available during the warmer seasons. All this adds up to the general impression that there is a perceptible preference among the local population to move into cleaner fuels as long as these are both available and affordable as compared to wood.

The load development and load management initiatives have not produced desired results though they are extremely important for the viability and sustainability of decentralized and stand alone SHPs. This can only gather momentum if appliances are made simple and affordable while stable power becomes available in the target areas. Substantial support from the Government in terms of liberal financial and organizational inputs would be needed over the years for this purpose. It is felt that it is still not too late to launch fresh initiatives to revive this activity among participating States with the active mobilization of Panchayats, NGOs and CBOs, along with social marketing personnel. However, this critical activity can only be sustained by carefully and systematically identifying and incentivising change agents within the local community who would readily adopt and effectively demonstrate the benefits of low wattage appliances.

6. ACTIVITY BLOCK : PROJECT EXECUTION

Work under this central activity block was organized in two parts. The first being the preparation of model documents necessary for both implementing and replicating the demonstration projects in the participating States. The National Consultant who was assigned the responsibility for this was M/s. I.J.Raju, New Delhi while the International Consultant were M/s. Mead & Hunt, USA and M/s. SKAT, Switzerland. With active consultation among these agencies, model tender documents were prepared which were subsequently used for inviting tenders for all the demonstration projects.

The second part of this activity block envisaged the setting up and commissioning of 20 demonstration projects. To begin with there were serious delays in the identification of sites so work on this major activity block could only commence in 1997-98 which was virtually the last year of the project as initially planned. According to the information provided to us by the NPC/MNES 17 out of 20 demonstration projects had been completed and commissioned so as to have started regular generation of power. According to the list (provided as annexure 3.1 to this chapter) only 3 projects have yet to be commissioned namely Gangotri, Nindighagh and Jalimghagh. It is important to clarify that the 17 SHPs have been commissioned and are in a position to generate power however this does not mean that they have started regular generation and evacuation of power.

Of the 10 demonstration projects visited by our team (in Aug.- Oct., 2003) as many as 8 were fully commissioned and generating and evacuating power. Only two of the 10 projects visited by our team though commissioned were not evacuating power. These were Lingti in Spiti Valley of Kinnaur and Pussimbing in Darjeeling District of West Bengal. It should also be mentioned that inspite of fairly difficult terrain in most of these project sites the civil construction was undertaken in record time in most cases inspite of severe climate disruption, land slides, flash floods and a very short working period as compared to less difficult or soft areas. Substantial delays are also reported to have taken place in the erection and installation of E&M equipment by certain manufacturers who were awarded these contracts. Since in most cases the civil construction and E&M procurement and installation was contracted out to separate entities the lack of coordination, and technical disagreements among them have been one of the major causes of delay in the early commissioning of these projects. The National consultant who was given the responsibility of coordination and the sorting out of such differences should have been more active in order to have avoided the delays caused in commissioning of various projects. It must also be realized that the concrete impact of the demonstration projects would only materialise after stable and uninterrupted power generation and regular evacuation of power from these SHPs is achieved. Since different sub-projects have come on stream at different points of time, some as early as 2001 and others as late as end of 2003, their impact on the target areas is likely to vary. This activity block which has been in more senses than one the central or core activity block has thus been partly completed.

7. ACTIVITY BLOCK : ENVIRONMENT ASSESSMENT

Small Hydro Projects by their very nature and design are relatively environment friendly and benign. However, in order to completely eliminate the slightest of environmental disturbance all possible mitigation measures should be ensured. Moreover it is possible for such projects to considerably improve and augment environmental quality in the target area. The project thus envisaged to prepare Environmental Management Plans (EMPs) as well as Environmental Improvement Plans (EIPs) for each sub-project. The execution of this activity block was entrusted to the National Consultant namely the CES, New Delhi, who were to be assisted and guided by the International Consultant, M/s. Mead & Hunt, USA.

On the basis of a checklist based on a pilot survey of 10 sites and after obtaining the necessary feed back from the International Consultants, the CES went ahead and prepared EMPs as well as EIPs for all the 20 demonstration projects. These were then sent to the implementing agencies concerned for appropriate action while executing the projects. Our subsequent visits to some of these sites revealed that nothing significant had been done so far in order to enhance the environment as clearly suggested by the Mid Term Evaluation Mission, we also feel that a lot more could have been done by the implementing agencies considering that financial provisions were made for this activity in each project. What was perhaps needed was the active involvement of the local community under the guidance of an appropriate NGO and CBO rather than leaving this responsibility on the Developer. General guidelines prepared through the experience gained in formulating EMPs and

EIPs could however be used in future projects in this SHP sector.

8. ACTIVITY BLOCK : TRAINING

The development of the Institutional and human resource capabilities from the national right down to the local levels, which are needed for the implementation of the small hydel projects was one of the three important immediate objectives of the project. It was visualized that official and personnel involved in all the stages of implementation should be capable of independently planning, designing, constructing, monitoring, operating and managing these small hydel projects. While three national Technical Institutions were to be developed and equipped to carry out these tasks, one of them namely the AHEC was to be given the responsibility of the National Consultant and M/s. Micro Hydro Power Corporation, Switzerland would be the International Consultant for this activity. The only National Technical Institution that seems to have been developed and strengthened under the project was the AHEC, Roorkee. The other two in Itanagar and Guwahati were initially involved in the conduct of some training programmes but soon lost interest, as a consequence they were not able to develop as visualized. This has been a major set back in this activity block and has certainly reduced the impact of hilly hydro project in Eastern and North Eastern parts of the country which otherwise has a very significant small hydel potential. However it should be mentioned that even in the case of AHEC the development of testing facilities and applied research had really not developed to the extent desired.

A large number of training programmes of varying duration and contents were organized from 1996 to 2000. Training related to several aspects of small hydro development such as preparation of DPRs, survey and investigation, identification of sites and on water mill development. In all 160 Technical Officers and other personnel drawn from various State Agencies, NGOs and Local Bodies had been trained under these National Orientation Programmes till December, 2003. As many as 59 officials involved in the implementation of SHPs in the Centre, State, Private and NGO sectors were also deputed to attend training abroad through a series of fellowship programmes specially designed to expose them to similar projects in other countries. Discussions by our team has revealed that most officials and personnel trained under this activity block did not remain to work in this sector long enough and were often transferred to other departments, this meant that a 'core' team of officials at the national, state, and local levels could not be fully established. We tend to strongly agree with the opinion expressed by the Mid Term Evaluation Mission that HRD efforts need consolidation and appropriate personnel policies need to be evolved for this to be ensured. Yet another deficiency in this effort has been the neglect of local people and Panchayats in the management and maintenance aspects of SHPs. The most effective way for training persons at the local level would be to support developers to take such initiatives at the sub project level. This is evident from the effective apprenticeship hands on training provided to fresh operators and staff by Sai Engineering Foundation in practically all the State managed SHPs in Himachal Pradesh where they have been awarded O&M contracts.

The overall impact of training and institution building has been significant with the setting up of the AHEC on a stronger foundation and developing the leading apex institution as a National Resource Centre for Small Hydel Development. However here too the continual support of the MNES and other international donors is required in strengthening testing facilities and in developing applied research.

9. ACTIVITY BLOCK : PEOPLES PARTICIPATION.

This activity block envisaged the development of management and ownership models for the SHPs through village level elected bodies, cooperatives, NGOs and CBOs and User Association as well as Self Help Groups. As a part of this very challenging activity block a community based Management and Ownership Model was attempted at the Jankichatti SHP which was handed over to a local body for O&M, management and collection of revenues. However this initiative has still not effectively spread among the other demonstration projects.

State Nodal Agencies who own as many as 14 of the 20 demonstration projects have in a very few cases initiated some action for peoples participation particularly the involvement of NGOs. Two projects namely Juthed in Chamba and Kothi in Kullu district of Himachal Pradesh are now being operated and maintained by the Sai Engineering Foundation which is an NGO. It must be stressed that the NGO through these O&M contracts has been able to train and involve several local persons in the operation of these SHPs. However the wider participation of the local community specially women in the management and ownership of these sub projects has not come about. However realizing the importance of peoples participation gained through the project, fresh initiatives have been launched to enlist more active participation in several participating States in future SHP projects. What is perhaps rather conspicuous about this activity block is that no efforts were made to involve National and International Consultants for this important activity unlike all other activity blocks. No expertise or institutional support seems to have come forth in this regard. Leading NGOs both National and International could have been assigned the responsibility regarding this crucial activity block unfortunately no attempts seem to have been made in this regard even after the Mid Term Evaluation and also considering that this activity relates to one of the significant objectives of the project of strengthening local human resource capabilities and evolving management and ownership models based on local participation.

10. ACTIVITY BLOCK : MASTER PLAN

The project also envisaged the preparation of a Master Plan containing a National strategy and incorporating detailed investment proposals for the optimum utilization of Small Hydel Resources in the Himalayan and Sub-himalayan regions. This national strategy document was to be prepared on the basis of a comprehensive review of the existing environmental, legal and economic policy framework for the development of Small Hydel Projects in these regions. The plan was also to be based on the experiences gained through the demonstration projects. The National Consultant for this activity was Consulting Engineering Services, New Delhi while the International Consultant appointed for the purpose was Mead & Hunt, USA.

A World wide survey report was prepared on the basis of experience with small hydel projects in Nepal, Indonesia and Sri Lanka where similar conditions and challenges existed. A survey of investment strategies existing patterns and structure of subsidies , model guidelines for survey and investigation and the preparation of Detailed Project Report (DPRs), recommendations on managerial, licensing and ownership issues and Power Purchase Agreements were systematically compiled. The Master Plan document was then prepared by the CES in close consultation with the International Consultant. The plan was then discussed in the MNES and also carefully reviewed by the Mid Term Evaluation Mission Team and various suggestions made by the reviewers were incorporated and the report finalized. This Master Plan envisaged the setting up of small hydro projects with a capacity of 1200 MW over a period of 15 years. The Plan also provided State wise strategies to be followed in order to expedite the development of SHPs in the various participating States.

The relevance and impact of this activity is reflected by the fact that the MNES has been able to incorporate the salient features of this Master Plan in the 10^{th} Five Year Plan document for the small hydro sector in the country. A plan target of SHP projects which will account for 600 MW of power generation has been proposed for the period 2002-2007. Of these projects 150 MW of capacity is planned to be set up in the State sector while 450 MW of capacity would be created through private sector participation. Various financial institutions have shown their willingness to finance SHP projects. Several business associations such as ASSOCHAM and CII have also started initiating meetings with industrialists to motivate and sensitize them on SHP development by industrial groups, such efforts is likely to strengthen and accelerate the small hydel movement in the country. Considering these encouraging developments one can only conclude that the preparation of the Master Plan under the project has provided a systematic basis and a sound framework for the evolution of a National Strategy for SHP development and has thus had a very significant overall impact in this energy sub-sector.

RESULTS ACHIEVED BY THE PROJECT

Turning finally to the question as to whether mechanisms and modalities have been put in place to ensure sustainability of the project results it must be stressed that due to delay in implementation and the neglect of some critical activity blocks some of the results are still not explicitly visible. However they are likely to increasingly materialize over a longer period of time.

One can however list out the overall positive results that have been achieved.

1. The setting up of 17 of the 20 demonstration projects of varying design and specification incorporating the latest technologies available and which suit a wide range of topographical and terrain conditions. These provide the basis for replication and further development of SHPs in the Himalayan and Sub-himalayan region.

2. The setting up of mechanically upgraded water mills and some upgraded for localized generation of power which are

also capable of being improved and replicated on a wider basis.

3. Availability and adaptation of suitable State of the art technology for SHPs in Himalayan and Sub-himalayan conditions.

4. The building of capacity in selected institutions concerned with the Small Hydro Sector and the creation of an experienced and trained pool of personnel for planning and implementation of SHPs.

5. The creation of a fairly comprehensive and useful data base which provides the basis for the future expansion of SHPs.

6. Invoked a certain degree of private and NGO participation if not any wide spread participation by the local population.

7. Improved the quality and availability of power in several target areas and induced a slow but steady development of loads.

8. Gradually increased the use of domestic and commercial electrical devices particularly for lighting and water heating applications.

9. Provided a basis for commercial applications of electrical energy in rural services and local rural industry sector such as wood processing, grinding, ginning and metal working. A visible beginning has been made in this regard in some target areas.

Immediate Objectives, Success Criteria and Terminal Evaluation

No.	Immediate Objectives	Success Criteria	Terminal Evaluation
1.	To develop a national strategy and a master plan with detailed investment proposals for the optimum utilization of small hydel resources of the Himalayan and Sub-Himalayan regions.	i) A success criterion would be the acceptance of the master plan by the MNES and its incorporation in the 9th Five Year Plan, with necessary budget provisions. ii) Another criterion would be the interest evinced by potential international donor agencies by way of commitment of funds for some of the projects included in the master plan. The interest evinced by Private Developers and Financial Institutions in the country would also constitute a success criteria.	**i) The national strategy and Master Plan developed under the project formed the basis of the national strategy to achieve the target for capacity addition of 130 MW during the Ninth Plan. Actually an aggregate capacity of 269 MW was achieved during the period 1997-2001. The objective can thus be said to have been achieved successfully.** iii)MNES took a conscious decision to undertake small hydro projects as a commercial activity with private sector participation. In order to achieve this objective the Ministry announced fresh incentives to provide financial support for conducting feasibility studies, interest subsidy for commercial projects, and distributed capital grants to Government sector project. The scheme was extended to projects up to 25 MW in November, 1999. The commitment of funds for these projects from, International donor agencies was not sought. This success criteria was therefore rendered in fructuous. The strategies used to involve private sector and financial institutional participation has been very successful considering the response of the private sector for allotment of the developed sites in various States.

No.	Immediate Objectives	**Success Criteria**	**Terminal Evaluation**
2.	To develop a package of commercially viable and environmentally sound technologies, on the basis of installation and commissioning of twenty demonstration units at various selected places, for generation and use of small hydel power and to develop appropriate models for ownership, management and maintenance of the small hydel projects through a people centered and participatory approach.	i) A success criterion would be the adaptation and replication of these demonstration projects on a major scale throughout the hilly regions of India. ii) Another success criterion would be the reduction in the cost of installed capacity per KW and in the cost of electricity per KW hour compared to pre-project situation and stepped-up acceptance of end-use appliances by the people. iii)The third criterion would be the participation of the local people in the ownership, management and maintenance including collection of revenue and expenditure of the small hydel projects.	i) Of the 20 demonstration projects only 17 are functional. Only a few of them have been generating power for the last 2 years. It is too early to judge whether commercially viable and environmentally sound technologies in these projects are going to be replicated. Our survey shows that these projects have been used as a bench mark by the new entrants in this sector and experience gained in these projects has been used to improve the new projects. ii) It is too early to comment on the success of this criteria as even the generation in the 17 demonstration projects have not stabilized so far. However these are clear indicators of the gradual acceptance of end use appliances by the local people. This success criteria is thus partially achieved. iii) The third success criteria which required participation of the local people in the management including collection of revenue and expenditure in maintaining the Small Hydro Programme. This has not visibly happened and the project has failed in this respect.
3.	To develop the institutional and human resources capabilities, from the local to national levels, needed for the execution/	i) A success criteria would be the establishment of a 'core team' of officials at the	i) The success criteria envisaged in this project has been partially met at the national and State level. There is no scope to train local people in maintenance and management aspect of the project due to change in strategy to commercialize small hydro programme. The

No.	Immediate Objectives	Success Criteria	Terminal Evaluation
	implementation of the project and for sustainable development of the mini-micro hydel sector in hilly regions.	national and state levels who would be able to handle independently the planning, design, construction, maintenance, operation and management as well as a large number	project has therefore failed to achieve this success criteria. The project has failed to achieve this criteria due to
3.		of local people, in Panchayats or other local bodies, trained in the management and maintenance aspects of small hydel projects. ii) The other success criteria would be the extensive use of the three selected technical institutions, in the fields of testing, training, applied research and in the provision of consultancy and information services for small hydel projects.	its deviation from being based on stand alone sub project to that based on commercial grid connected sub projects or captive industry related sub projects such as plantation based SHPs. ii) Out of three selected technology institutions only AHEC has been developed for training consultancy and information services. Testing and applied research still needs consolidation. The other two institutions have not shown any interest in small hydro programme. The project has thus partially succeeded to achieve this success criteria.

RATING OF PROJECT COMPONENTS :

On the basis of our discussion in the project design, its implementation, and the project results as seen in the previous chapters as well as the present chapter, it is necessary for our Evaluation Team to assign specific ratings to each of the project components. These ratings have been provided below as suggested in the UNDP/ GEF Terminal Evaluation Guidelines.

RATING ASSIGNED BY THE EVALUATION TEAM FOR EACH OF THE PROJECT COMPONENTS:

PROJECT COMPONENT	RATING

I. Outcomes/ Achievement of objectives : a) Environmental objectives b) Developmental objectives	 Marginally Satisfactory Satisfactory
II. Project Implementation	Satisfactory
III. Participation a) Stakeholder Participation b) Public Involvement	 Satisfactory Unsatisfactory
IV. Project Sustainability	Satisfactory
V. Project Monitoring and Evaluation	Marginally Satisfactory

ANNEXURE 3.1

LIST OF UNDP/GEF HILLY HYDRO DEMONSTRATION PROJECTS

S.No	Name	Location	Capacity	Cost	Developer	Status & Date of Commissioning
1.	Solang	Dist: Kullu State : H.P	1000KW		A.Power Himalayas (Private)	Completed
2.	Raskat	Dist: Kullu State : H.P	800 KW		Indu Sree Power (Private)	Completed
3.	Titang	Dist: Kinnaur State: H.P	800 KW		Sai Eng. Foundation (NGO)	Completed
4.	Soneprayag	Dist: Rudraprayag State: Uttaranchal	500 KW		UJVN	Completed
5.	Bikuriagad	Uttaranchal	500 KW		UREDA	Completed
6.	Lingti	Dist: Lahoul & Spiti State : H.P	400 KW		HIMURJA	Completed but not functioning
7.	Kothi	Dist: Kullu State: H.P	200 KW		HIMURJA	Completed
8.	Jalimghagh-II	Dist : State: Bihar	200 KW		BHPC	Incomplete
9.	Nindighagh-II	Dist : State: Bihar	200 KW		BHPC	Incomplete
10.	Pussimbing	Dist:Darjeeling State: West Bengal	200 KW		Sycotta Tea Estate (Private)	Completed but not functioning
11.	Chamong	Dist:Darjeeling State : West Bengal	150 KW		Bio Tea Estate (Private)	Completed
12.	Gangotri	Dist: State:Uttaranchal	100 KW		UREDA	Completed but not commissioned
13.	Kanvashram	Dist: State:Uttaranchal	100 KW		UREDA	Completed
14.	Juthed	Dist :Chamba State : H.P	100 KW		HIMURJA	Completed
15.	Purthi	Dist: State: H.P	100 KW		HIMURJA	Completed

16.	Sural	Dist: State: H.P	100 KW		HIMURJA	Completed
17.	Yakla	Dist: State: Sikkim	100 KW		Defence	Completed
18.	Kalmoni	Dist: Kamrup State: Assam	100 KW		MKB Pvt.Ltd (Private)	Completed
19.	Daragaon	*st:* *te:West Bengal*	20 KW		WBREDA	Completed
20.	Nazirakhat	Dist: Kamrup State: Assam	10 KW		ASTEC	Completed

CHAPER IV
THE IMPACT ASSESSMENT

OBJECTIVES AND MAJOR ISSUES ADDRESSED :

The task of conducting an impact assessment study of the 20 UNDP-GEF small hydro demonstration units in 13 Himalayan and Sub-Himalayan regions was taken up by the Indian Institute of Public Administration in close consultation with the UNDP (GEF) and the MNES, Government of India. The findings of the study were expected to assist the UNDP (GEF) and Government of India to carefully assess the success of the project in achieving the desired objectives and document the lessons learnt so that these could be shared both within and outside the country.

The impact assessment study was primarily intended to analyze the effectiveness of the technical organizational, and financial assistance provided in achieving the clearly articulated objectives of the project. It was also required to highlight whether the project had been able to build and sustain management capacities at the local and national level. Moreover, this study was intended to comprehensively review the institutional, organizational and policy factors as well as the human resources harnessed for implementing and sustaining this Hilly Hydro Project.

As stated in the study proposal, the impact assessment study was conducted at two distinct levels, (1) sub project or pilot level and (2) the over all project level. At the sub project level, issues related to the operational status of the power stations, impacts on livelihoods, economy and environment in the immediate vicinity of the power stations were addressed. At the overall project level, the areas of investigation included environment, economy, society and the market. The impact on the environment was to be assessed in terms of deforestation trends and GHG emissions. Socio-economic assessment was based on the study of consumption behaviour, cultural aspects, traditional beliefs, change in occupation, time saved and outlook towards society of the targeted beneficiaries in the catchment area of the project. The overall impact of the project on various markets such as technology and project related equipment including markets for distribution of low wattage appliances was also to be looked into.

The major issues that the study addressed at the overall national as well as sub project or pilot level and which were broadly required to be covered under the terms of reference provided to the Study Team were as follows :

1. Assessment of the physical progress and sustainability of each sub-project and its success in evincing interest from private developers.

2. Compile and analyze the production data of electricity generation by each sub project and assess the total Carbon Emission Reduction (CER) and GHG emission reduction as envisaged in the project document. This included information regarding quantity of fuel wood saved corresponding to actual electricity generated using given project parameters and stimulate simple projections of fuel wood savings based on the patterns of usage and the changes therein.

3. Assess the impact of electricity tariff charged by each sub project, and the returns on investment, as well as the constraints to revenue generation, revenue collection and

pricing in terms of commercial viability of each sub project.

4. Assess deforestation trends in the catchment area of each sub project and the extent of settled cultivation induced by electrically energized irrigation.

5. Assess the extent of benefits derived by households, villages, commercial/ construction/ production units, cooperatives, user associations and self help groups from the project and also assess the extent of their involvement.

6. Assess the impact of the project on the life of women in terms of reducing the need to collect fuel wood and other drudgery.

Besides, employment status of the persons involved in operation and maintenance of the SHP were assessed and to the extent to which there had been a reduction in migration of local population to urban areas.

7. Assess the impact of water mills including electricity generating water mills, their potential, and acceptance and future usage.

8. Assess the suitability of technology selection and any innovation and adaptation taken up in each sub project and the extent of utilization of local expertise and resources.

9. Assess all administrative aspects related to the role of the State Government and its interface with the developers, users and user institutions and state policy initiatives on Power Purchase Agreements and overall SHP development.

10. Assess the impact of low wattage devices and analyze load development in terms of assimilation, acceptance and usage.

11. Assess the functioning of the revolving fund facility and its effective implementation and sustainability.

12. Assess capacity development of key local partners, in planning, design, construction, maintenance, operation and management

of SHP in the country and also assess the impact of training programmes and work shops in replication activities.

13. Assess the feed back of developers and local implementing agencies in support of SHP development, bottlenecks and facilitation of funding/ support/ subsidies by the State Governments.

14. Assess the potential interest of donor organizations by way of commitment of funds in each participating State, and elaborate on the possibilities of long term sustainable funding from the Central and State Governments.

IMPACT STUDY METHODOLOGY AND DATA BASE :

This report on the impact assessment study of the UNDP-GEF hilly hydro project is an attempt to analyze the major issues addressed with respect to the development of small hydro power in the 13 Himalayan and Sub-Himalayan States on the basis of field visits to 10 project sites by a project team from the Indian Institute of Public Administration. Care has been taken to ensure that both the Western and Eastern Himalayan States were covered. The projects visited within a period of 4 months included the pilot visit made to Titang in Himachal Pradesh, followed by Raskat, Kothi, Solang, Lingti and Juthed, all in Himachal Pradesh. Soneprayag in Uttaranchal, Kalmoni in Assam, Pussimbing and Chamong in West Bengal. The project team was to determine whether the project had the desired impact on the targeted beneficiaries and to what extent it had influenced the livelihoods and outlook of the local population in the target areas covered by the sub project under this Small Hydel initiative.

This study was predominantly based on primary data with utmost care been taken to supplement it with secondary data. In each of the project sites visited the project team contacted specific sources which the team identified would be helpful in analyzing the impact. The methodology and related procedures adopted for conducting the study are briefly explained below :

1. A team consisting of the Project Director, one Research Associate, two Research Assistants and one Consultant visited 10 of the 20 demonstration units and collected information regarding these projects. Local investigators were also hired in the respective States to assist the team in collecting primary information.

2. The primary data that forms the basis for assessing the impact of the project and which includes detailed information collected from individual beneficiary households and non-beneficiary households was supplemented with primary data collected from Panchayati Raj Institutions, user groups, local voluntary groups and self help groups in the catchment area of the project. This data was collected through comprehensively designed field schedules covering important aspects of project implementation that reflected the impact of the project on the target beneficiaries. This was supplemented by carefully structured interviews, meetings and discussions with village elders, women's

groups and office bearers of cooperative societies.

3. The secondary data for the study was collected at various levels starting from the UNDP/GEF and the MNES, Government of India to State Government, Department of Power, State Electricity Boards as well as State Power Corporations. Secondary data from sources such as the major power equipment manufacturers, the developers and other related scientific and technical institutions both national and international was also gathered wherever necessary. The Census of India, National Sample Survey, and Plan documents were also consulted and utilized. For specific requirements of the

study, the team also consulted the Credit Plans of the District Lead Bank, information available from the District Rural Development Agency, the District level industries and power authorities and the District Statistical Office.

4. Officials posted as Senior Managers and Administrators in the power, industry, agriculture, rural development sectors apart from teachers, health officials and managers of financial and credit institutions also provided useful information with respect to the development of the SHP.

5. Census Reports related to the project area, the Statistical Handbooks pertaining to the State as well as concerned districts in which the

projects were located and project related documents starting with the Project Document itself and all related documents, Evaluation and Status Report pertaining to the project were referred to in detail.

The tools utilized for collection of data were as follows :

(i) Household Beneficiary / User Schedule (both groups)

(ii) Schedule for Developer/ Sub project Implementer

(iii) Schedule for Related Local Agencies (Facilitators/ User Associations/ Cooperatives/ Self Help Groups/ PRIs/ NGOs)

(iv) Schedule for Block Level Line Agencies related to Forestry, Energy, Agriculture, Industry, Irrigation, Water Supply and Sanitation.

Each of these questionnaires or field schedules were carefully structured in order to conform to the various issues that had been incorporated in the detailed objectives of the impact study and various issues to be investigated as indicated in the TOR provided by the UNDP (GEF).

The central questions posed during the study could not however be measured solely by the outcome of the project as other exogenous factors would be at play affecting the outcomes. To ensure methodological rigour, it was most essential to estimate the 'Counterfactual' which is, what would have happened had the project not taken place at all (Baker Judy L; 1998).

The determination of the 'Counterfactual' was thus at the core of the evaluation design. Since no base line survey was available for the specific project catchment / coverage areas under study, those beneficiaries that fell or were located within the effective outreach of the project was treated as the 'Observation Group' and those similarly placed in terms of topographic, socio-economic, and livelihood indicators but who were not covered or ineffectively covered by the project were treated as the 'Control Group' in the experimental or survey design.

The methodology utilized for the analyses of the impact study was thus an integrated methodology using both quantitative and qualitative techniques. For analyzing both the primary and secondary data, time series and cross section analyses, simple regression models and forecasting techniques were attempted however these did not produce convincing or robust results and were thus incorporated to only a limited extent or indirectly used in the study results.

CHAPTER – V

THE FUNCTIONING OF THE SMALL HYDEL DEMONSTRATION PROJECTS AND TRENDS IN POWER CONSUMPTION IN TARGET AREAS

As mentioned earlier the Hilly Hydro Project envisaged the setting up of 20 SHPs in various remote locations in the 13 participating States in the Himalayan and Sub-Himalayan regions. Of these 20 SHPs as many as 17 had been constructed and commissioned till December 2003. These demonstration SHPs or sub-projects not only incorporated different technologies specifically suited to the prevailing head and flow conditions in each of the selected locations but were also different in terms of installed capacities ranging from as low as 20 KW to 1 MW. None of the 20 SHPs however exceeded 1 MW as they were mostly visualized as viable 'stand alone' mini power stations serving the needs of a limited area in these remote hilly regions. These were mainly areas where it was considered infeasible and expensive to supply power through the existing State electricity grids. However, in States like Himachal Pradesh and Uttaranchal the State electricity grid had already been extended to most of these remote locations inspite of the fact that power supply in these 'tail end' locations on the State grid was both unstable and weak. With the unstable and weak grid available in most remote locations there was a tendency among most of the demonstration SHPs which were built under the project in these States and mostly in these remote locations, to get grid connected. This tendency was further reinforced on the basis of the low economic viability of the sub projects due to the very limited load that was available in these areas, and evacuation of excess power during the off peak load periods was in most cases considered to be the more viable option in order to sustain operations and achieve financial viability. It may be further stressed that grid connectivity did not necessarily mean that the SHP could not function in an isolated stand alone mode. While in some cases such as the SHPs in Raskat, Solang / Kothi and Soneprayag, this was true and the SHPs became totally 'grid dependent' for their functioning, in the case of Titang and Juthed the necessary technical modifications were incorporated in order to enable the SHP to switch over from grid mode to isolated mode in accordance with the status and stability of the State grid. This flexibility has in fact gone a long way in ensuring both the stability and strengthening of the State grid through tail end injection and supplementation of power supply as well as helped to reap the advantages of stand alone or isolated mode operations at the time when the State grid fails or is disrupted, which has been observed to be quite frequent. This flexibility has also ensured a higher plant utilization rate in the case of these sub-projects as we shall see later in our present discussion.

GENERAL OBSERVATIONS ON THE FUNCTIONING OF SELECTED SUB-PROJECTS:

Of the 17 SHPs commissioned under the Hilly Hydro Project till December 2003 our field team was able to visit only 10 SHPs. The team visited 6 demonstration projects located in the districts of Kinnaur, Lahaul & Spiti, Kullu and Chamba in Himachal Pradesh and 1 demonstration project located in Soneprayag of Rudraprayag district, Uttaranchal Pradesh. Apart from these the team also visited three SHPs developed by private tea plantation companies one in Assam and another two in Darjeeling District of West Bengal. During these visits our field teams systematically collected a whole range of data related to each of the SHPs visited. The data relating to various aspects of the functioning and organization of these selected SHPs was collected through the canvassing of a detailed developer schedule or questionnaire, specifically designed for the purpose.

In Table 5.1 we present some general information that we have obtained for selected SHPs that we have visited, while some of the information has been obtained from the detailed project report for these sub-projects, others have been obtained either from the office records of the concerned developer as well as on the basis of discussion and power station records maintained at the project sites.

We first of all see that the planned project costs as indicated in the DPRs for these selected SHPs have most often not been exceeded significantly by the actual costs finally incurred for setting up the project. In most cases it is seen that the actual costs have only marginally exceeded the planned costs except perhaps in the case of the Lingti SHP located in the vary remote and difficult area of Spiti valley. This excessive cost-over run has been mainly caused on account of severe damage to the civil structures of this SHP due to flash floods that severely damaged the entire diversion weir and completely silted the over two kilometer long covered concrete water channel and the entire desiltation tank. As a result most of the civil construction had to be undertaken all over again. Severe siltation and damage resulted in the drastic fall in the required water flow which resulted in the forced shut down of one of the two turbines installed in this plant. In case of the Kothi SHP too there seems to have been a substantial escalation in costs and though there have been no flash floods or other disruption here discussions revealed that the transportation of building materials and equipment turned out to be more expensive and time consuming because of the improper access road from the main road down to the power house site. This problem was compounded during the construction phase by the denial of proper access road by the Forest Department which even now continues to intermittently raise various objections that have been a constant source of concern and harassment for the State Nodal Agency that has developed the project.

Table 5.1 : General Information on Selected SHP Sub Projects

Name of Sub-Project	Total cost of project (as in DPR) (Rs Lakhs)	Total cost of project Actually Incurred (Rs Lakhs)	Date of Start of Construction (Civil)	Date of installation of E &M Devices	Date of Commission / First test run	Date of Final Commission	Date of Grid Connect.	PPA (Period)	Date of signing of PPA / Captive Use	Cost of generation per unit (Rs)	Rate for Power Purchased per unit (Rs)	No. of O & M Staff Employed	Qualification of Staff			Local or Outsider		Total Wages paid per month (Rs)
													Engg.	With Diploma or Tech. Qualification	Without Tech. Qualification	Local	Outsider	
Solang	687.2	690.61	Jun-99	Jan.2002	June.02	June.02	June.02	30 Years	Aug.00	1.80	2.25	9	1	7	1	7	2	51000
Titang	459	444	Nov-00	Dec. 2001	Dec.01	Feb.02	Feb.02	40 Years	Oct.00	1.80	2.50	9	4	2	3	4	5	37300
Raskat	486	498	Dec-99	Jan.2001	Aug.01	Aug.01	Aug.01	40 Years	Aug.00	1.82	2.50	9	1	2	6	7	2	44500
Sonprayag	485	458	Apr-98	Aug.2002	Aug.02	Dec. 02	Dec. 02	NA	NA	0.87	1.70	8	0	4	4	7	1	26600
Lingti	642	850	NA	NA	NA	NA	NA	Not Signed	NA	1.65	2.50	8	2	3	3	4	4	34830
Pussimbing	NA	NA	NA	NA	NA	NA	NC	No PPA	NA	NA	Captive Use	NA	NA	NA	NA	NA	NA	NA
Kothi	190	272	NA	NA	June.01	June.01	June.01	Not Signed	NA	2.06	2.50	8	1	3	4	5	3	33769
Juthed	90	123	NA	NA	Dec.00	Dec.00	Jan.01	Not Signed	NA	2.30	2.50	4	1	2	1	0	4	42180
Kalmoni	99.7	107	NA	NA	June.03	June.03	N.C	No PPA	Captive Use	1.46	Captive Use	5	1	1	3	5	0	14360

Chamong	144	N.A	Nov-00	Mar.01	Mar.03	Mar.03	N.C.	No PPA	Captive Use	NA	Captive Use	2	0	0	2	2	0	3600

The Table 5.1 also gives us a rough idea regarding the time period taken to construct and finally commission some of these SHPs. We could get a rough idea regarding project execution time in the case of only 5 out of the 10 SHPs we visited as information regarding the dates on which civil construction commenced was not made available to us in case of the remaining five. While the Titang sub project was constructed and commissioned in just 15 months the Raskat SHP took around 20 months to come on line while the Chamong SHP took 28 months to become operational. The Solang SHP was constructed and commissioned in 36 months. The longest time period for execution of the project was in the case of Soneprayag which took 56 months to be finally commissioned, surprisingly there does not seem to have been any escalation in costs in spite of the long execution period in fact the actual cost incurred is reported to be less than the estimates provided in the DPR for this project.

What seems to be rather disturbing is the fact that while power purchase agreements which were required to be entered into before commissioning have been entered into between the developer and the HPSEB only in the case of three demonstration SHPs, these have been projects taken up either by the private or the NGO developer, in the case of three other state run projects developed by HIMURJA namely Lingti, Kothi and Juthed no power purchase agreement has been entered into though the SHPs have been evacuating power and feeding the State grid ever since these projects were commissioned. Though the records of power evacuated by these SHPs developed and owned by HIMURJA is being maintained regularly no payments have been made so far by the HPSEB to the State Nodal Agency, thereby weakening its financial autonomy and self sufficiency and thus maintaining its status as a mere appendage to the parent power department.

The estimated or anticipated cost of generation per unit has also been indicated in the DPRs these are however based on a number of assumptions which are likely to hold only after stable and regular optimum generation is achieved while they seem to be in the range of Rs. 1.65 to Rs. 1.80 per Kwh for SHPs ranging from 400 KW to 1 MW capacities, the estimated costs of generation seem to be higher in the lower capacity range of 100 to 200 KW SHPs though there are some exceptions such as the Kalmoni SHP and the Soneprayag SHP. The rate at which power is purchased by the HPSEB at present is Rs. 2.50 per Kwh while in Uttaranchal the State Power Corporation purchases each unit at a lower rate of Rs. 1.70 per Kwh. This differential does provide the basis for long term viability of the SHPs but for the moment with most SHPs not having achieved a stable optimum generation of power the costs of generation per Kwh are likely to be higher than estimated on the basis of assumption relating to ideal conditions.

OPERATING HOURS AND PLANT RECORD OF SELECTED SHPs :

The selected SHPs that our team visited had at the time of our visit operated for various periods of time after each of them had been fully commissioned. A wide range of operational data is recorded in great detail on an hourly basis in the daily log books of the power station. This data has been recorded and maintained in each of the SHPs from the date of final commissioning of that power plant.

In Table 5.2 we have compiled for each of the selected SHPs and for their respective operating periods (which as mentioned earlier has varied according to their date of final commissioning) the actual operating hours as compared to the potential operating hours that were available for power generation, the difference between these provides us with the plant idling hours for each selected SHP. We are thus able to get a clear idea of the number of hours the plant idled as compared to the potential operational hours that were available to it. Unfortunately we were not able to obtain the relevant data in the case of two of the ten sub projects we selected and visited namely Lingti and Pussimbing, in fact both these SHPs were non operational during our visit and were reported to have been so or only partially operational for quite a long period of time, due to various civil and mechanical snags.

Turning to the actual figures compiled in Table 5.2 we find that the proportion of plant idling time to the potential operating time available has been fairly high in the Chamong, Solang and Kothi sub projects. They are also found to be moderality high in the case of Titang, Juthed and Soneprayag sub projects. However in the case of Kalmoni and Raskat plant idling hours as a proportion of potential operational hours available has been exceptionally low. It may be stressed that while Raskat had functioned for a relatively longer period of 24 months, the Kalmoni sub project had operated for only 4 months at the time of our visit, but irrespective of the different periods of operation both these plants had idled for only a little over 1 percent of the total time of operation available to each of them, perhaps indicating both the high quality of equipment and manpower in these sub projects.

Table 5.2 : OPERATING HOURS AND PLANT IDLING FOR SELECTED SHPS

Name of Sub Project	Actual Capacity Installed	Period of Operation	No. of Months Operated	No. of Days Operated	Potential Operational Hours	Actual Operational Hours	Plant Idling Hours	% of Actual Operational Hrs to Potential Operational Hrs	% of Plant idling hrs to Potential Operational Hrs
SOLANG	1000 KW	July02-Sep03	15	433	10447	3247	7200	31.08	68.92
TITANG	800 KW	Feb02-Sep03	20	601	14424	9230	5194	63.99	36.01

RASKAT	800 KW	Aug01-July03	24	730	17520	17280	240	98.63	1.37
SONPRAYAG	500 KW	Dec02-Oct03	11	330	7920	5682	2238	71.74	28.26
LINGTI	400 KW	Data not available yet							
PUSSIMBING	200 KW	Data not available yet							
KOTHI	200 KW	July01-Aug03	26	792	19008	8428	10580	44.34	55.66
JUTHED	100 KW	Jan01-Sep03	33	1003	24072	16413	7659	68.18	31.82
KALMONI	100 KW	June03-Sep03	4	104	2328	2303	25	98.93	1.07
CHAMONG	100 KW	June03-Aug03	3	78	2208	420	1788	19.04	80.96

The fairly high levels of plant idling are mainly on account of shut downs caused by water flow, electro-mechanical snags, or grid failures. While in Solang the high levels of plant idling time have been reported as being caused by electro-mechanical faults specially with the alternator, the problem in Chamong has been mainly due to the faulty governer. In Kothi, Soneprayag and Titang SHPs the problem of plant idling time is mainly caused by the frequent breakdowns in the State grid to which these plants are connected. It may be mentioned that high velocity winds coupled with the long spans of these transmission lines lead to frequent short circuiting and tripping of the power plants. These problems of frequent grid disruption is relatively more serious in the Titang sub project area.

CAUSES OF SHUTDOWNS RESULTING IN LOSS OF OPERATING HOURS IN SELECTED SHPs :

As mentioned above plant shut downs can occur on account of two major sets of problems. The first cause of plant shutdowns is grid instability. Here either the grid frequencies do not match the permissible frequency range required to synchronize the plant for evacuation or in other cases the plant does not operate as the grid is altogether not available.

In Table 5.3 we have obtained data on the frequency, duration and causes of shutdowns for only 7 of the 10 SHPs that we have visited. The Titang SHP which has operated for a period of 20 months has experienced the largest number of shutdowns. In the operating period of 20 months the Titang power station is reported to have shut down 1787 times. While there were as many as 81 shut downs per month on account of grid failure, as well as, other water flow and electro-mechanical snags. Of the 5193 hours that the plant lost due to shut downs as many as 3599 hours was lost due to the instability or absence of the grid. The hours lost due to other reasons was 1594.

Table 5.3 : CAUSES OF SHUT DOWNS AND LOSS OF OPERATING HOURS IN SELECTED SHPS

Name of Sub Project	No. of Months Operated	No. of Shut Down due to			Shut Downs per month due to Grid Failure	Shut Downs per month due to Other Factors	Hours Lost due to Grid Failure (Hrs)	Hours Lost due to Other Factors (Hrs)	Total Hours Lost (Hrs)	% of Hours Lost due to Grid Failure	% of Hours Lost due to Other Factors
		Grid Failure (Nos)	Other Factors* (Nos)	Total (Nos)							
SOLANG	15	154	110	264	10.27	7.33	135	7065	7200	1.87	98.13
TITANG	20	1629	158	1787	81.45	7.90	3599	1594	5193.63	69.3	30.7
RASKAT	24	NA	NA					240.00	240	0.00	100.00
SONPRAYAG	11	716	46	762	65.09	4.18	1601	637	2238	71.55	28.45
LINGTI	Data not available										
PUSSIMBING	Data not available										
KOTHI	26	NA	NA				1097	9483	10580	10.37	89.63
JUTHED	33	355	69	424	10.76	2.09	1809	5850	7659	23.62	76.38
KALMONI	4	2	10	12	0.50	2.50	2	23	25	9.52	90.48
CHAMONG	3	0	1	1	0.00	0.33	- -	1788	1787.6	-	100.00

Note : * Other factors are Electro Mechanical Snags, Water Flow Snags and Maintenance

It is thus seen that the instability and failure of the grid was the major cause of plant shutdown in the case of the Titang SHP. A similar situation seems to have prevailed in the case of the Soneprayag SHP. Here again the frequency of grid failures and grid instability has been as high as 65 per month for the operating period of around 11 months. The Soneprayag SHP has thus lost over 71 percent of its operating time due to grid instability and grid failure.

In the case of the Solang, Kothi and Juthed SHPs the grid seems to be relatively more stable. Shut downs have been caused mainly due to water related or electro-mechanical problems in the case of these SHPs with over 75 percent of the operating time being lost due to shutdowns caused by these other factors*.

While frequent electro-mechanical snags are a cause for concern in some of these SHPs major problems with some components, and the availability of spares and timely replacement are issues that need to be carefully reviewed if these SHPs are to function normally and at their respective optimum capacities.

POWER GENERATION/ EVACUATION AND PLANT USE EFFICIENCY IN SELECTED SHPs

The selected SHPs visited by our field teams provided us with figures relating to the total number of operating hours that each station functioned after full commissioning but also the number of units of power that were evacuated during the operating period for each plant. Given the installed capacity of each plant, it is thus possible during the hours of operation recorded in each case to estimate the potential power capable of being generated and to then compare these figures with the actual generation of power recorded for these operating hours. This would provide us with a measure of the plant use efficiency for each SHP for which data was made available to us.

The figures compiled for various selected SHPs in Table 5.4 for power actually generated as compared to what could potentially be generated through the capacity installed in the case of each selected SHP shows that the plant use efficiency has been fairly high in the case of Titang, Raskat and Kothi sub projects. This is encouraging because the stability and availability of the grid in the case of Titang SHP has been far from satisfactory. This is mainly on account of the fact that the Titang SHP has been able to operate on a stand alone basis even when the grid was not available. The Kothi SHP however does not have capabilities of operating on a stand

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* **In the case of the Kothi SHP heavy snow fall at the SHP site and lack of a proper access road to the plant has often impeded the timely deployment of operating staff, thereby affecting operations.**

alone basis but in spite of its grid dependence it has achieved high plant utilization efficiency this has been due to the grid being more stable and better maintained in the area.

Table 5.4 : POWER GENERATION/ EVACUATION AND PLANT USE EFFICIENCY IN SELECTED SHPS

Name of Sub Project	Potential Operational Hours	Total Operational Hours	Actual Unit generated Kwh (Units)	Actual Units Power Generated per Hour	Potential Power generated Kwh (Units)	Plant Use Efficiency (%)
SOLANG	10447	3247	2534552	780.58	10447000	24.26
TITANG	14424	9230	4362092	472.58	11539200	37.80
RASKAT	17520	17280	5728862	331.53	14016000	40.87
SONPRAYAG	7920	5682	989622	174.17	3960000	24.99
LINGTI						
PUSSIMBING						
KOTHI	19008	8428	1489754	176.76	3801600	39.19
JUTHED	24072	16413	532329	32.43	2407200	22.11
KALMONI	2328	2303	12234	5.31	232800	5.26
CHAMONG	2208	420	1518	3.61	220800	0.69

In the case of the Solang SHP though the plant is connected to the 33 KVA grid which is reported to be very stable, the plant has had to face a series of problems related to its electro-mechanical equipment. This has been the major constraining factor and has reduced plant use efficiency. It is also reported that with the complete replacement of defective electro-mechanical equipment which was damaged the Solang plant has achieved higher generation and is now functioning in a satisfactory manner raising the plant use efficiency significantly.

It should also be mentioned that while the plant use efficiency in the case of the two tea plantation based SHPs at Kalmoni in Assam and Chamong in Darjeeling, West Bengal the generation has been limited mainly on account of the low loads that are available during the off season for the tea growers. This load is likely to go up during the next peak tea processing season and thereby higher plant use efficiency is likely in both these projects where power is in captive use and provided to the private plantation grid. It should also be noted that the installed capacity in both these locations is currently in excess of the present load and utilization of power within the plantations and thus it is not surprising that the plant use efficiency is found to be rather low. However in spite of the very limited operating period that has been available in these plantation based SHPs due to their recent commissioning it is reported that the limited electric power that has been generated has effectively replaced the use of diesel oil that was being used to generate power for various applications. It is reported that as much as 50 thousand liters of diesel has been substituted by hydel power during one tea processing season alone in the case of Chamong project. In Kalmoni too there has been a significant saving of diesel during the relatively brief operation period for the SHP, and saving of diesel is expected to further improve in the next tea processing season.

It may be thus concluded that even though there has been no significant replacement of fire wood and other fossil fuels in the case of SHPs in the Western Himalayan regions visited by our team there seems to be much greater scope for the effective substitution of fossil fuels within the tea plantation projects. It is also fairly clear from our discussion that with the availability of hydel power in the North Eastern States one could expect a significant shift from the predominant practice of 'Jhum' or shifting cultivation to more settled forms of scientific and irrigation based agriculture particularly in the North Eastern States where shifting cultivation is still widely practiced and is leading to severe environmental problems.

TRENDS IN ELECTRICITY CONSUMPTION IN SOME SELECTED SUB PROJECT TARGET AREAS :

Having briefly looked into the functioning of selected SHPs and also having seen that some of these which were commissioned relatively earlier than others, and have been a operation for fairly long periods of time, it would not be unreasonable to expect that the overall power situation in the target areas catered to by these SHPs or at least those habitations falling within a fairly close range of these SHPs would have experienced an improvement in power supply. The general perception of the sampled population in such areas has been that both the quality and regularity of power has improved significantly. Our discussions with the sampled population during the field visits confirmed these perceptions regarding power supply. We thus considered it worth while to substantiate these perceptions on the basis of empirical data, to the extent possible.

The stable and regular operations of the SHPs over a period of time, at least after their initial 'teething problems' had been overcome, was expected to stabilize and supplement the availability of power in the target area. It was expected that the infusion of power by the SHPs into the local grid would not only strengthen and stabilize the grid, particularly its 'tail end' or extremities but also lead to increases in electricity consumption in these areas.

In such a situation one would logically expect the consumption of electricity in these areas to improve significantly as more people in these areas would invest in and adopt the use of electrical appliances and gadgets that would otherwise not be used in the event of power supplies being unstable and erratic.

The records pertaining to electricity consumed in each target area is usually maintained at each sub-station/ transformer through which the concerned area is served. Each of these sub-stations/ transformers normally caters to all the consumers in a large village panchayat or at times a group of smaller hamlets or villages belonging to a panchayat. While the power consumption for each individual electrified household is recorded and monitored through individual electricity meters installed for the purpose, the total power drawn from each sub-station/ transformer is also recorded and monitored by the State Electricity Authority or utility that transmits and distributes power. The data on power consumption is thus available for each sub-station/ transformer in the target area and further more for three distinct categories of consumers namely domestic consumers, institutional consumers, and commercial consumers.

It was felt that the overall trends in the average monthly, bi-monthly or quarterly consumption of electricity in a few carefully selected settlements or villages in the target area for comparable periods prior to and after the setting up of the SHP would provide us with the means of confirming whether there had been any impact in terms of improved power consumption due to the setting up of the SHPs. Normally a target area extends over a distance of 8 to 12 kilometers on either side of the point at which the power generated by the SHP is fed or infused into the grid.

Table 5.5 : TRENDS IN ELECTRICITY CONSUMPTION IN SELECTED TARGET AREAS

Name of Sub-Project / SHP and Location	**Date of Commencement of Power Generation and Operational Status**	**Reference Period Prior to Commencement of Power Generation**	**Reference Period After Commencement of Power Generation**	**Average Bi-Monthly Power Consumption Prior to Commencement of Generation (in units) ***	**Average Bi-Monthly Power Consumption After Commencement of Power Generation (in units) ***	**Percentage change in Power Consumption Prior to and After Commencement of Power Generation (in %age)**
Titang Kinnaur Dist., H.P.	February, 2002	March, 01 - Jan, 02	Feb, 02 - July, 03	22838	30038	32
Lingti Spiti Sub-Div., Lahaul & Spiti Dist., HP	Commissioned but	March, 01 -Jan, 02	Feb, 02 - July, 03	7315	5618	-23
Kothi Kullu Dist., H.P.	June, 2001	May, 99 - May, 01	June, 01 - Sept, 03	12271	13152	7
Juthed Chamba Dist., H.P.	December, 2000	May, 99 - Nov, 2000	Dec, 2000 - Sept, 03	1184	1743	47
Raskat Kullu Dist., H.P.	August, 2001	N.A.	N.A.			
Solang Kullu Dist., H.P.	June, 2002	N.A.	N.A.			
Soneprayag Rudraprayag Dist., Uttaranchal	December, 2002	N.A.	N.A.			
Kalmoni Kamrup Dist., Assam	June, 2003	N.A.	N.A.			
Chamong **Darjeeling Distt., W.B.**	Commissioned but	N.A.	N.A.			
Pussimbing Darjeeling Dist., W.B.	Commissioned but not fully operational	N.A.	N.A.			

Figures relates to selected Sub-Stations/ Transformers in Target Area of the SHP
Source : ***HSEB, Himachal Pradesh. (Obtained from concerned SDO of the Target Area***

The geographical dimensions of each target area also depends on the installed capacity of each SHP with higher capacity SHPs catering to or covering a larger target area, and a larger number of habitations in that area.

We have first of all confined our attempt at estimating trends in power consumption to very select habitations within a sub project target area. We have thus limited ourselves to only the data pertaining to two or three sub stations which serve the needs of two or three villages in each of the sub project target areas that we have selected for our field survey. Secondly we have also confined this exercise to those SHPs that were commissioned relatively earlier such as the Juthed sub project which was operational in December 2000, the Kothi sub project which started regular generation of power in June, 2001 and the Lingti and Titang sub projects which was commissioned in January, 2002.

As seen in Table 5.5 we have obtained and compiled the average bi-monthly power consumption for a few sub-stations/ transformers in each of these selected SHPs target areas. These figures have been compiled for two distinct and fairly comparable reference periods, one for the period prior to the commissioning of the concerned SHP and the other for the period after the commissioning of the SHP.

As seen in Table 5.5 the average bi-monthly consumption of electricity in selected sub-stations/ transformers in the Titang sub project target area was 22838 Kwh (units) in the period March 2001 to January 2002 (ten months) prior to the commissioning of the Titang SHP. The bi-monthly average consumption of electricity however increased significantly for the same sub-stations/ transformers for the post commissioning period February 2002 to July 2003 (17 months) to 30038 Kwh (units). The post commissioning average bi-monthly electricity consumption as compared to the pre commissioning average bi-monthly electricity consumption increased by as much as 32 percent in the case of the selected sub stations served by the Titang SHP. Similarly in the case of selected sub stations served by the Juthed SHP the average bi-monthly electricity consumption increased by as much as 47 percent in the post commissioning period. In the case of selected sub stations catered to by the Kothi SHP the increase in the average bi-monthly electricity consumption in the post commissioning period as compared to the pre commissioning period was only 7 percent which does not seem very significant and could have been due to the normal growth rates in electricity consumption that exists in the case of supplies through the normal State grid.

In the case of the Lingti SHP however the average bi-monthly consumption of electricity in the selected sub-stations/ transformers was 7315 Kwh for the period of March 2001 to January 2002 prior to the commissioning of the project but for the post commissioning period the bi-monthly average dropped to only 5618 Kwh which was a drastic reduction in average power consumption of as much as 23 percent. This can only be explained by the fact that the power supply situation which was already quite critical prior to the commissioning of the Lingti project further deteriorated in the post commissioning period as the Lingti project was constantly constrained from power generation due to various snags. It was seen in the earlier section that the Lingti project suffered severely on account of flash floods that badly crippled its weir, the siltation of water channels seriously affected water flows, and caused nozzle blockages through severe siltation. As a result this SHP has never been able to generate stable power till date. This perhaps reflects the negative impact that this SHP has had on the target areas expected to be served by it. Since the 22 KVA grid that originates in Pooh in Kinnaur extends to the Spiti valley and is fed by the Titang SHP before it enters Spiti, it is reported that the tail end injection of power by the Titang SHP has at least provided some relief to the bordering areas between the two districts and thus halted the further deterioration of the power situation in parts of Spiti which are closer to the Titang target area. However it seems that unless the Lingti SHP starts regular generation the situation in the Spiti valley is likely to continue to be critical if not deteriorate further specially during the difficult winter months in this remote area.

It needs to be stressed that the consumption of electricity normally grows in practically all areas as more and more persons realize the benefits of electrical power as compared to other less cleaner and perhaps less accessible and depletable energy sources. This normal or natural growth of electrical energy consumption has been particularly impressive in the hilly States which have extended electrification to fairly remote rural areas. States such as Himachal and Uttaranchal thus claim to be fully electrified with practically all habitations connected to the State electricity grids that have been extended at enormous cost to most of the remote village habitations. Through most of these habitations are thus electrified the power supply in these places is far from stable and regular. In each of the selected target areas we have considered, there has been a natural or normal rate of growth in power consumption even in the absence of any supplementary power having been made available through the setting up of the SHPs. We have thus gone a step further in our exercise related to pre and post project power consumption in selected sub-stations/ transformers in the SHP target areas by estimating the rate of growth in the average bi monthly electricity consumption during the pre project reference period and comparing it with the rates of growth in the average bi-monthly electricity consumption for the same set of sub-stations/ transformers in the post project reference period.

Table 5.6 : TRENDS IN PPE AND POST PROJECT POWER CONSUMPTION IN SELECTED SUB-STATIONS/ TRANSFORMERS IN TARGET AREAS

Name of Sub-Project	Date of Commencement of Power Generation	Reference Period Prior to Commencement of Power Generation By SHP	Average Bi-monthly Power Consumption Prior to commencement of Power Generation (in units)	Reference Period After Commencement of Power Generation by SHP	Average Bi-monthly power consumption after commencement of Power Generation (in units)	Rate of change of Bi-monthly Power consumption Prior to Commencement of Power Generation (% age)	Rate of change of Bi-monthly Power consumption after commencement of Power Generation (% age)
Titang (As Observation Group)	February, 2002	March, 01 - Jan, 02	22838	Feb, 02 - July, 03	30038	32	72
Lingti (As Control Group)	Commissioned but not fully operational	March, 01 -Jan, 02	7315	Feb, 02 - July, 03	5618	36	2
Kothi (As Observation Group)	June, 2001	May, 99 - May, 01	12271	June, 01 - Sept, 03	13152	5	18
Juthed (As Control Group	December, 2000	May, 99 - Nov, 2000	1184	Dec, 2000 - Sept, 03	1742	5	17

For the selected sub station/ transformers in the Titang target area we find that during the pre project reference period between March 2001 and January 2002 the rate of growth of bi-monthly average consumption has been around 32 percent this normal or natural rate of growth in the pre project period in this area is by itself fairly high and is due to the fact that the local rural economy is considerably diversified and thus provides greater scope for increased energy use as seen in Table 5.6. What is perhaps more significant is that the rate of growth of average bi-monthly power consumption in these selected sub stations/ transformers for the reference period from February 2002 to July 2003 has sharply increased to as much as 72 percent an increase of nearly 30 percent as compared to the pre project situation. Similarly for both the selected sub stations/ transformers in the Kothi and Juthed sub project target areas it is seen that the pre project growth rates which were a mere 5 percent in both cases have significantly changed to 18 and 17 percent respectively an increase of 13 and 12 percent respectively as compared to the normal or natural pre project growth of electricity consumption of 5 percent. This perhaps convincingly substantiates our earlier results and goes to show that in three out of the 4 SHPs for which we have carried out this limited exercise, the post project impact on the average bi-monthly power consumption has been quite significant thereby reinforcing the contention that the setting up of the SHPs have made a significant impact in the target areas. In the case of the Lingti SHP however the impact on power consumption has been clearly negative. While the normal or natural growth of power consumption in the selected sub stations/ transformers in the Lingti target area was as high as 36 percent in the pre project reference period from March 2001 to January 2002 it deteriorated sharply to a mere 2 percent in the post project reference period from February 2002 to July 2003. With the Lingti SHP still crippled by serious operational snags and unable to produce the much needed power, the power situation in Spiti has deteriorated significantly. Here again but in a rather negative manner the impact of the SHP is clearly evident.

Finally from our overall field assessment it may be mentioned that smaller plants in the range of 50 – 200 KW have been observed to be functioning more effectively and viably than those of larger capacities. This broadly indicates that the optimal size of plants for a project of this nature should be in the range of 50 KW to 200 KW. Additional capacities can however be planned in subsequent phases subject to the development of load in the catchment area.

CHAPTER VI

THE IMPACT OF DEMONSTRATION PROJECTS IN THE TARGET AREAS

The ability of the people inhabiting the areas covered by the Small Hydel Demonstration Projects to assimilate and utilize energy for the sustainable improvements in their livelihoods and productivity depends to a great extent on how diversified and naturally endowed the local economy is to begin with. The division of labour that sparks off productivity and diversification in what is a predominantly agricultural economy of these regions is central to the transition of these local subsistence economies to a dynamic economy based on growth and development. The more the system diversifies the more it seems to be able to and is likely to productively utilize energy for its sustainable development. Energy is thus a means to development and cannot be an end in itself. It can only enhance and catalyze the development process and not substitute or replace it by itself.

The entire process of development has often been visualized as starting from the division of labour that inevitably leads to a quantum leap in labour productivity which in turn sparks off increases in incomes and demands that induce further diversification as well as the deepening and widening the local economy enhancing livelihood possibilities and improving the quality of life. What initially appears to be a stagnant subsistence economy gets metamorphosised into a dynamic accumulative economy of self sustaining growth and development clearly and explicitly marked by a strong mutually interactive relationship between development and energy use.

If the entire process of development in these remote hilly regions is viewed in this perspective then the logical first step in ones analysis of the manner in which the local agricultural economy in these regions responds to the provision of clean and stable electrical energy provided by harnessing the Small Hydel potential would be to start with the degree of agricultural diversification in these local economies. It would also be useful to systematically trace the interactive dynamic between development and energy utilization.

On an a-priori level one would expect the dominant sequence of this interactive process to be that higher levels of agricultural and occupational diversification would correspond to higher incomes which in turn would induce higher levels in the quality of life and lifestyles that in turn induce higher levels of energy consumption. It would thus be logical to expect a close positive correlation between the four broad but critical parameters of this process namely the levels of agricultural and occupational diversification in the sampled target areas, levels of income, quality of life, levels of lifestyle and physical habitation conditions, and also the quality and levels of energy availability and the utilization of energy in the sampled target areas.

In this section of the report we shall look into and analyze these broad parameters on the basis of sample data collected by our field teams during the survey of selected target areas. The survey of households was carried out in six target areas each covered by one of the demonstration sub-projects. Only in one case was a common sample taken for households covered by two such sub-projects of Solang and Kothi in Kullu District of Himachal Pradesh as both these projects were covering the same target area. In each of the selected target areas a sample of 60 households were covered. These households were not selected from any single village or habitation but were selected from at least two to four distinct villages in the operational range of the concerned sub-project after detailed discussions with the sub-project staff. All the relevant information related to the sampled households was canvassed though a detailed questionnaire. As mentioned in the methodology that was planned for assessing the impact. We initially intended to divide the sample in two parts for each target area. One part of the house hold sample was to cover households which were electrified and the other the households that were not electrified in order to assess the differential impact of electricity on these two segment of the sample. The fist group of households was to be classified as the ‘observation group’ and the second consisting of those households which were not electrified were to be treated as the ‘control group’. The observed differences between these two groups was to be used to assess the degree of impact each sub-project had on the target area population. However due to the fact that in all the target areas covered the majority of the households were electrified, we were not in a position to use the planned classification of the observation and control groups as suggested initially. We then had to resort to a fresh classification wherein we made comparisons between distinct target areas. The households sampled from the Titang sub-project area (60 HH) was treated as an observation group and compared with the households sampled from the Lingti sub-project areas (60 HH) which we treated as the control group. This was done because the Titang sub-project household samples was relatively better serviced in terms of availability of power and also enjoyed relatively better and stable quality of power as compared to the Lingti sub-project households. This was because the Titang SHP had been in regular operation for a longer period of time and had started to augment the 22 KVA State grid serving the Titang target area. The power situation in this target area due to the tail end injection of power into the 22 KVA grid by the Titang SHP was reported to be much better than the power situation in the Lingti target area. Moreover we considered that the comparisons made between the Titang and Lingti target areas would be appropriate because both these SHPs were located in comparable terrain and climatic conditions.

Using similar justification we also classified the households from target areas of the Raskat and Solang/ Kothi sub-projects in Kullu district of Himachal Pradesh as the observation group[*] and compared these with the households drawn from the Juthed and Soneprayag sub-project target areas which were treated as the control group sample for this study. Here again the observation group and control group samples were drawn and compared due to the similarities in the geographical and terrain conditions, though this sample was drawn from two different States.

It may be mentioned that we have thus compared the sampled data for two sets of observation and control groups and also

[*] Here again the power supply in the areas was relatively better and of better quality and regularly due to early commissioning of Raskat and Solang/ Kothi SHPs and the tail end injection of power into the grid in these target areas had considerably augmented the power supply in this observation group target areas as compared to the situation prevailing in the Juthed and Soneprayag sub-project target areas.

finally made comparison between the entire observation group sample of 180 households and the total control group sample of 180 households drawn from the selected sub-project target areas for which household samples were drawn for the study.

AGRICULTURAL DIVERSITY IN THE TARGET AREAS :

As mentioned earlier the degree of diversity in agriculture in rural areas provides wider possibilities for various applications of electrical energy apart from basic agricultural applications like electrical pumping of water for crop irrigation, spraying, dusting and fogging operations. There are secondary processing applications such a drying, canning and other food processing and preservation activities. While in a very few of the target areas diesel and kerosene generators are being used for some of these agricultural operations, the stable and regular availability of power in these remote locations would increasingly lead to a significant substitution of these fossil fuels by electrical energy. If we turn to our survey results for the target areas we find that the degree of agricultural diversification varies substantially over the different sampled locations as seen in Table 6.1.

Table 6.1 : Agricultural Diversity Among Sampled Households in Target Area

Name of Sub-Project Area	Total Sampled HHs	Avg. Land Holding per HH (in Bighas)	No. of HH Growing Different Crops				Annual Value of Crop Output (Rs) Produced by Sampled HHs				Annual Value of Output From Crops (in Rs)
			Cereal Crops	Pulses	Vegetable Crops	Fruits Crops	Cereal Crops	Pulses	Vegetable Crops	Fruits Crops	
Titang as OG	60	13	15 **(24.32)**	10 **(16.22)**	44 **(72.97)**	29 **(48.65)**	70500 **(9.87)**	5075 **(0.71)**	200499 **(28.06)**	438367 **(61.36)**	714441
Lingti as CG	60	12	56 **(93.33)**	30 **(50.00)**	10 **(16.67)**	0 **(0.00)**	270536 **(84.76)**	15225 **(4.77)**	33410 **(10.47)**	0 **(0.00)**	319171
Raskat & Solang/ Kothi as OG	120	10	88 **(73.48)**	103 **(85.98)**	59 **(49.24)**	36 **(29.92)**	145826 **(25.18)**	236520 **(40.83)**	77415 **(13.37)**	119466 **(20.63)**	579227
Juthed & Sonprayag (as CG)	120	7	85 **(70.83)**	29 **(24.17)**	21 **(17.50)**	0 **(0.00)**	177524 **(57.24)**	22509 **(7.26)**	110113 **(35.50)**	0 **(0.00)**	310146
For Observation Group Area	180	11	103 **(57.10)**	113 **(62.73)**	103 **(57.15)**	65 **(36.17)**	216326 **(16.72)**	241595 **(18.68)**	277914 **(21.48)**	557833 **(43.12)**	1293668
For Control Group Area	180	9	141 **(78.33)**	59 **(32.78)**	31 **(17.22)**	0 **(0.00)**	448060 **(71.20)**	37734 **(6.00)**	143523 **(22.81)**	0 **(0.00)**	629317
For Total Impact Area	360	9	244 **(67.72)**	172 **(47.75)**	134 **(37.19)**	65 **(18.08)**	664386 **(34.55)**	279329 **(14.53)**	421437 **(21.92)**	557833 **(29.01)**	1922985

Note : **Figures in Parenthesis are Percentage Distribution of Responses**

In the Titang sub-project target area and for the 60 sampled households which we have categorized as an 'observation group', we notice a fairly significant degree of agricultural diversification with a fairly high number of the total sampled households growing a variety of vegetables and fruit crops apart from basic cereals and pulses. Among these crops one finds the cultivation of high valued commercial vegetable crops and fruit crops such as almonds and apples. The value of these crops produced by the 60 sampled households is also estimated to be substantial. However in the Lingti sub-project target area and for the sampled households that form our first comparable control group, the level of agricultural diversification is seen to be lower as compared to the Titang sample. Though the terrain and climatic conditions are very similar most sampled households in the Lingti sample cultivate only basic cereals and pulses though a few have also ventured into vegetable cultivation. While the average size of land holding observed for the two samples is similar the value of agricultural output is comparatively lower for the Lingti sample perhaps indicating lower levels of productivity as well compared to the Titang sample.

Turning to our second observation group sample of 120 households drawn from the combined target areas of Raskat and Solang/ Kothi sub-projects we again find that the degree of agricultural diversification among these households is significant with roughly more than 30 percent of the sampled households growing vegetable and fruit crops apart from the cultivation of basic cereals and pulses.

The situation for the second control group sample of 120 households drawn from the combined Juthed and Soneprayag sub-project target areas is that agriculture among these households is relatively less diversified as compared to the corresponding observation group sample drawn from the Raskat and Solang/ Kothi sub-project target areas. While the average size of land holding for the observation group sample is distinctly higher than for the control group sample the value of agricultural outputs also varies substantially between the two groups. It is thus clearly evident that there is a much higher level of agricultural diversification for our total study sample of observation group households as compared to the control group households.

We can on this basis draw two very limited, cautious, and rather speculative set of conclusions. Firstly that the higher degree of agricultural diversification may be partly due to the relatively better power situation in the observation group sample target areas, both in terms of the quality and regular availability of electricity in these target areas, enabling value additions and higher productivity[*] specially brought about by effective tail end injection of power by the sub-projects in the area which in turn has been made possible because of the relatively better transmission and distribution infrastructure in these areas. Secondly even if one presumes that the present direct impact of the sub-projects on agriculture is only marginal if not imperceptible the probability or likelihood of a progressively higher impact is clearly visible in the years to come though it may be too early to come to a definite conclusion on this issue at the present stage. It is also possible to suggest that if one uses these results as a benchmark then a similar exercise a few years down the line would be in a better position to more accurately quantify and prove the more direct impact of electrical power on the local agricultural economy in the target area.

NON-FARM OCCUPATIONAL DIVERSITY IN THE TARGET AREAS :

Agricultural diversification is inevitably accompanied by the commercialization of agriculture which provides further avenues for livelihood. As the market for agricultural goods expands so do incomes and demands for various goods and services inducing occupational diversification specially in the non farm sector of the local or regional economy.

Our small sample survey results for the target areas provided in Table 6.2 shows that in both the Titang sub-project area as well as the Raskat and Solang/ Kothi sub-project areas there is a relatively higher degree of non-farm occupational diversity. While in Titang nearly 40 percent of the 60 sampled

[*] These increases in productivity and value additions may have come about indirectly by the lengthening of the working day due to effective domestic lighting rather than through the direct use of electrical energy in farm operations.

households are engaged in various non farm occupations only 10 percent of the sampled households in the Lingti sub-project area are engaged in non farm activity.

Table 6.2 : Non-Farm Occupations Among Sampled Households in Target Area

Name of Sub-Project Area	No. of HH Sampled	No. of HH Involved in Non-Farm Activity	No. of Sampled HH Involved in Non farm Activities						Annual Value of Non Farm Output (Rs)	Annual Value of Non Farm Output per HH (Rs)
			Tool Making and Metal Work	Wood Processing & Carpentry	Weaving Knitting & Tailoring	Pottery & Stone Work	Rural Services	Hospitality & Tourism		
Titang as OG	60	23 **(38.33)**	3 **(13.04)**	7 **(30.43)**	3 **(13.04)**	1 **(4.35)**	7 **(30.43)**	2 **(8.70)**	1150000	19167
Lingti as CG	60	6 **(10.00)**	0 **(0.00)**	2 **(33.33)**	1 **(16.67)**	0 **(0.00)**	2 **(33.33)**	1 **(16.67)**	216000	3600
Raskat & Solang/ Kothi as OG	120	72 **(60.00)**	1.2 **(1.67)**	5 **(6.94)**	5.2 **(7.22)**	3 **(4.17)**	20.4 **(28.33)**	37.2 **(51.67)**	3366324	28053
Juthed & Soneprayag (as CG)	120	41 **(34.17)**	0 **(0.00)**	6 **(14.63)**	1 **(2.44)**	4 **(9.76)**	15 **(36.59)**	15 **(36.59)**	1652128	13768
For Observation Group Area	180	95 **(52.78)**	4.2 **(4.42)**	12 **(12.63)**	8.2 **(8.63)**	4 **(4.21)**	27.4 **(28.84)**	39.2 **(41.26)**	4516324	25091
For Control Group Area	180	47 **(26.11)**	0 **(0.00)**	8 **(17.02)**	2 **(4.26)**	4 **(8.51)**	17 **(36.17)**	16 **(34.04)**	1868128	10378
For Total Impact Area	360	142 **(39.44)**	4.2 **(2.96)**	20 **(14.08)**	10.2 **(7.18)**	8 **(5.63)**	44.4 **(31.27)**	55.2 **(38.87)**	6384452	17735

Note : Figures in Parenthesis are Percentage Distribution of Responses

In the second observation group sample drawn from the Raskat and Solang/ Kothi target area one can find that as many as 60 percent of the 120 sampled households are actively engaged in non farm occupations as compared to the control group sample of 120 households drawn in the Juthed/ Soneprayag target area. In this area only 34 percent of the households sampled are engaged in non-farm occupations. It is convincingly clear that the degree of non-farm occupational diversity in the observation group sample is distinctly higher than that for the control group sample in our study. The higher occupational diversity is also accompanied by the higher value of non-farm incomes for the observation group sample as compared to the control group sample. Here again it is possible to cautiously conclude that to some extent the occupational diversity may have come about particularly in rural services and the tourism and hospitality sectors on account of the relatively better power situation in the observation group target area as compared to the control group target area. However one would be on firmer grounds to also conclude that considering the higher levels of non farm occupational diversity in the observation group target areas the possibility of a significant impact on diverse opportunities of livelihood do exist for the years ahead. However as mentioned earlier it seems to be two early to draw any definite conclusions in regard to this impact. One can however, speculate that the likelihood of the impact exists to a greater extent for the observation group sample as compared to the control group.

SOCIAL AND EDUCATIONAL PROFILE OF THE SAMPLED HOUSEHOLDS IN THE TARGET AREA :

It has been argued earlier that increased livelihood opportunities through a more occupationally diversified rural economy often translate into improvements in social and educational attainments among the population, such as gender empowerment and higher literacy levels and thus greater awareness regarding health, hygiene and nutrition. It should also be stressed that better lighting and communication facilities along with wider exposure to knowledge and awareness through media which is often made possible through electrification catalysis the entire process of social and educational development in the community. The social and educational status of the people is thus an important determining factor for the increased use of cleaner and more efficient modern fuels such as electricity. However, a great deal depends on the stable availability to power as well as its affordability as compared to other primitive and polluting fuels. The provision of electrical power in a poor and illiterate community by itself may not create the expected impact as the basic understanding and assimilation of the benefits of electrical power is likely to be low in such a community. However, stable and affordable power for basic lighting purposes along with the development of the radio and television along with better communication systems brings about the necessary level of public awareness that is necessary to spark off a gradual but definite increase in the use of electrical power for cooking, heating and other livelihood applications. The availability of electrical power for lighting purposes provides more hours of learning for children significantly improving their educational and mental attainments and capabilities. It also provides more time for women to improve their traditional home based vocations and reduces the domestic drudgery of hewing wood and drawing water. All this adds up to a significant improvement in the quality of life particularly for women and children in the household.

It is therefore necessary to highlight the social and educational status of the sampled households in the target area and to see if there are any tangible differences in the social and educational status of the sampled households belonging to the observation group as compared to that of the control group. On the basis of the sex composition of the members of sampled households it is seen that the sex ratio which normally reflects the level of gender sensitivity is distinctly higher among the observation group sample as compared to the control group as seen in Table 6.3. The levels of literacy is also relatively higher in the observation group sample as compared to the control group. The predominance of the tribal population provides an additional dimension to our analysis as the greater homogeneity and cohesiveness among the tribal population provides ideal conditions for the faster assimilation and adoption of electrical energy in day to day improvements in the quality of life through collective awareness and effective demonstration, that arises out of social cohesiveness in closely knit tribal communities.

Table 6.3 : Social and Educational Profile of Sampled Households in Target Area

Name of Sub-Project	No. of HH Sampled	Sex Composition of HH			Social Composition of HH		Literacy Status of Members *	
		Males	Females	Total	Tribals	Non-Tribals	Literate	Illiterate
Titang as OG	60	171 **(49.00)**	177 **(51.00)**	348	58 **(97.00)**	2 **(3.00)**	257 **(77.88)**	73 **(22.12)**
Lingti as CG	60	190 **(52.78)**	170 **(47.22)**	360	60 **(100.00)**	0 **(0.00)**	248 **(75.15)**	82 **(24.85)**
Raskat & Solang/ Kothi as OG	120	387 **(48.48)**	411 **(51.52)**	798	70 **(58.00)**	50 **(42.00)**	587 **(77.95)**	166 **(22.05)**
Juthed & Sonprayag (as CG)	120	452 **(53.00)**	401 **(47.00)**	853	8 **(6.50)**	112 **(93.50)**	528 **(66.25)**	269 **(33.75)**
For Observation Group Area	180	557 **(48.64)**	589 **(51.36)**	1146	128 **(71.00)**	52 **(29.00)**	844 **(77.93)**	239 **(22.07)**
For Control Group Area	180	642 **(52.94)**	571 **(47.06)**	1213	68 **(37.67)**	112 **(62.33)**	776 **(68.86)**	351 **(31.14)**
For Total Impact Area	360	1199 **(50.85)**	1160 **(49.15)**	2359	196 **(54.44)**	164 **(45.56)**	1620 **(73.30)**	590 **(26.70)**

Note : * Excluding Infants below 5 years

Figures in Parenthesis are Percentage Distribution of Responses

Here we would be in a position to draw more definite conclusion regarding the impact of electrical power on the social and educational status of the population in the target area. The more regular and stable supplies of power brought about by the SHPs in the observation group sub-project areas particularly through better lighting communication and wider exposure to media (Radio and Television) has had a significant impact on the social and educational status of the local population. We shall however comment more extensively on the issue later in this chapter when we look into the perception of the sampled local population regarding supply of electrical power in the target areas.

THE ECONOMIC PROFILE OF SAMPLED HOUSEHOLDS IN TARGET AREA :

Having discussed the social and educational status of the sampled household in the target area we now look into the economic profile of the households. As the economic status of the households improve there are corresponding changes in their consumption patterns. This is normally reflected in the progressive increases in non food consumption as with increases in income people tend to spend relatively lower proportions of these additional incomes on basic foods and more on the consumption of more processed and superior foods. Having satisfied their basic food requirements households tend to move on the consumption of non food consumption goods and services. These progressive changes in the consumption patterns is also likely to be present in the consumption of fuels as people with higher and growing incomes move from relatively inferior and polluting fuels such as wood and coal to more superior and efficient fuels such as LPG and electricity for meeting their increasing energy requirements. This gradual process of the substitution of inferior fuels by cleaner and more efficient superior fuels again leads to an improvement in the quality of life in terms of related environmental and health benefits.

Turning now to the economic status of the sampled households in the target area we see from Table 6.4 that the average number of persons per sampled households or the average family size varies from one set of sampled households to the other. The average size of households in the Titang sub-project sample is relatively lower than that observed in the Lingti sub-project sample. Likewise the family size in the

Raskat and Solang/ Kothi sub-project area sample is distinctly lower than that observed in the Juthed/ Soneprayag sample. On the whole it is seen that while the average size of the family is lower at 6.4 persons for the observation group sample it is higher at 6.7 persons for the control group sample.

Table 6.4 : Economic Profile of Sampled Households in Target Area

Name of Sub-Project Area	No. of HH Sampled	Avg. No. of Persons Per HH	No. of Members Employed in HH	Dependent Members of HH	Avg. Annual Incomes per HH	Avg. Annual Expenditure per HH	Average Expenditure on Food per HH	Avg. Expenditure on Non food per HH
Titang as OG	60	5.8	190 **(54.46)**	158 **(45.54)**	80231	71204	30470 **(42.79)**	40733 **(57.21)**
Lingti as CG	60	6.0	149 **(41.43)**	211 **(58.57)**	74236	39368	20606 **(52.34)**	18762 **(47.66)**
Raskat & Solang/ Kothi as OG	120	6.7	444 **(55.58)**	354 **(44.42)**	52613	40510	20665 **(51.01)**	19846 **(48.99)**
Juthed & Sonprayag (as CG)	120	7.1	421 **(49.38)**	432 **(50.62)**	36511	28304	14471 **(51.13)**	13833 **(48.87)**
For Observation Group Area	180	6.4	633 **(55.24)**	513 **(44.76)**	66422	55857	25568 **(45.77)**	30290 **(54.23)**
For Control Group Area	180	6.7	570 **(46.99)**	643 **(53.01)**	55374	33836	17538 **(51.83)**	16298 **(48.17)**
For Total Impact Area	360	6.6	1203 **(51.00)**	1156 **(49.00)**	55452	41367	20225 **(48.89)**	21142 **(51.11)**

Note : Figures in Parenthesis are Percentage Distribution of Responses

Table 6.4 also indicates that the number of persons employed is also higher for the observation group as compared to the control group. This is further supported by the fact that the number of dependent members in the household is also considerably lower in the observation group sample as compared to the control group. We also see that the average annual incomes reported to have been earned by the sampled households in the observation group are considerably higher than that of the control group and so is the case for the reported annual average expenditures. Moreover the reported average annual non food expenditure is also distinctly higher than that on food related expenditure in the observation group sample while this is clearly not the case for our control group sample.

It is thus possible to conclude from the discussion above that the economic status of the sampled households in the observation group seems to be relatively better than that of the sampled households in the control group. Though this relatively better economic status may be only very marginally influenced by the better access to electricity by the observation group it does indicate that the probability of a progressively higher level of utilization of electrical energy clearly exists for the observation group and therefore the impact of the SHPs particularly in terms of a significant shift from inferior and polluting fuels to cleaner forms of energy will in all probability become more apparent in the days to come. Thus the likelihood of a significant impact on the further enhancement of incomes through the higher use of electrical power in the observation group sampled cannot be ruled out*.

LIFESTYLES AND DWELLING CONDITIONS IN THE TARGET AREA :

It is also important to carefully study the general life style and living conditions of the population in the target areas. The nature, size and design of dwellings would to a considerable extent determine the benign effects of the availability and stable access to electrical power, specially in terms of applications such as effective lighting and heating of living and other functional spaces within and around these dwellings. For instance the widespread prevalence of traditionally constructed dwelling often large in size, may not provide conducive conditions for the effective use of electrical energy for lighting and heating purposes and thus render these applications redundant and unviable to a great extent thereby lowering the expected impact. These problems are likely to be compounded if these dwellings are not properly insulated or ventilated rendering them less energy efficient. There seem to be two possible approaches to tackle this problem the quicker but relatively less effective solution perhaps lies in those initiatives which adopt electrical energy applications to suit the needs and requirements of traditional dwelling design. The development of low wattage and more dispersed lighting and heating devices are a

* Here again one could only suggest that the present study could be used as a bench mark to arrive at more definite conclusions on the actual impact in the days to come.

necessary step in this direction the equally important issue of whether these devices once developed would be increasingly assimilated and utilized by the population residing in these traditionally styled habitations would depend on their affordability as well as the awareness regarding the beneficial effects of these devices. The second and more fundamental long term solution which is not in anyway incompatible with the first approach and can be implemented simultaneously is to increasingly initiate energy efficient and energy friendly design and construction of dwelling to optimally and efficiently utilize the availability of electrical power in the target areas. These architectural and innovative interventions in the area are therefore necessary even on a limited scale, to create a powerful demonstration effect which could then be assimilated by others in order to ensure the necessary impact, bringing about more energy friendly design and dwelling construction in the target areas.

The actual ground level conditions regarding life styles and dwelling conditions in the target area is seen in Table 6.5. It is quite obvious from this table that in most target areas sampled dwelling irrespective of whether they belong to the observation or control groups have among them a fairly significant proportion of sampled dwellings which may be categorized as traditional large sized houses with combined or commonly used functional spaces. These combined or common functional spaces normally contain a centrally located wood fired hearth commonly known as the ‘tandoor’ which serves the family’s needs for both cooking and room heating simultaneously. The boxlike metallic frame of this traditional tandoor has provisions for a metal chimney that evacuates the smoke out of the house while radiating heat which warms the entire common space. The room is thus used as a place to cook and eat, as well as a place to sleep for the entire family. It is also seen that in a fairly substantial number of cases the ventilation and visibility in these houses as well as the quality of heat insulation is not satisfactory. This is because among the poorer households though the house may be moderate to large in size they are built using locally available stone, clay, slate and bamboo which are the only affordable materials that can be procured easily, they are thus categorized as ‘Kucha’ or ‘Semi Kucha’ houses. The standards of sanitation and lighting in the bathing areas and lavatories is also very poor and pose the risks of accidents and infectious diseases. However, what is encouraging is to see is that in the case of new houses that are steadily replacing the older dwellings or being built anew through a gradual process of family sub divisions, the designs are contemporary using ‘modern’ and more conventional building materials such as cement, steel and concrete.

Table 6.5 : PROFILE OF SAMPLED HOUSEHOLDS DWELLINGS IN THE TARGET AREA

Name of SubProject Area	No. of HH Sampled	Style of Dwelling Unit		Area of Household			Combined Functional Living Spaces	Segregated Functional Living Spaces	Ventilation / Visibility		Heat Insulation Quality		Quality of Sanitation		Water Supply	
		TRD.	CONTMP.	Small	Medium	Large			S	NS	S	NS	S	NS	Piped Water	Other Sources
Titang as OG	60	41 **(67.57)**	19 **(32.43)**	2 **(2.70)**	**16** **(27.03)**	42 **(70.27)**	42 **(70.27)**	18 **(29.73)**	28 **(46.67)**	32 **(53.33)**	21 **(35.00)**	39 **(65.00)**	26 **(43.33)**	34 **(56.67)**	45 **(75.68)**	15 **(24.32)**
Lingti as CG	60	57 **(94.29)**	3 **(5.71)**	1 **(1.67)**	14 **(23.33)**	45 **(75.00)**	57 **(94.29)**	3 **(5.71)**	19 **(31.67)**	41 **(68.33)**	8 **(13.33)**	52 **(86.67)**	18 **(30.00)**	42 **(70.00)**	43 **(71.43)**	17 **(28.57)**
Raskat & Solang/ Kothi as OG	120	36 **(29.92)**	84 **(70.08)**	13 **(11.06)**	69 **(57.20)**	38 **(31.67)**	34 **(28.41)**	86 **(71.59)**	58 **(48.33)**	62 **(51.67)**	53 **(44.17)**	67 **(55.83)**	26 **(21.67)**	94 **(78.33)**	99 **(82.58)**	21 **(17.42)**
Juthed & Sonprayag (as CG)	120	77 **(64.42)**	43 **(35.58)**	47 **(39.29)**	35 **(29.29)**	38 **(31.41)**	75 **(62.18)**	45 **(37.82)**	28 **(23.33)**	92 **(76.67)**	33 **(27.50)**	87 **(72.50)**	23 **(19.17)**	97 **(80.83)**	103 **(85.83)**	17 **(14.17)**
For Observation Group Area	180	76 **(42.47)**	104 **(57.53)**	15 **(8.27)**	85 **(47.14)**	80 **(44.53)**	76 **(42.36)**	104 **(57.64)**	86 **(47.78)**	94 **(52.22)**	74 **(41.11)**	106 **(58.89)**	52 **(28.89)**	128 **(71.11)**	144 **(80.28)**	36 **(19.72)**
For Control Group Area	180	134 **(74.38)**	46 **(25.62)**	48 **(26.75)**	49 **(27.15)**	83 **(46.11)**	131 **(72.88)**	49 **(27.12)**	47 **(26.11)**	133 **(73.89)**	41 **(22.78)**	139 **(77.22)**	41 **(22.78)**	139 **(77.22)**	146 **(81.03)**	34 **(18.97)**
For Total Impact Area	360	210 **(58.42)**	150 **(41.58)**	63 **(17.51)**	134 **(37.14)**	163 **(45.32)**	207 **(57.62)**	153 **(42.38)**	133 **(36.94)**	227 **(63.06)**	115 **(31.94)**	245 **(68.06)**	93 **(25.83)**	267 **(74.17)**	290 **(80.65)**	70 **(19.35)**

Note: TRD. = Traditional CONTMP. = Contemporary S= Satisfactory NS= Not Satisfactory

Figures in Parenthesis are Percentage Distribution of Responses

Here again the sizes predominantly range from 'medium' to 'large' but have more segregated functional living spaces such as separate kitchens, living rooms, and bed-rooms. The ventilation and visibility through provisions for natural lighting is often well planned and the quality of sanitation is also relatively better than observed in the case of traditional houses. These contemporary dwellings occur more frequently and are found more in the observation group target areas as compared to the control group target areas. It should also be stressed that in the more traditional dwelling units the electrical wiring arrangements are fairly unplanned and rudimentary leaving large areas of the house uncovered and badly illuminated. In the more contemporary dwellings however the wiring layouts and the relatively larger number of electrical sockets and plug points cater to all the mainly segregated functional spaces. These dwellings by far are certainly more 'energy friendly' enabling a more efficient and effective utilization of electrical power for day to day household applications. With the progressive changes in design the assimilation and use of electrical energy for lighting and other domestic applications can be expected to progressively rise in the future.

THE ENERGY CONSUMPTION PROFILE IN THE TARGET AREA :

We now turn to the important issue of the various types of fuels used by the sampled households in the target area. On the basis of our household survey we have attempted to throw some light on the overall composition of fuels consumed by the sampled households and the share of each specific fuel used in this energy consumption profile of the sampled population in the target area. In Table 6.6 we have compiled not only the total quantity of each fuel consumed annually by the sampled households in each sub-project target area selected but also the value of this annual consumption has been estimated by using landed cost of these fuels in

the specific target areas sampled.

Table 6.6 : ENERGY CONSUMPTION PROFILE OF SAMPLED HOUSEHOLDS IN THE TARGET AREA

Name of Sub-project Area	No. of HH Sampled	Quantity of Fuel wood Consumed Annually (Qt.)	Value of Fuel wood Consumed Annually (Rs)	Quantity of Kerosene Consumed Annually (in liter)	Value of Kerosene Consumed Annually (Rs)	Quantity of LPG Consumed Annually (Cyld.)	Value of LPG Consumed Annually (Rs)	Quantity of Diesel Consumed Annually (in liter)	Value of Diesel Consumed Annually (Rs)	Quantity of Elect. Consumed Annually (in units)	Value of Elect. Consumed Annually (Rs)	Total Value of Energy Consumed Annually (Rs)
Titang As OG	60	1164	273616 (44.84)	1171	14050 (2.30)	769	215222 (35.27)	2432	58378 (9.57)	65325	48994 (8.03)	610260 (100.00)
Lingti As CG	60	1114	261857 (48.02)	2318	27813 (5.10)	720	201600 (36.97)	514	12343 (2.26)	55543	41657 (7.64)	545270 (100.00)
Raskat & Solang/ Kothi As OG	120	3267	767809 (67.61)	3277	39327 (3.46)	627	175636 (15.46)	2018	48436 (4.26)	139353	104515 (9.20)	1135724 (100.00)
Juthed & Sonprayag (as CG)	120	3223	757333 (74.14)	4809	57703 (5.65)	162	45489 (4.45)	900	21600 (2.11)	99854	139354 (13.64)	1021479 (100.00)
For Observation Group Area	180	4431	1041425 (59.65)	4448	53377 (3.06)	1396	390858 (22.39)	4450	106814 (6.12)	204678	153509 (8.79)	1745984 (100.00)
For Control Group Area	180	4337	1019190 (65.05)	7127	85516 (5.46)	882	247089 (15.77)	1414	33943 (2.17)	155397	181011 (11.55)	1566749 (100.00)
For Total Impact Area	360	8768	2060615 (62.20)	11575	138893 (4.19)	2278	637947 (19.26)	5864	140757 (4.25)	360075	334520 (10.10)	3312733 (100.00)

Note : Figures in Parenthesis are Percentage Distribution of Responses

This provides us with a basis to compare the importance of the share of each fuel in the overall consumption of various fuels in the area. The fuels commonly used in the area are wood, kerosene oil, Liquid Petroleum Gas (LPG), Diesel and Electricity. The most commonly used fuel being wood it is used mainly for cooking. Kerosene is however quite frequently used in way side restaurants and hotels catering to the tourists visiting some of these areas. LPG on the other hand is commonly used for cooking specially during the summer months as its availability declines during the severe winter months when roads are blocked and it is not possible to transport this fuel regularly though a certain amount of stocking of LPG takes place to tide over the winter months but there are obvious physical and financial limits to such inventories. Diesel is used mainly for generators which have several agricultural and local industry and service applications. Electricity which is the focus of our study is mainly used for domestic lighting and entertainment purposes and at times for water and room heating. Its commercial uses are still very limited in the target areas. Looking into the actual results of our survey we see in Table 6.6 that for our first observation group sample of 60 households drawn from the Titang sub-project target area the proportion of fuel wood accounts for nearly 45 percent of total value of fuels consumed annually by the sampled households. However, it is also encouraging to see that the share of the relatively cleaner fuel LPG is as high as 55 percent. The share of electricity is only 8 percent. If we combine wood, kerosene and diesel which are ‘less cleaner’ fuels and compare their share with LPG and Electricity in the total value of annual fuel consumption we find that in the Titang sub-project area sample, the share of these ‘less cleaner fuels’ is nearly 57 percent of the value of annual fuel consumption while the cleaner fuels account for as much as 43 percent of the total annual fuel consumption by the sampled households. For our first control group sample of 60 households drawn from the Lingti sub-project area we find that the proportion of fuel wood accounts for nearly 48 percent of the total value of fuels consumed by our sampled households annually. The combined share of ‘less cleaner’ fuels is around 55 percent however cleaner fuels like LPG and electricity account for as much as 44 percent of the annual value of fuel consumption. It is however encouraging to see that both in these interior target areas there is a substantial presence of cleaner fuels mainly on account of the special efforts made by the oil companies to provide access to LPG supplies in spite of the very difficult transport conditions in these target areas. With more stable and affordable power its share in the cleaner fuel basket is likely to rise.

For our second observation group sample of 120 households drawn from the Raskat and Solang/ Kothi sub-project target areas we find that the proportion of fuel wood accounts for as much as 67 percent of the value of annual fuel consumption by the sampled households.

Here again it is quite disturbing to find that in spite of the relatively better transport and communication systems as also the quality of and regularity of electricity supply, the proportion of ‘less cleaner fuels’ accounts for as high as 75 percent of the total value of fuel annually consumed by the sampled households. The share of ‘cleaner fuels’ such as LPG and electricity is only around 25 percent of the total value of annual fuel consumption. The individual share of electricity is around 9.20 percent of the annual value of energy consumption which even if low at present is higher than that observed in the first control group sample drawn from the Lingti sub-project target area.

For our second control group sample of 120 household drawn from the Juthed/ Soneprayag sub-project target area fuel wood accounts for as high as 74 percent of the value of annual energy consumption by the sampled households. The proportion of ‘less clean fuels’ is also disturbingly high at nearly 82 percent of the value of annual fuel consumption. As for the proportion of cleaner fuels such as LPG and electricity the proportion is as low as 18 percent though this is mainly due to the much lower levels of LPG consumption is this area. However, the proportion of electricity consumption in this control group sample which is at 13.64 percent is distinctly higher than the corresponding observation group. This may not be an account of higher electricity consumption per se but mainly on account of the higher domestic tariff for electricity in the Soneprayag sub-project target area. The domestic tariff is Rs. 1.90 per unit in Soneprayag as compared to Rs. 0.75 in Juthed. This higher tariff structure is responsible for inflating the value of electricity consumed as a proportion to the value of total fuel consumption in this control group sample.

For our observation group sample as a whole the value of fuel wood consumption to total annual consumption of fuel is a little over 59 percent as compared to nearly 73 percent in the control group sample. The proportion of the value of ‘clean fuels’ in the observation group sample is about 31 percent which again is distinctly higher than the proportion of the value of clean fuels which is only 27 percent for our control group in spite of the figure being inflated due to higher electricity tariff in Soneprayag. All this seems to indicate, if not very convincingly, that even though the consumption of electricity is low in comparison to the total fuel consumption there is a tendency to move into cleaner options if the relative costs are reasonable this seems particularly so in the observation group sample as compared to the control group sample. Though there does not seem to be any significant substitution of fuel wood by electricity there is likely to be a movement in the direction as the power supply as well as the quality of distribution services improves in these target areas. We come to this conclusion as the field level data shows us quite convincingly that the propensity to use cleaner and more efficient fuels already exists in these target areas and is in fact distinctly higher for the observation group sample.

RANGE OF DOMESTIC ELECTRICAL APPLIANCES USED BY SAMPLE HOUSEHOLDS IN TARGET AREA :

The range of domestic electrical appliances used by the sampled households in the target area reflects not only the functional felt needs of the families in the area but also their propensity and eagerness to utilize these appliances to reduce drudgery and improve their quality of life. On an a-priori level one can expect that a wider range of appliances would be utilized depending upon the quality and regularity of electrical supplies in this area. Stable voltage is essential for the proper functioning of most common domestic appliances including common incandescent/ tube lights mixers, grinders and audio equipment. The range and regular utilization of appliances thus increase with improvement in the quality of electrical supplies which becomes possible when there is adequate power produced as well as efficiently transmitted and distributed in the area. It is only on the basis of stable domestic applications of electrical energy that households gradually move into commercial and vocational applications of electrical energy. However, the two basic underlying factors that determine both domestic, commercial and vocational applications are the quality and reliability of supplies on the one hand and its affordability on the other.

We have been arguing that in some of the target areas both the quality and reliability of power supplies are most likely to have improved by the tail end injection of power from the demonstration sub-projects into the local grid thereby strengthening and stabilizing the grid. It is from these areas with relatively stable and regular supplies that we have drawn our observation group sample of households. The control group sample on the other hand is drawn from those sub-project areas where the grid is still unstable and weak and where due to this and other reasons the sub-projects have not yet been able to stabilize and regularize power supply.

This being so it would be interesting to see if the range of appliances used in these two groups of samples reflects in any way the quality of electrical energy supply in these areas.

In Table 6.7 we not only list the number of electrified sample households in each sub-project area utilizing various domestic electrical appliances but also the percentage distribution of these households using each of the listed appliances. For instance in the 60 households sampled in the Titang sub-project target area which we have categorized as our first observation group all the sixty are electrified households and each of these 60 households utilize common electric bulbs. Among the 60 sampled electrified households as many as 12 have reported the use of tube lights, and 4 households have even been observed to be using low wattage CFL lamps. This clearly shows that the most widespread functional utilization of electric power is for lighting and illumination purposes, and that the quality of power is good enough for the use of tube lights and incandescent lamps, which are very sensitive to voltage fluctuations. It is also extremely encouraging to find that at least a few households who have started to use low wattage CFL lamps having perhaps become conscious and sensitized about the efficient and economic use of power and its conservation.

The next most widespread and popular application of electricity seems to be for domestic entertainment as many as 47 of the sampled households in the Titang sub-project area have and use television sets while as many as 45 of the sampled households use radios, tape recorders and other types of audio equipment as many as 75 to 78 percent of the sampled households use electrical appliances used for entertainment.

ıble 6.7 : RANGE OF ELECTRICAL APPLIANCES USED BY SAMPLED HOUSEHOLDS IN THE TARGET AREA

Name of Sub-Project Area	No. of Sampled HH Electrified	No. of Electrified Sampled Households Utilising Various Electrical Appliances												
		Bulbs	Tube lights	CFL Lamps	Radio/Tape Record	TV	Electric Iron	Room Heaters/ Cooking Heaters	Water Heating Devices	Mixi/ Grinder	Fans	Ovens/ Hot Cases	Fridge	Washing Machines
Titang as OG	60 (100.00)	60 (100.00)	12 (20.00)	4 (6.67)	45 (75.00)	47 (78.33)	8 (13.33)	25 (41.67)	14 (23.33)	9 (15.00)	1 (1.67)	1 (1.67)	0 (0.00	0 (0.00)
Lingti as CG	60 (100.00)	60 (100.00)	4 (6.67)	0 (0.00)	40 (66.67)	28 (46.67)	2 (3.33)	4 (6.67)	8 (13.33)	3 (5.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Raskat & Solang/ Kothi as OG	120 (100.00)	120 (100.00)	19 (15.83)	5 (4.17)	63 (52.50)	86 (71.67)	10 (8.33)	19 (15.83)	34 (28.33)	15 (12.50)	4 (3.33)	3 (2.50)	4 (3.33)	1 (0.83)
Juthed & Sonprayag (as CG)	94 (78.33)	94 (100.00)	6 (6.38)	1 (1.06)	48 (51.06)	31 (32.98)	3 (3.19)	6 (6.38)	7 (7.45)	3 (3.19)	1 (1.06)	0 (0.00)	0 (0.00)	0 (0.00)
For Observation Group Area	180 (100.00)	180 (100.00)	31 (17.22)	9 (5.00)	108 (60.00)	133 (73.89)	18 (10.00)	44 (24.44)	48 (26.67)	24 (13.33)	5 (2.78)	4 (2.22)	4 (2.22)	1 (0.56)
For Control Group Area	154 (85.56)	154 (100.00)	10 (6.49)	1 (0.65)	88 (57.14)	59 (38.31)	5 (3.25)	10 (6.49)	15 (9.74)	6 (3.90)	1 (0.65)	0 (0.00)	0 (0.00)	0 (0.00)
For Total Impact Area	334 (92.78)	334 (100.00)	41 (12.28)	10 (2.99)	196 (58.68)	192 (57.49)	23 (6.89)	54 (16.17)	63 (18.86)	30 (8.98)	6 (1.80)	4 (1.20)	4 (1.20)	1 (0.30)

Note : Figures in Parenthesis are Percentage Distribution of Responses

The next in ranking of appliances seem to be those related to room and water heating while 25 of the sampled 60 households in Titang sub-project area were observed to be in possession of room and cooking heaters, 14 of the sampled households owned immersion rods or geysers for water heating. It was also observed that while 9 households used various cooking and food processing electrical appliances such as mixers, grinders, whippers and churners, as many as 8 of the sampled households possessed electric irons. While there was just 1 out of the 60 sampled households in the area that used a fan yet another was the rare user of an oven. There were no households in the sample that were using refrigerators or washing machines. In complete contrast the sample of 60 households drawn from the Lingti sub-project target area displays utilization of much lower range of electrical appliances as seen in Table 6.7.

Our recorded field observations for the second observation group sample of 120 households drawn from this Raskat and Solang/ Kothi sub-project areas shows that the range of functional domestic electric appliances in use are in fact more diverse as compared to the Titang observation group sample while the field observations for the second control group drawn from Juthed and Soneprayag sub-project areas shows a more limited range of domestic electric appliances being utilized.

It may be finally concluded on the basis of our field observations that there is a wider and more diverse use of domestic electrical appliances among the observation group sample as compared to the control group sample. Though it is too early to venture into any definite conclusion regarding the impact of the SHPs it is clearly evident that the quality and regularity of power supply which has been made possible by the SHPs particularly in the observation group areas has certainly induced the more diversified functional utilization of electrical energy among the beneficiary population in these areas. As the power generation and distribution in these areas in particular stabilizes there is likely to be a significant impact in these areas in terms of the functional uses of electrical power for both domestic and commercial purposes and thereby the further catalyses of the synergy between power , quality of life and livelihoods in these areas.

An early but definite beginning has been made in the commercial applications of electrical energy in some of the observation group as well as control group sampled areas*. There are indications that attempts are on the way to introduce electrical power for functional applications like compressors and welding machines. The application of power in irrigation and other agricultural and food processing applications are yet to be established on a

* The team during its visit to the Juthed target area visited a household in village which had installed an electrically operated grinding mill, an oil extruding machine. And a ginning machine for wool and cotton, along with a saw mill under the same roof. However this may have been a rate case of early entrepreneurship.

regular basis however even such prospects seem quite bright in the years to come as the local power situation stabilizes and the SHPs come fully on line and are able to function at the optimal levels for which they have been designed.

PERCEPTIONS REGARDING THE QUALITY OF POWER AND DISTRIBUTION SERVICES IN TARGET AREAS :

The impact of the SHPs on the lives and livelihoods of the covered or targeted population is reflected not only in the quality and regularity of power supply in the area but also depends on the existing quality of transmission and distributional services in the target areas. It is there fore necessary to assess the quality of power supply and related transmission and distribution services in the target areas on the basis of responses canvassed on the sampled households in both the observation and control groups. This will help us to see if there are significant and tangible differences in the quality if power supply and power services among the samples drawn from each sub-project target area.

First of all as seen in Table 6.8 while all the sampled households covered during our survey in the Titang, Lingti, Raskat and

Solang/ Kothi sub-project target areas were electrified there were a fairly large number of sampled household in both the Juthed and Soneprayag sub-project areas which were not electrified.

Table 6.8 : PERCEPTIONS REGARDING QUALITY OF ELECTRICAL SERVICE AMONG SAMPLED HOUSEHOLDS IN TARGET AREAS

Name of Sub-Project Area	No. of HH Sampled	No. of Sampled HH Electrified	No. of Sampled HH Not Electrified	Frequency of Shutdowns		Voltage Fluctuations Registered		Meters in Working Condition		Meter Reading Recorded	
				High	Low	High	Low	Yes	No	Yes	No
Titang as OG	60	60 (100.00)	0 (0.00)	35 (58.33)	25 (41.67)	29 (48.33)	31 (51.67)	58 (97.30)	2 (2.70)	58 (97.30)	2 (2.70)
Lingti as CG	60	60 (100.00)	0 (0.00)	45 (75.00)	15 (25.00)	50 (82.86)	10 (17.14)	58 (97.14)	2 (2.86)	58 (97.14)	2 (2.86)
Raskat & Solang/ Kothi as OG	120	120 (100.00)	0 (0.00)	45 (37.50)	75 (62.50)	47 (39.17)	73 (60.83)	105 (87.50)	15 (12.50)	105 (87.50)	15 (12.50)
Juthed & Sonprayag (as CG)	120	94 (78.33)	26 (21.54)	72 (76.60)	22 (23.40)	75 (80.03)	19 (20.13)	93 (98.94)	1 (1.06)	85 (90.43)	9 (9.57)
For Observation Group Area	180	180 (100.00)	0 (0.00)	80 (44.44)	100 (55.56)	76 (42.22)	104 (57.78)	163 (90.77)	17 (9.23)	163 (90.77)	17 (9.23)
For Control Group Area	180	154 (85.56)	26 (14.36)	117 (75.97)	37 (24.03)	125 (81.13)	29 (18.97)	151 (98.24)	3 (1.76)	143 (93.04)	11 (7.14)
For Total Impact Area	360	334 (92.78)	26 (7.18)	197 (58.98)	137 (41.02)	201 (60.16)	133 (39.88)	315 (94.21)	19 (5.79)	306 (91.62)	28 (8.27)

Note : Figures in Parenthesis are Percentage Distribution of Responses

It was seen that as many as 20 to 24 percent of the sampled households in these two areas had not opted for a domestic electrical connection. This was mainly due to the poor economic condition of the families who reported that even the initial charges to be paid to the utility provider for obtaining a metered domestic connection was too steep for them to afford leave alone the costs of domestic wiring and subsequent electricity charges. However it was also seen that with the improvement in the economic condition of the household more of those presently without access to electricity would readily acquire the domestic connections as they are aware of the advantages of domestic lighting and want to keep up with their more fortunate fellow villagers. The quality and regularity of electrical power in the target area is normally reflected in the frequency of shut down or black outs as well as voltage fluctuation. In the sample of 60 households from the Titang sub-project target area as many as 35 out of the 60 respondents reported a high frequency of shutdowns and disruption of power supply while as many as 25 or 41 percent of the sampled households felt that the frequency of shutdowns were low. In the Lingti sub-project target area sample which forms our first control group sample as many as 45 or 75 percent of the sampled households reported a high incidence of disruption in power supply. For our second observation group sample of 120 households drawn from the Raskat and Solang/ Kothi sub-project target areas only 45 sampled households reported a high incidence of disruption while a majority of the remaining households reported disruption in supply to be low. For our second control group sample of 120 households drawn from the Juthed/ Soneprayag sub-project target areas a fairly large number of households as many as 76 percent reported high frequency of shutdowns and power disruption. The responses obtained and recorded in Table 6.8 for reported voltage fluctuations and voltage instability are also very similar for the respective observation and control group samples clearly indicating that the quality of power enjoyed by the observation group sample is relatively better than that of the control group sample.

Table 6.9 : PERCEPTIONS REGARDING QUALITY OF ELECTRICAL SERVICES AMONG SAMPLED HOUSEHOLS IN TARGET AREA

Name of Sub-Project Area	No. of HH Sampled	No. of Sampled HH Electrified	Regular Receipt of Bills		Frequency of Bill Receipts Bills				Regularity of Payment		Payment of Bills		Awareness Regarding Rates		Opinion Regarding Electricity Charges	
					In Summer		In Winter									
			Yes	No	2 months	3-6 months	2 months	3-6 months	Yes	No	In Village	Outside Village	Yes	No	Reasonable	High
Titang as OG	**60**	60 (100.00)	58 (97.30)	2 (2.70)	16 (27.03)	44 (72.97)	11 (18.92)	49 (81.08)	58 (97.30)	2 (2.70)	24 (40.54)	36 (59.46)	16 (27.03)	44 (72.97)	34 (56.76)	26 (43.24)
Lingti as CG	**60**	60 (100.00)	58 (97.14)	2 (2.86)	60 (100.00)	0 (0.00)	0 (0.00)	60 (100.00)	58 (97.14)	2 (2.86)	46 (77.14)	14 (23.33)	12 (20.00)	48 (80.00)	36 (60.00)	24 (40.00)
Raskat & Solang/ Kothi as OG	120	120 (100.00)	106 (88.64)	14 (11.36)	97 (80.68)	23 (19.32)	46 (38.33)	74 (61.67)	109 (90.91)	11 (9.09)	27 (22.50)	93 (77.50)	15 (12.12)	105 (87.88)	66 (55.00)	54 (45.00)
Juthed & Sonprayag (as CG)	120	94 (78.33)	88 (93.62)	6 (6.38)	56 (59.41)	38 (40.75)	12 (12.27)	82 (87.23)	93 (99.10)	1 (1.06)	22 (23.32)	72 (76.84)	16 (17.02)	78 (82.98)	39 (41.33)	55 (58.84)
For Observation Group Area	180	180 (100.00)	164 (91.11)	16 (8.89)	113 (62.80)	67 (37.20)	57 (31.86)	123 (68.14)	167 (93.04)	13 (6.96)	51 (28.51)	129 (71.49)	31 (17.09)	149 (82.91)	100 (55.59)	80 (44.41)
For Control Group Area	180	154 (85.56)	146 (94.99)	8 (5.01)	116 (75.22)	38 (24.88)	12 (7.49)	142 (92.21)	151 (98.34)	3 (1.76)	68 (44.29)	86 (55.99)	28 (18.18)	126 (81.82)	75 (48.60)	79 (51.50)
For Total Impact Area	360	334 (92.78)	310 (92.90)	24 (7.10)	229 (68.53)	105 (31.52)	69 (20.63)	265 (79.24)	318 (95.21)	16 (4.79)	119 (35.63)	215 (64.34)	59 (17.59)	275 (82.41)	175 (52.37)	159 (47.68)

Note : Figures in Parenthesis are Percentage Distribution of Responses

As regard the quality of services provided by the electricity utilities in the target area as reflected in the working conditions of the meters installed, the regular recording of meter reading, regularity and frequency of billing and payments, as well as the convenience of bill payments, there does not seem to be any distinct differences in the responses obtained from the observation group sample as compared to the control group respondents as seen in the Table 6.8 and 6.9.

This may in fact reflect the stark ground reality of there being not much to choose from as regards the quality of electrical services in these areas. These responses may also reflect a certain level of cynicism and indifference among the user population which may have evolved and developed through experiencing low quality services over the years. This general indifference may also be reflected in the very low level of awareness regarding electricity rates and differential user slabs or charges and also a substantial number of respondents expressing their reservations regarding the reasonableness of the electricity tariff. The expectation that the quality of services would be relatively better for our observation group sample is not borne out very convincingly by these results. One may even venture to add that the situation being so may to a great extent have diluted the expected impact of electrical power on the lives and livelihoods of the covered population in these target areas. The improvement in the quality of electricity distribution services is a necessary condition for ensuring the expected impact. In these isolated locations this is only possible through active peoples participation and policy measures to initiate such participation and involvement through innovative concepts like joint power management involving an active partnership between the utilities and the local population in the provision of appropriate and convenient low cost distributional services in these target areas, including the maintenance and repair of the distribution infrastructure.

RESPONSE OF SAMPLED HOUSEHOLDS ON THE INFLUENCE OF ELECTRICITY ON THE QUALITY OF LIFE OF CHILDREN AND WOMEN :

One of the major expectations from the setting up of demonstration SHPs under the Hilly Hydro Project was that improvements in power supply in the target areas would improve the quality of life of the children in the target area. With adequate domestic lighting and appliances that would enable them to access information through the radio and television. This would not only improve their educational standards with additional hours of learning provided by lighting, but also enhance their general awareness regarding the World around them as well as additional knowledge on health, nutrition and hygiene, through the news, education, and entertainment media services that they would be able to access.

Like wise significant improvements in the quality of life of the women folk in the households was also expected not only through greater awareness on health, nutrition and hygiene but also the availability of longer working hours inside the home thereby providing more opportunities for domestic vocations and also by reducing domestic drudgery through improvements in cooking and water heating brought about by the use of domestic appliances and cleaner fuel.

As seen in Table 6.10 most households sampled for both the observation groups respondents drawn from the Titang as well as the Raskat, Solang/ Kothi target areas were of the opinion that electricity had a positive influence on the lives of children in terms of improved educational capability and aptitude, increased awareness regarding health, nutrition and hygene as well as improvements in school performance. In the Lingti and Juthed/ Soneprayag control group sample however there were relatively less positive responses and there seemed to be a larger number of respondents who felt that such an impact had been insignificant or at times (through very rarely did we come across such responses) even adverse.

Table 6.10 : Responses on the Influence of Electricity on the Quality of life of Children in the Target Area

Name of Sub-Project	No. of HH Sampled	No. of Sampled HH Electrified	Influence of Electricity on the Quality of Life of Children (No. of Responses)											
			Education/ Awareness				Health/ Nutrition/ Hygiene				Improved School Performa			
			S	M	I	A	S	M	I	A	S	M	I	
TITANG as OG	60	60 (100.00)	28 (46.67)	26 (43.33)	6 (10.00)	0 (0.00)	24 (40.00)	29 (48.33)	7 (11.67)	0 (0.00)	29 (48.33)	20 (33.33)	11 (18.33)	(0
Lingti CG	60	60 (100.00)	12 (20.00)	24 (40.00)	24 (40.00)	0 (0.00)	10 (16.67)	26 (43.33)	24 (40.00)	0 (0.00)	27 (45.00)	16 (26.67)	15 (25.00)	(3
Raskat & Solang/ Kothi as OG	120	120 (100.00)	27 (22.50)	58 (48.33)	35 (29.17)	0 (0.00)	25 (20.83)	60 (50.00)	35 (29.17)	0 (0.00)	71 (59.17)	25 (20.83)	24 (20.00)	(0
Juthed & Sonprayag (as CG)	120	94 (78.33)	23 (24.47)	51 (54.26)	18 (19.15)	2 (2.13)	18 (19.15)	58 (61.70)	18 (19.15)	0 (0.00)	29 (30.85)	43 (45.74)	21 (22.34)	(1
For Observation Group Area	180	180 (100.00)	55 (30.56)	84 (46.67)	41 (22.78)	0 (0.00)	49 (27.22)	89 (49.44)	42 (23.33)	0 (0.00)	100 (55.56)	45 (25.00)	35 (19.44)	(0

For Control Group Area	180	154 (85.56)	35 (22.73)	75 (48.70)	42 (27.27)	2 (1.30)	28 (18.18)	84 (54.55)	42 (27.27)	0 (0.00)	56 (36.36)	59 (38.31)	36 (23.38)	(1
For Total Impact Area	360	334 (92.78)	90 (26.95)	159 (47.60)	83 (24.85)	2 (0.60)	77 (23.05)	173 (51.80)	84 (25.15)	0 (0.00)	156 (46.71)	104 (31.14)	71 (21.26)	(0

Note : S = Significant, M = Moderate, I = Insignificant, A= Adverse
Figures in Parenthesis are Percentage Distribution of Responses

However for both the observation and the control groups we found the majority of responses on this issue indicating that there had been a positive impact and that this impact seemed to have been more pronounced in the observation group sample areas as compared to the control group sample.

Similarly in Table 6.11 we have tabulated the responses related to the impact of electricity on the women in the sampled households. Here however while we notice that the impact seems to have been far less pronounced in terms of general awareness health, nutrition, and hygiene the responses related to more working hours available to women in the household is significant and most respondents indicated that women have had more labour time for vocational and other household tasks.

Table 6.11 : RESPONSES ON THE INFLUENCE OF ELECTRICITY ON THE QUALITY OF LIFE O WOMEN IN THE TARGET AREA

Name of Sub-Project	No. of HH Sampled	No. of Sampled HH Electrified	Influence of Electricity on the Quality of Life of Women (No. of Responses)											
			Education/ Awareness				Health/ Nutrition/ Hygiene				More Working Time/Labour T			
			S	M	I	A	S	M	I	A	S	M	I	
TITANG as OG	60	60 (100.00)	24 (40.00)	13 (21.67)	23 (38.33)	0 (0.00)	26 (43.33)	21 (35.00)	13 (21.67)	0 (0.00)	44 (73.33)	5 (8.33)	11 (18.33)	(0.
Lingti as CG	60	60 (100.00)	10 (16.67)	15 (25.00)	35 (58.33)	0 (0.00)	11 (18.33)	15 (25.00)	34 (56.67)	0 (0.00)	29 (48.33)	14 (23.33)	17 (28.33)	(0.
Raskat & Solang/ Kothi as OG	120	120 (100.00)	18 (15.00)	39 (32.50)	63 (52.50)	0 (0.00)	25 (20.83)	48 (40.00)	47 (39.17)	0 (0.00)	78 (65.00)	23 (19.17)	19 (15.83)	(0.
Juthed & Sonprayag (as CG)	120	94 (78.33)	9 (9.57)	33 (35.11)	52 (55.32)	0 (0.00)	8 (8.51)	40 (42.55)	46 (48.94)	0 (0.00)	26 (27.66)	52 (55.32)	16 (17.02)	(0.
For Observation Group Area	180	180 (100.00)	42 (23.33)	52 (28.89)	86 (47.78)	0 (0.00)	51 (28.33)	69 (38.33)	60 (33.33)	0 (0.00)	122 (67.78)	28 (15.56)	30 (16.67)	(0.
For Control Group Area	180	154 (85.56)	19 (12.34)	48 (31.17)	87 (56.49)	0 (0.00)	19 (12.34)	55 (35.71)	80 (51.95)	0 (0.00)	55 (35.71)	66 (42.86)	33 (21.43)	(0.
For Total Impact Area	360	334 (92.78)	61 (18.26)	100 (29.94)	173 (51.80)	0 (0.00)	70 (20.96)	124 (37.13)	140 (41.92)	0 (0.00)	177 (52.99)	94 (28.14)	63 (18.86)	(0.

Note : S = Significant, M = Moderate, I = Insignificant, A= Adverse

Figures in Parenthesis are Percentage Distribution of Responses

As for the reduction of drudgery among women the responses have been mixed. This is on account of the fact that most domestic functions such as cooking and water heating were still carried out on the basis of traditional fuels such as wood and the widespread use of electricity particularly for cooking and heating inside the household was still to be adopted.

GENERAL TRENDS IN HEALTH AND MIGRATION IN THE TARGET AREAS :

Turning now to responses related to general health and the incidence of common ailments in the target area it is seen that there are a significant number of respondent who report the incidence of respiratory ailments and water borne infections however reported incidents of these frequently occurring ailments are marginally lower for our observation group sample as compared to the control groups as seen in Table 6.12.

Table 6.12 : Responses on Common Ailments* Among Sampled Households in the Target Area

Name of Sub-Project	No. of HH Sampled	Incidence of Common Ailments * (No. of Responses)								
		Respiratory Ailments			Water Borne Ailments			Eye Ailments		
		Severe	Mild	No Complaints	Severe	Mild	No Complaints	Severe	Mild	No Complaint
TITANG as OG	60	19 **(31.67)**	2 **(3.33)**	39 **(65.00)**	3 **(5.00)**	15 **(25.00)**	42 **(70.00)**	3 **(5.00)**	6 **(10.00)**	51 **(85.00)**
Lingti as CG	60	10 **(16.67)**	12 **(20.00)**	38 **(63.33)**	2 **(3.33)**	20 **(33.33)**	38 **(63.33)**	0 **(0.00)**	7 **(11.67)**	53 **(88.33)**
Raskat & Solang/ Kothi as OG	120	7 **(5.83)**	70 **(58.33)**	43 **(35.83)**	4 **(3.33)**	27 **(22.50)**	89 **(74.17)**	0 **(0.00)**	12 **(10.00)**	108 **(90.00)**
Juthed & Sonprayag (as CG)	120	26 **(21.67)**	60 **(50.00)**	34 **(28.33)**	8 **(6.67)**	28 **(23.33)**	84 **(70.00)**	4 **(3.33)**	16 **(13.33)**	100 **(83.33)**
For Observation Group Area	180	26 **(14.44)**	72 **(40.00)**	82 **(45.56)**	7 **(3.89)**	42 **(23.33)**	131 **(72.78)**	3 **(1.67)**	18 **(10.00)**	159 **(88.33)**
For Control Group Area	180	36 **(20.00)**	72 **(40.00)**	72 **(40.00)**	10 **(5.56)**	48 **(26.67)**	122 **(67.78)**	4 **(2.22)**	23 **(12.78)**	153 **(85.00)**
For Total Impact Area	360	62 **(17.22)**	144 **(40.00)**	154 **(42.78)**	17 **(4.72)**	90 **(25.00)**	253 **(70.28)**	7 **(1.94)**	41 **(11.39)**	312 **(86.67)**

Note : * Particularly Related to Air and Water Quality
Figures in Parenthesis are Percentage Distribution of Responses

It may be noted that with fuel wood serving as the main source of cooking and heating most of the respiratory ailments are on account of smoke inhalation and water contamination in the households. Finally it was also expected that with the setting up of the SHPs there would be more opportunities for local employment which would halt migration of the rural population from the target areas. Our field survey in the target area however reveals that there has not been any significant migration or immigration in the target areas.

Table 6.13 : Responses on Migratory and Immigratory Trends Among Sampled Households in the Target Area

Name of Sub-Project	No. of HH Sampled	Family Members Migrating		Reason for Migration		Family Members Immigrating		Reason for Immigration	
		Yes	No	Education	Employment	Yes	No	Education	Employment
TITANG as OG	60	0 (0.00)	60 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	60 (100.00)	0 (0.00)	0 (0.00)
Lingti as CG	60	7 (11.67)	53 (88.33)	4 (57.14)	3 (42.86)	2 (3.33)	58 (96.67)	2 (100.00)	0 (0.00)
Raskat & Solang/ Kothi as OG	120	3 (2.50)	117 (97.50)	2 (66.67)	1 (33.33)	0 (0.00)	120 (100.00)	0 (0.00)	0 (0.00)
Juthed & Sonprayag (as CG)	120	18 (15.00)	102 (85.00)	12 (66.67)	6 (33.33)	0 (0.00)	120 (100.00)	0 (0.00)	0 (0.00)
For Observation Group Area	180	3 (1.67)	177 (98.33)	2 (66.67)	1 (33.33)	0 (0.00)	180 (100.00)	0 (0.00)	0 (0.00)
For Control Group Area	180	25 (13.89)	155 (86.11)	16 (64.00)	9 (36.00)	2 (1.11)	178 (98.89)	2 (100.00)	0 (0.00)
For Total Impact Area	360	28 (7.78)	332 (92.22)	18 (64.29)	10 (35.71)	2 (0.56)	358 (99.44)	2 (100.00)	0 (0.00)

Note : Figures in Parenthesis are Percentage Distribution of Responses

While there has been no migration reported by the sampled households in the observation group as seen in Table 6.13 there are a few cases reported in the control group sample out of the total sample of 360 households there have been only 28 cases of migration and only 2 cases of immigration in the sampled target areas.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS BASED ON THE TERMS OF REFERENCE

In this chapter of our report we have attempted to briefly bring together the various major conclusions of our Impact Assessment and Terminal Evaluation. We have tried to broadly sequence these conclusions on the basis of the Terms of Reference provided by the Sponsors[1]. These conclusions which relate to the assessment of the impact of the project at both the overall national and sub-project levels are accompanied by specific recommendations that we feel could be considered for strengthening and streamlining future initiatives for the development of the Small Hydel Programmes in the country that are likely to be taken up in the years ahead.

Terms of Reference I : The physical progress and sustainability of sub projects set up under the Hilly Hydro Project and their success in evincing interest from private developers.

Of the 20 demonstration sub projects envisaged under the UNDP/GEF Hilly Hydro projects[2], 17 have been completed and commissioned. Of these at least 15 are said to be operational. The team visited 10 of the 17 projects that have been completed[3], of which as many as 8 were fully operational though only 5 of these had been functioning regularly for a period of one full year. From the operational data collected by our field team for each of these projects, it can be concluded that at the present stage of operations these projects may be just about broadly breaking even in financial terms. However as and when stable generation of power is achieved at the plant load factor of 60 percent as against the 20 to 40 percent as seen at present, it is possible to visualize that these projects will be financially viable and sustainable.

It may also be mentioned here that the team's interaction with the developers has revealed that other interested potential developers were regularly evincing interest in the functioning

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[1] The final terms of reference as seen in Appendix of this report have been carefully combined under 14 broad heads in order to avoid overlaps and repetition. It may be stated that this has in no way excluded any of the terms specified in the final list of issues which were required to be covered by the study.

[2] list of sub projects provided as Annexure 7.1 of this chapter.

[3] List of sub-projects visited by the study team is provided in Annexure 7.2 of this chapter.

of these demonstration sub projects. We can thus conclude that the sub projects have been to some extent successful in attracting the interest of a potential developers not only in the participating States but from other regions of the country as well. It can also be said that the performance of these sub projects will certainly assist in paving the way for further investments in the small hydro sector but this is likely to happen only if they also demonstrate their financial viability through stable production and effective evacuation of power at lower costs. However it should also be stated that the failure to achieve stable production and effective evacuation may also lead to a negative demonstration effect that is likely to affect further investments in this vital sector. It is therefore essential to assist the sub projects in swiftly overcoming the present constraints particularly by strengthening and supporting proper evacuation arrangements and also promptly attending to electro-mechanical failures that have been taking a great deal of time at present leading to prolonged shut downs and consequent loss of power production. The living and working conditions of the operating staff specially when they are required to operate in these remote and difficult locations and under adverse climatic conditions also needs to be given due attention in order to sustain efficient levels of power generation and evacuation. The teams interaction with operating staff has led to the impression that all is not well in this regard and improvements are possible and necessary.

Terms of Reference II : The actual electricity generation by the sub projects and the resulting fuel wood saving as well as corresponding CER and GHG emission reduction using assumptions based on both the initial project document and the revised assumptions based on actual field observations by the study team.

From the detailed operational data collected by the field team, it is seen that the sub projects are at present operating at 20 to 40 percent Plant Load Factor (PLF) as compared to the 60 percent envisaged in the initial project document. Power generation by the sub projects is thus fairly limited. Furthermore the power used for cooking and heating purposes by the local population is much lower than that which had been envisaged in the initial project document. While the project document assumed that as much as 50 percent of the power generated by the SHPs will be used for cooking and heating applications in the catchment areas/ target areas our field observations indicate that only around 25 percent of the power available is at present used for such applications, and that too mainly during the winter months. The fuel wood saving and corresponding reduction in emission is therefore likely to be much lower than what has been envisaged in the project document. With the total capacity of 4700 KW currently installed under the hilly hydro project the actual fuel wood savings per year as a consequence of the power generated works out to be only 1111 tones/ year as compared to the 7100 tones/ year anticipated in the project document. The corresponding GHG emission reduction is also much lower at 535 tones/ year as compared to what was envisaged in the project document. However the UNDP/GEF hilly hydro project has certainly served as the major catalyst for the creation of an additional installed capacity to the tune of 1530 MW in the small hydro sector till July, 2003. Of this capacity as much as 543.30 MW has been installed in the hilly regions and would under the most conservative assumptions lead to a fuel saving of 1.28 lakh tones/ year. With the corresponding GHG reduction of nearly 57825 tones/ year. It may thus be concluded that even assuming a lower plant load factor and very moderate use of electricity in cooking and heating, the fuel wood saving as well as emission reduction is likely to be fairly impressive[4]. The basic foundations/ facilities created through the UNDP/GEF hilly hydro project has certainly been a significant contributory factor in enabling possibilities for this impressive nation wide prospective reduction in fuel wood consumption and the corresponding reduction in GHG emission.

In the case of the remaining small hydro capacity of 987.10 MW installed in the non hilly areas till July, 2003 and which is likely to replace the use of diesel apart from other fossil fuel saving applications the annual saving of diesel is expected to be as high as 864.69 million liters/ year and the corresponding GHG reduction through diesel saving is expected to be as high as 2.3 million tonnes/ year. The details of estimates of fuel wood and diesel savings and corresponding GHG emission reduction is provided in **Table** annexed of this chapter. **(See Annexure 7.3)**

Terms of Reference III : The impact of electricity tariff charged by each sub project and the return on investment, as well as the commercial viability of the demonstration sub projects.

[4] The conclusions drawn by Local Benefits Study Team Report UNDP-GEF 2004 is at variance with our views particularly regarding fuel wood savings and related GHG emissions. These conclusions are mainly based on their brief visit and interaction with the local population in a few sub project target areas, while our larger survey of target areas reveal that the use of electricity for cooking and heating purposes though limited at present is progressively increasing and more widespread, than that perceived by the Local Benefits Study Team. Moreover our more optimistic outlook is based on the projections made on the basis of overall SHP capacity additions till July, 2003.

Most of the sub projects visited by the study team were connected to the State grid, and here the State Electricity Board/ Utilities were solely responsible for both determining tariff and also the collection of revenues. The demonstration sub projects were thus purely “production entities” and were being paid for the power supplied to the grid by them on a regular basis by the concerned electricity board. The payment was being made only in those cases where in the Power Purchase Agreement (PPA) had been duly signed according to the project design. It is however important to note here that in the case of some demonstration sub projects such as those at Kothi, Juthed and Lingti developed by the State Nodal Agency, HIMURJA, the Power Purchase Agreement had not been signed at the time of our field visit and consequently there had been no payments made for the power supplied by these projects to the grid. Since no revenue has been generated in these cases, even roughly estimating commercial viability in the case of these projects is not possible. However if the ‘notional’ revenue which is due in the case of these projects is compared with the overall cost of operations including interest cost, these projects seem to be commercially viable even at the fairly low levels of present generation of power.

In the case of sub projects in the private and NGO sector, PPAs have been signed and regular payments are reported to be received by the developers from the concerned State Electricity

Board. It is encouraging to note that even with rather low levels of generation compounded by evacuation problems and grid instability these sub projects are being able to cover costs through their present operations, and would over time be able to generate moderate levels of profit after these present constraints are successfully overcome.

Terms of Reference IV : Trends in deforestation in the catchment area of each sub project and the extent of settled cultivation induced by electrically energized irrigation.

Our team's interaction with the catchment/ target area population, community leaders, and forest officials posted in these areas clearly indicate that there has been no noticeable trends in the reduction in deforestation in these areas subsequent to the setting up of the demonstration projects. It is however encouraging to note that with the increasing availability of LPG in adequate quantities particularly during the summer months, there has been a noticeable shift to the use of cooking gas among the households in the area. This is specially so among the well to do households, however fuel wood continues to be the dominant cooking and heating fuel particularly during the harsh winter months. What seems to primarily hinder the substitution of fuel wood by electricity is that there is a fall in the generation of power during the winter months. This is mainly on account of reduced water flows due to the freezing of glaciers and rivulets that feed the SHPs. This fall in generation of power during winter gets aggravated by frequent disruptions in the grid due to heavy snow fall and the regular snapping of overhead cable or transmission lines. It is also seen that apart from lower power availability, the non existence of differential power tariff during the difficult months also leads to the higher use of fuel wood. The proper maintenance of the distribution grid along with lower differential tariff during the harsh winter months could perhaps lead to much greater fuel wood saving in the target areas.

As to the extent of settled cultivation there has been hardly any noticeable change as these areas have had settled irrigation based cultivation even prior to the setting up of SHPs. However it is important to note that electricity energized irrigation is still not in existence and has not replaced the gravity based local irrigation system that dominate these areas. It is also very important to mention that in some areas the diversion of water for power generation has disrupted the gravity based irrigation systems in some target areas creating hostility among the local farming community towards some of the demonstration sub projects.

Terms of Reference V : The extent of benefits derived by the local target population in the project area in terms of the expansion of commercial and small industrial activities, employment generation in project and non project related activities, and trends in the migration of local population to urban areas.

The local population in the sub project affected areas/ target areas have primarily benefited in terms of the increase, stability, and dependability of power supply. This is clearly reflected in the significant increases in power consumption in the post-project period as compared to the pre-project period. With this increase in power consumption there has been a visible increase in the use of electrical appliances of various kinds. Home lighting and entertainment applications have improved considerably and there are also some indications that cooking and heating appliances are also being procured by local households to a limited extent. The slowly increasing use of domestic electrical appliances has brought about a definite improvement in the quality of life. This gradual increase in domestic electrification has also been accompanied by changes in the design and construction of dwellings in the area which is a significant development. The newly constructed dwelling units in particular have incorporated better insulation and ventilation as compared to the traditional housing designs in these areas.

There has also been a marginal increase in non domestic commercial and industrial applications of electrical power as reflected in the use of compressors, electric motors and electric welding appliances used in the small wayside workshops. However, large or small scale industrial and agricultural applications of electric power have yet to come about in these target areas.

While there has been some involvement of the local population in the project specially during its civil construction stages, their involvement for operation and maintenance of the sub projects has been very marginal. It is seen that only a few local persons have managed to find employment as lower level operating or watch and ward staff in the sub projects. The migratory trends among the local population to urban areas has also not undergone any significant changes due to the project.

Thus while there have been some indirect benefits at the local level such as improvement in power supply there have been hardly any direct local benefits for the target population at the present stage of the project. However these direct local benefits are likely to emerge as power generation and evacuation achieves stability.

Terms of Reference VI : Project impact on the life of women by supporting and reducing the need to collect fuel wood and other forms of domestic drudgery, their employment, and improvement in living standards.

With significant improvements in the quality and availability of electrical power brought about by some of the sub-projects in their target areas there has been an increase in the use of electricity in domestic lighting and entertainment through the use of radios and televisions. There have thus been some improvements in the quality of life inside the home particularly for women and children. Women have more time for domestic tasks and for pursuing indoor vocations such as spinning, weaving, knitting and tailoring. With the lengthening of working hours for women due to domestic lighting, the time available for outdoor work such as agriculture and animal husbandry has also increased leading to higher productivity and household incomes. Moreover there has been a general increase in awareness among women regarding health and hygiene through their exposure to the electronic media. However the drudgery of fuel wood collection and use specially among women has not declined as most cooking and heating is still based on the use of fuel wood, specially among the less well to do households in the target areas.

On the whole the impact of the project on the life of women has been mixed and not always beneficial. While on the one hand it has benefited them in terms of increasing awareness and enabled them to spend more time with children, and in pursuing their indoor vocations, it has at the same time also increased their drudgery by increasing working hours particularly outside the home.

Terms of Reference VII : Impact of water mills upgradation including those upgraded with add on electricity generating capabilities, their potential, their acceptance by the local population, and their prospects for future replication.

While the project envisaged both mechanical and electrical up gradation of 100 traditional water mills, this target was achieved and also exceeded. Under the project 143 water mills were upgraded in the participating States till December, 2003. Suitable prototypes and designs were developed and tested at the AHEC, Roorkee. These testing and designing facilities were also developed under the hilly hydro project. Apart from on the spot orientation training provided by the installation teams at the water mill sites, institutional training programmes on the water mill components of the project were also regularly organized for the benefit of the local bodies, NGOs and water mill owners at AHEC, Roorkee. As a result of this initial effort made possible by the hilly hydro project, there has been a marked increase in the interest shown by the village panchayats and water mill owners specially in the State of Uttaranchal. These potential developers have been particularly keen on electrical up gradation of the traditional water mills. This growing interest has also been on account of the active involvement of the SNA in Uttaranchal which has very effectively disseminated and propagated the required information to potential beneficiaries in the State. However, other SNAs are yet to follow the lead provided by UREDA.

Based on these initial but encouraging responses from a large number of potential beneficiaries which has been triggered off by the hilly hydro project the MNES has also moved forward by launching a fresh revamped scheme for water mill up gradation. The water mill components of the project has also succeeded in establishing some manufacturing facilities in some parts of the country and these in turn has led to other manufacturers in the area taking an active interest in this sector. Along with this slow but steady development of an indigenous manufacturing base for water mill components there have been a significant number of NGOs, who are keen on actively participating in this sector specially in Himachal Pradesh, Uttaranchal, Jammu & Kashmir and Arunachal Pradesh. On the whole the hilly hydro project has thus been able to provide the much need impetus for effective expansion of the modernized water mill sector.

However It is also important to mention that of all the 143 water mills upgraded under the project most of them have been mechanically upgraded while only 3 of these water mills have been upgraded for local electricity generation. This also goes to show that as a means of localized power generation and use, the project has yet to make a significant field level impact. Even in the cases where water mills have been mechanically upgraded resulting in marked improvement in efficiency the results on the ground have not always been favourable. While there has been a marked improvement in the volume of grain which is ground per day this has also led to the redundancies in the traditional mills in the area effecting the livelihoods of those who have not been able to upgrade their mills. The improper and hasty selection of beneficiaries who are also change agents in this demonstration project, has to some extent blunted the expected impact. Moreover the lack of effective post installation monitoring, maintenance, and availability of spares, has forced a fairly large number of mill owners to revert back to the traditional mills.

Terms of Reference VIII : The suitability of technology selection, innovations and adaptation taken up in the sub projects, and the extent of utilization of local expertise and resources.

The hilly hydro project has made a very comprehensive effort in the selection of the most appropriate state of the art technologies available at present. It has not only succeeded in choosing the right technology mix but also in adapting these to varying and diverse site conditions and environments. Thus providing a fairly impressive range of choices and options for potential small hydro developers. Technology selection and adaptation has been one of the most significant achievements of the hilly hydro project and has laid a very strong foundation for the effective and efficient exploitation of the vast small hydel potential in this country[5].

It should also be mentioned that both the building and operation of these small hydel projects involve a fairly high level of civil, mechanical and electrical engineering skills, which are hardly available among the local population in these remote and isolated locations. Thus the extent of utilization of local expertise and skills has very limited scope if any. However these projects, over the long run, would provide employment and career opportunities for adequately trained and experienced local youth belonging to these areas. Moreover since these projects also utilize fairly sophisticated material inputs which are normally not available in these areas the utilization of local resources is also limited. However the use of material such a stone, earth, slate and timber particularly in civil works related to the sub projects do provide some scope for using local resources abundantly available in these project areas. It is encouraging to note that several sub projects have effectively utilized these local resources in their civil construction and thereby significantly reduced construction and transportation cost. It is important to emphasize that the site itself and also the water availabilities in these areas

[5] For details regarding the technology matrix developed under the project see Annexure 7.4 of this chapter.

constitute the basic local resources that have made these projects possible. The utilization of hitherto unused local natural resources have been thus made possible by the project.

Terms of Reference IX: Administrative aspects related to the role of the State Government and its interface with the developers, users and user institutions and state policy initiatives on Power Purchase Agreements and overall SHP development.

The Himalayan and Sub-Himalayan Region of India is shared by 13 States. The UNDP-GEF Hilly Hydro Project was implemented covering all the 13 states namely Jammu & Kashmir, Himachal Pradesh, Uttaranchal, Bihar, West Bengal, Assam, Arunachal Pradesh, Meghalaya, Mizoram, Manipur, Nagaland, Sikkim and Tripura. The project had interaction with all the states. Data on institutional framework and preparedness of States to take up small hydro activity was collected in 1996. This formed the basis of project related activities in each state during execution of the Hilly Hydro Project. Site-surveys to identify potential small hydro sites were carried out in all the states to set up demonstration projects. The hilly hydro technical team and national and international consultants visited each state and short listed demonstration project sites. Zonal Plan and Master Plan for all the 13 participating states were prepared. There were in-depth interactions and review meetings to finalise the zonal plan and master plan. Initially, at least one potential site was identified in each state to set up a demonstration project. However, it is observed that finally demonstration projects were taken up in only six states. The main reason reported for this was techno-economic viability of site to set up SHP project, lack of availability of funds with some states to meet balance cost for demonstration projects (50% of the cost was to come from the concerned state) and limited time available to complete the projects. Most of the north-eastern states, which have extremely remote locations have been left out. The watermill activity was confined to only four states, as these are the only states where watermills are traditionally widely used by the villagers.

The Study team visited and interacted with the State Government officials and developers in the states of Himachal Pradesh, Uttaranchal, West Bengal and Assam. The State Government interface with the developers, users and user institutions was found to highly enabling in Himachal Pradesh followed by Uttaranchal, West Bengal and Assam. The administrative environment in Himachal Pradesh, Uttaranchal and West Bengal is very conducive for Small Hydro Development and the state administration along with the SNAs have been actively encouraging private developers to set up SHP projects. The first two private sector SHP projects in Himachal Pradesh and the first NGO owned SHP project in the country has been set up as part of the UNDP-GEF Hilly Hydro Project with the active involvement and commitment of the State Government. Based on the potential sites identified as part of the Zonal Plan, the Government of Himachal Pradesh had (till the impact study and terminal evaluation) allotted 295 potential sites with an aggregate capacity of 365 MW to Private Developers. Similarly, the Government of Uttaranchal had allotted 30 potential sites with an aggregate capacity of 199.3 MW to Private Developers. The Government of West Bengal had so far allotted 5 SHP projects to private developers with a capacity of 30 MW. Tea gardens had also started showing increasing interest in setting up SHP projects in West Bengal and Assam after the successful completion of demonstration projects in these States. In general, the interface between the state government, developers, users etc. was found to be fairly satisfactory in the state visited by the study team. However there is much scope for improvement and streamlining of the administrative support system as well as related procedures. The strengthening of the State Nodal Agencies in terms of manpower and finances would further improve the enabling environment and speed up SHP development in the participating States.

The State of Jammu & Kashmir and Bihar have also started encouraging the private sector to set up SHP projects. J&K had announced 12 potential sites with an aggregate capacity of 67.25 MW and invited private sector to set up the projects. The north-eastern states were yet not prepared for inviting private sector to set up SHP projects and there was no such policy in the States. Ministry of Non-Conventional Energy Sources had been regularly interacting with all the states to convince them for private sector participation. So far, 15 States in the country had announced their policy for private sector participation. Brief details are given in **Annexure 7.5** of the chapter.

Most of these and other states are observed to have regular interaction with Alternate Hydro Energy Centre, IIT Roorkee to seek help and guidance on the development of SHP projects in grid connected as well as decentralized mode. AHEC was also assisting some of these States in the process of developing remote village electrification through local grids fed and augmented by small hydro projects. The strengthening of AHEC as part of UNDP-GEF Hilly Hydro Project was found to be extremely useful and was providing the necessary support to the SHP sector in the country. In all, it was observed that there had been good interaction and interface between the State Governments, the sole technical institution, and project developers of small hydro. In this regard, the contribution of UNDP-GEF Hilly Hydro Project was clearly visible, and was seen to have laid the foundations for greater synergy among stake-holders which was one of the most crucial elements for sustaining the Small Hydel movement in the country.

Terms of Reference X : Impact of low wattage devices and load development in terms of assimilation, acceptance, and usage.

Ensuring a uniform load specially in the context of decentralized or stand alone Small Hydel Power Projects posed as a major challenge affecting the power load factor as well as the economic viability of such projects. This was particularly important since the project was initially visualized for catering to the power requirements of remote areas through stand alone SHPs. Uniform load development during non peak hours and load limitations during peak hours was an essential condition for the techno-economic sustenance of each plant. The project had therefore envisaged the development of Low Wattage Appliances specially for space and water heating purposes, so as to ensure the development and utilization of uniform loads during the non peak hours of the day and also during late night hours when the load in the area was likely to be relatively low. These appliances were to be developed as prototypes which would then be field tested through trials in project sites around three selected SHPs already commissioned and regularly functioning in a decentralized set up. It was expected that the experience gained from these tests and trials would then be used for both improving the appliances and utilizing those that were found suitable and acceptable by the local population in and around the demonstration sub-projects. While M/s. Tide Technocrats a Bangalore based company was appointed the National Consultant for this activity block the international consultant was M/s. SKAT, of MHPG Group, Switzerland. The overall National Consultant for the field implementation of the activity was Consulting Engineering Services, New Delhi.

It is learnt that based on a world wide product survey and user experiences several prototype appliances were either indigenously developed with the help of local manufacturers or imported from various countries. These appliances included low wattage water heating systems, low wattage cookers, night-storage space heating appliances, load limiters and load limiter managers, as well as dual tariff meters. These devices were widely tested in three functioning project locations namely Jankichatti (in Uttaranchal), Nindighagh (in Bihar) and Bazgo (in Ladakh, J&K).

The testing of these devices, and the demonstration and public dissemination of these appliances was undertaken by Consulting Engineering Services who inturn involved local NGOs in the areas for advocacy purposes. However the feedback from local users was reported to be far from encouraging. Our teams discussions with representatives of M/s. Tide Technocrats as well as other concerned officials indicated that while water heating devices were well received by the local population the cost of these appliances was considered unaffordable by the local population. It was also revealed that devices such as space heaters and cookers did not evince much interest among local users. Discussions also indicated that the delayed funding and reimbursement of the NGOs for the advocacy services rendered, led to their progressive withdrawal and non participation, and as a result of this no firm orders for these devices materialized. With this lack of firm orders the manufacturers of these devices could not sustain their efforts and soon lost interest and motivation for the further production and supply of these devices.

Due to the premature termination of the activity, the experience gained in the three pilot locations could not be utilized in any of the 20 demonstration projects that were subsequently set up[6]. Moreover the predominance of grid connected SHPs under the project contrary to the stand alone SHPs envisaged initially in the project document may have also led to a considerable reduction in the concerns related to load development. It is also relevant to note here that the collapse of this important activity block may have by itself contributed to the subsequent shift from stand alone SHPs to grid connected sub projects. The collapse of the load development and load control initiatives is also likely to have long term implications for the development and energy security of remote regions through decentralized power generation and distribution in the future.

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[6] Some desperate attempts at developing local load were made through the subsidized distribution of conventional appliances in the Titang SHP target area by Sai Engineering Foundation perhaps indicating the relevance of load development in the context of poor grid connectivity.

On the whole load development and load management initiatives did not produce the desired results though they were important components for ensuring the viability and sustainability of specially the stand alone decentralized SHPs. The development of low wattage and load control devices could have only developed if these appliances were simple to operate and affordable. This could only be ensured in the initial stages of this activity block by liberal financial and organizational support by the Government. Unfortunately no such support was forthcoming leading to the failure of this important activity block.

Terms of Reference XI: Assess the functioning of the revolving fund facility and its effective implementation and sustainability.

As part of UNDP-GEF Hilly Hydro Project a revolving fund of US $ 1.4 million (Rs. 6.01 crores) was created with Indian Renewable Energy Development Agency (IREDA), the financial institution under the administrative control of MNES. The objective of creating such a revolving fund was to support private sector/NGO SHP projects under the UNDP-GEF Hilly Hydro Project. The revolving fund was created in December 1997. Out of this revolving fund, as envisaged, IREDA has supported the following three demonstration projects under UNDP-GEF Hilly Hydro Project.

S.No.	Name of the project	Developer	Loan Sanctioned by IREDA (Rs)
1	Solang (1000 KW)	A Power Himalayas	3.69 crores
2	Raskat (800 KW)	M/s Indusree Power	2.61 crores
3	Titang (800 KW)	M/s Sai Engineering Foundation (NGO)	0.97 crores
		Total	**7.27 crores**

It may be seen that against an amount of Rs. 6.01 crores, IREDA had provided loan of Rs. 7.27 crores for these projects. The balance amount had been given by IREDA from its own resources. The loan was provided at a interest rate of 15.5%. All the three projects financed through this revolving fund had been commissioned and had started repaying the loan to IREDA. These projects had commenced commercial generation. The two private sector projects are the first two small hydel projects in Himachal Pradesh to be set up by private sector. The Titang project being the first project set up by an NGO in the country. It has been decided by the Project Executive Committee that this revolving fund would be utilised for continuously supporting other small hydropower projects in the hilly areas of India. In all, the revolving fund created as part of the project had been effectively utilised and would be sustained. IREDA has been sending regular reports on the utilisation/repayment of loan to the Ministry and reflecting it in its balance sheet and annual report. The size of the evolving fund being limited to begin with, only a limited number of projects could be supported at any point of time and unless the fund was augmented private and NGO sector participation was likely to be constrained. However the setting up of the revolving fund and its successful operation under the project has laid the foundations for a focused institutional mechanisms for financial support to private and NGO participation in the expanding Small Hydel Sector in the country, which SHP developers can look forward to availing in the years to come.

Terms of Reference XII : Capacity Development of Key local partners in planning, design, construction, maintenance, operation and management of SHPs in the country and the impact of training programmes and workshops in replication activities.

The development of institutional and human resource capabilities within the country from the national to the local levels needed for the effective implementation of the Small Hydel Projects was one of the three important immediate objectives of the project. It was visualized that officials and personnel involved in all the stages of implementation should be provided with the capacity building inputs and training to independently plan, design, construct, monitor and manage these Small Hydel Projects.

For providing this technical and training support; three National Technical Institutions were to be developed and adequately equipped to carry out these tasks. One of them namely the AHEC, Roorkee, was to be given the responsibility of the lead institution, or the National Consultant, while M/s. Micro Hydro Power Corporation, Switzerland would be the International Consultant for this activity.

It was observed that the only National Technical Institution that was developed and strengthened under the project was the AHEC at Roorkee. The other two in Itanagar, and Guwahati who were initially involved in the conduct of some training programmes seem to have lost interest, and as a consequence were not able to build their capabilities and infrastructure, both in terms of manpower and equipment, as visualized. This was a major setback in this important actively block and has led to the reduction of the impact in the North Eastern participating states in particular, which are otherwise endowed with a very substantial small hydro potential. Even in the case of the AHEC it was observed that the extent of testing facilities and applied research could not be developed to the extent desired.

Training at different levels and on various aspects of SHP development and watermills has been one of the successful and effective activities of UNDP-GEF Hilly Hydro Project. Number of study tours and training programmes were organised during the project period. While most of the training programmes were targeted to strengthen State Government Officials so that they are self sufficient in conceptualizing, designing and execution of SHP projects, some private developers and consultants were also trained. Two dedicated training programmes were organised for the watermill owners so that this activity could be self-sustaining. It is reported that 60 officials were sent abroad on study tours and 113 officials were trained in-house on various aspects of SHP development. Training courses were also organised on GIS based identification of SHP sites at Roorkee and Guwahati. As a result of these training programmes the capabilities of AHEC has also improved and standard training modules have been developed and are now available with them for future training programmes. AHEC has now tied up with two other technical institutions in Central India (MACK, Bhopal) and Eastern India (Jadabpur University, Calcutta) for training and testing activity. Training has become a regular feature of MNES and atleast 3-4 training programmes are now organised every year. One international training programme is also organised every year where about 25 international participants from developing countries are trained on subjects related to Small Hydro Development . A list of training programmes organised as part of UNDP-GEF Hilly Hydro Project is given in **Annexure 7.6** of this chapter.

Discussions by our team however revealed that most officials and personnel trained under the activity block did not remain to work in this sector long enough, and were often transferred to other departments not directly concerned with Small Hydro Development. This meant that a “Core” team of well trained officials at the National, State, and local levels could only be partially established. Yet another weakness in this activity block has been the non involvement of local persons and panchayats in training for management of and maintenance of these projects. The most effective way of training persons at the local level would be to support developers to take up hands on training at the sub-projects level as done by Sai Engineering on a voluntary basis.

Terms of Reference XIII : The feedback of developers and local implementing agencies in support of SHP development, bottlenecks, and facilitation of funding; support; subsidy by State Governments.

The developers of the small hydel demonstration projects constitute the cutting edge of the entire Hilly Hydro Project. Their feedback on various issues related to the design, implementation, and impact of the project provides valuable insights for any evaluator.

During the course of our field visits a great deal of our time was spent in interacting with the developers in order to systematically canvas their feedback. The hilly hydro project was implemented through the involvement of three distinct types of developers namely the State Government developers (mainly the State Nodel Agencies for non conventional energy programmes), Private Sector Companies, and NGO developers. Though each type of developer reported having confronted different sets of problems while participating in the project, there were some important common issues that concerned all of them. There were three broad issues on which we could obtain the feedback from the developers. These were (a) Administrative issues largely pertaining to the problem of obtaining timely clearances and approvals from various state agencies/ departments; (b) Financial Issues or financial arrangements and incentives provided in support of SHPs under the Hilly Hydro Project; (c) Structural or Infrastructural Issues related to arrangements for the proper evacuation and purchase of power generated by the demonstration projects.

(a) Timely Clearances and Approvals : Developers of the SHPs under the hilly hydro project were required to obtain a very wide range of clearances and approvals from various state agencies and departments. According to the Developers most of these clearances and approvals were necessary only in the case of very large hydro electric projects that were likely to have sensitive ecological implications. This set of clearances and approvals had been extended mechanically so as to apply to all hydro electric projects irrespective of their size and ecological implications. As such some of these clearances and approvals did not seem necessary in the case of small hydel projects which were by their very design highly compatible with local environmental and ecological conditions. First of all the developers felt that considering the environmentally benign nature of the micro and mini hydel projects most of the clearances that may have been necessary for large hydro electric systems were not really required in the case of SHPs specially those with the capacities of less than 3 MW, and only caused avoidable delays in implementation and thus the final completion and commissioning of the projects.

Secondly the developers felt that in spite of the initial assurance that the government would provide a ‘single window’ clearance facility, the developers had to obtain environmental, water, air pollution and other clearances from various state government agencies. They were also required to obtain the approval and consent of the local panchayats where these projects were to be located, and also get clearances from the forest departments to be finally approved by the Government of India. According to the developers, all these clearances and approvals took a fair amount of time and effort which added to the delayed completion and commissioning of these projects. Moreover some developers reported that they had faced serious problems and delays in the transfer of public and forest land which in turn affected their ability to mortgage the land in order to access finances for the project.

The developers also felt that the state nodel agencies that were set up primarily to facilitate speedy clearances were themselves administratively weak and ineffective in assisting the developers to obtain the required clearances and approvals within a reasonable time frame, and that unless the SNAs were strengthened and provided with the necessary administrative clout they would not be able to effectively play this critical facilitating role in the speedy development of the small hydel sector in the participating States.

(b) Financial Arrangements and Support : While most developers seemed to be satisfied with the financial arrangements that had been created to support the development of the demonstration projects through the financial arm of the MNES namely IREDA, and also the provision of interest subsidy by the MNES, some were of the opinion that the State Cooperative Banks who had come forward to provide financing for NGO developers should also be entitled to the interest subsidy provided by the government to other nationalized banks and that the rules and conditionalities that were applicable to private developers for obtaining project finances be made to, apply to the NGO sector as well.

The NGO developer's feedback regarding the financial arrangements and support were rather negative and it was felt that the NGO sector in particular was being discriminated against by not being treated at par with private or state developers by IREDA. IREDA had imposed some additional conditionalities for obtaining project loan by the NGO developer in Himachal Pradesh which they had not insisted upon in the case of other private developers in the state. The additional conditionalities for obtaining the loans from IREDA imposed on the only NGO developer in the country namely Sai Engineering Foundation was to provide an undertaking from HIMURJA (State Nodal Agency for Himachal Pradesh) for the timely repayment of loans by the NGO developer, obtaining of an escrow account from the State Electricity Board by the foundation, and also the state government guarantee on behalf of Sai Engineering Foundation. These conditions did not however apply to private developers and were to be only imposed on the NGO.

It was also felt that since timely and adequate financial support was essential of the development of the small hydel projects the initial arrangements that existed did not encourage NGO developers and their active participation in the small hydro programme. It was however reported that most of these anomalies had been subsequently removed and that norms currently used by IREDA had been modified to facilitate NGO participation. Furthermore with the active intervention of NABARD the State Cooperative Banks were also allowed to finance small hydel project being developed by cooperative societies, self help groups and NGOs.

(c) Power Purchase and Evacuation Arrangements : According to the developers the timely execution and implementation of the power purchase agreement is essential for the removal of risks related to the future viability and sustainability of the SHP. Along with the purchase agreements the availability of a stable distribution grid in the area is equally necessary to ensure viability. This directly implies that their should be the physical infrastructure required for the regular evacuation of power. The proper interfacing of the project with the distribution grid requires that the power produced by the SHP be transmitted and fed into the nearest grid sub-station. However in remote locations the grid sub-stations are usually located away from the SHP and thus the proper interfacing of the project usually involves building the transmission lines from the SHP to the grid sub-stations. This is a fairly expensive proposition which the developer can least afford. Moreover as a consequence of the initial plans of the hilly hydro project to build and operate stand alone SHPs, this additional cost of grid connectivity did not figure in the DPRs that were prepared for the project. Getting the developer to subsequently pay for this grid connectivity was quite unreasonable according to the developers.

The other alternative which does not involve the creation of this transmission infrastructure is to allow direct interfacing to the grid by means of a four pole hard tap interface structure at a point on the grid nearest to the SHP. This may be a temporary arrangement till a regular substation can replace this temporary interface structure for the proper integration of the SHP to the State grid.

The major issue faced by the developers is the insistence of the State Electricity Boards that the grid sub-station be paid for by the developer rendering the project financially unviable. The developers felt that at the most they can bear the cost of direct interfacing, but expecting them to bear the additional cost of a transmission line and also the cost of setting up a grid sub-station would be too much to expect from an individual developer[7]. Thus according to the project developers, the cost of the sub-station as well as the transmission lines should be born by the Government through the State Electricity Boards as the SHP is only helping to augment and strengthen the state grid, through tail end injection of power.

According to the developers the cost of the evacuation infrastructure if included in the initial project cost would inflate the project costs to such an extent that it would seriously affect

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[7] Discussions with the State power utilities revealed that the current cost of setting up a grid sub-station is about Rs. 85 lakh, while the cost of high tension transmission lines works out to be about Rs 2.5 lakh per kilo meter.

the anticipated returns from this investment by the developer. The developers thus felt that if the government is genuinely keen on augmenting its power production through small hydel sector development involving private participation it should not only provide a stable and well maintained grid (a state grid or a local grid) but should also create the necessary infrastructure for the regular evacuation of power produced by the SHPs.

Even in the case of stand alone SHPs developed to serve remote areas and the energy needs of isolated populations the government should at its own expense create a local grid for the transmission and distribution of power prior to the setting up of the SHP by an individual developer so that adequate loads are already available before the SHP is set up. The developer in turn can then create capacity required to serve the available load in order to ensure the economic viability of his stand alone small hydel plant. Implicit in this argument is an important principle that needs to be followed that the available load and its assessment should precede the determination of plant capacity, particularly in the case of stand alone SHPs.

Grid connectivity and evacuation become necessary for larger capacity SHPs where local load is not adequate to fully utilize the capacity. In isolated locations where a large physical potential exists the phased increase of capacities in conformity with the expansion of the local grid seems the only alternative in order to ensure viability and sustainable private sector participation.

Terms of Reference XIV: Assess the potential interest of donor organisations by way of commitment of funds in each participating State, and elaborate on the possibilities of long term sustainable funding from the Central and State Governments.

According to the reports made available to the study team, there seems to be no commitment of funds by international donor organisations directly to the participating states at present. However, World Bank has provided a second line of credit of USD 110 million to IREDA for financing small hydro power projects in the country including those in Himalayan and Sub-Himalayan regions. The first line of credit of USD

70 million was only restricted to canal based small hydro power projects. This change of supporting SHP projects in Himalayan region can be directly attributed to the efforts made by Hilly Hydro Project and the enabling policies announced by the states participating in the project. It is also learnt that IREDA is charging lower interest rate in the Himalayan states and small capacity SHP projects in order to encourage SHP development in the Himalayan region. The State Governments are found to be committed to develop SHP potential at a faster pace following the success of demonstration projects set up under the Hilly Hydro Project. Central Government (Ministry of Non-Conventional Energy Sources) has also stepped up its effort by providing high priority to the SHP sector and has committed a developmental fund of Rs. 375 crores (USD 83 million) for the period 2002-2007. During this period, a capacity addition of 600 MW from SHP projects is targeted (450 MW from private sector participation and 150 MW by Government sector projects). The Ministry has set a target of adding 2000 MW capacity from SHP projects by the year 2012. These targets are based on the Master Plan prepared as part of UNDP-GEF Hilly Hydro Project and have been included in the Tenth plan of the Ministry of Non-Conventional Energy Sources. The small size SHP projects with community participation are now being regularly

deployed in and for remote village electrification in the country, on the same pattern as envisaged under the UNDP-GEF Hilly Hydro Project and are actively utilizing the experience gained thereby.

RECOMMENDATIONS FOR FUTURE SHP DEVELOPMENT :

The major recommendations that follow from these conclusions and those which could be considered for future Small Hydel Programmes are as follows :

1. The proper upkeep and regular maintenance of the electrical and mechanical components of the SHP should be ensured by the developers at all times. Though this is the sole responsibility of the developer once the project is commissioned it is essential for the State Nodal Agencies and the MNES to ensure that the manufacturers honour the service and maintenance contracts entered into with the developers at the time orders for the E & M equipment are awarded. The timely supply of essential spares should also be built into these contracts, as a statutory condition at the time the initial contract is awarded. This is all the more necessary as there is hardly any standardization of equipment which varies from one SHP to the other depending on a wide range of physical conditions that exist in different locations.

2. There is an immediate need to strengthen the testing facilities for electrical and mechanical equipment prior to final installation and commissioning. Such facilities should be created at the AHEC Roorkee and other regional Technical Institutions by providing adequate financial assistance for the purpose. Such testing facilities that are not available to smaller manufacturers of E & M equipment will also help in maintaining manufacturing standards.

3. Well established and experienced developers should be supported and incentivised to provide 'hands on' apprenticeship training to qualified local youth. This will provide a pool of well trained operating and maintenance staff for the expanding Small Hydel Sector. The manufacturers of Small Hydel Equipment as well as those involved in civil design and construction could also be encouraged to assist in the training of operators and management staff needed to man the new SHP projects that are likely to be developed and commissioned in the future, so that apart from institutional training

alone functional and practical training is also provided to build the human resource that is required to sustain and develop the Small Hydel Sector in the country.

4. Proper living and working conditions for the operating staff should be provided at the SHPs in order to ensure and sustain efficient levels of power generations and evacuation. The physical infrastructure necessary should be incorporated into the civil design of the SHP itself. This should consist of well furnished living and recreational space and amenities such as a reading room/ library and provision for television and indoor games.

5. It is also necessary to ensure the stability and proper maintenance of the State Grid to which the SHP is integrated. This can only be ensured if deemed energy generation is strictly enforced for all SHPs, and also uniformly extended to those interfaced with 11 KVA and 22 KVA state grids and not to only the lucky few who have the privilege of being located in softer areas served by a 33 KVA state grid.

6. Proper grid sub-station based integration and evacuation of power which also enables switching over to stand alone operations in the event of state grid failure is extremely critical in ensuring viability and sustainability of the SHP in such remote locations. A proper and reliable communication system between the SHP and the sub-station should also be statutorily ensured before the project is commissioned and permitted to operate. The necessary evacuation and local distribution/ grid infrastructure should be incorporated into the project design and the cost equally shared by the Developer and the Distribution Utilities in the case of both State grid connected and stand alone SHPs.

7. A differential lower electricity tariff for the hard winter months as compared to the summer months would go a long way in encouraging the use of electricity in the target areas and there by reduce fuel wood consumption and related GHG emissions.

8. There is also the need to encourage the use of low wattage devices by making them available at lower costs. This can be attempted through subsidized distribution and sale of these devices through NGOs, SNAs, and other appropriate social marketing agencies. The adoption of low wattage devices can also be encouraged through excise duty and import duty concessions, as well as sales tax concessions in the participating hilly regions in particular.

9. Rural Development Programmes related to wage employment generation, self employment generation, rural housing and infrastructure programmes should be properly integrated with the Small Hydel Programmes in order to ensure active local participation and sustainable development of the Small Hydel Sector. While SGRY can be usefully dovetailed into creation and maintenance of village power infrastructure or local distribution grids, the SGSY can be utilized to activate greater participation by Self Help Groups in the water mills sector both for a host of livelihood applications as well as for the generation and distribution of power in the villages. Even the rural housing schemes can incorporate energy efficient design so that the energy produced locally can be optimally and efficiently utilized.

10. SHPs should be statutorily required to incorporate provisions that would meet water requirements of local gravity based irrigation systems in the target area. This can be done through the redesigning of the weir and di-siltation cum forbay structures at the DPR stage itself. Such provisions are necessary to avoid local conflicts that can seriously disrupt the development of Small Hydel Projects.

11. Comprehensive Base Line Surveys need to be undertaken in the target areas by competent and independent agencies in order to assess the existing load in the area and also to estimate the likely development of the load in the target areas in the next ten years or so. This will not only ensure proper impact assessment but also assist the potential developer to plan his generation capacities in appropriate phases in order to ensure techno economic feasibility and financial viability.

12. Impact Assessments should only be undertaken after optimum power generation and stable evacuation has been achieved by each of the SHPs that have been commissioned. It is observed that a period of at least two years would be required for any project to achieve stable production and proper evacuation, and it is only then that the impact can be assessed realistically.

ANNEXURE 7.1

LIST OF UNDP/GEF HILLY HYDRO DEMONSTRATION PROJECTS

1	2	3	4	5	6	7
S.No.	**Name**	**Location**	**Capacity**	**Cost**	*Developer*	**Status & Date of Commissioning**
1.	Solang	Dist: Kullu State : H.P	1000KW		A.Power Himalayas (Private)	Completed
2.	Raskat	Dist: Kullu State : H.P	800 KW		Indu Sree Power (Private)	Completed
3.	Titang	Dist: Kinnaur State: H.P	800 KW		Sai Eng. Foundation (NGO)	Completed
4.	Soneprayag	Dist: Rudraprayag State: Uttaranchal	500 KW		UJVN	Completed
5.	Bikuriagad	Uttaranchal	500 KW		UREDA	Completed
6.	Lingti	Dist: Lahoul & Spiti State : H.P	400 KW		HIMURJA	Completed but not functioning
7.	Kothi	Dist: Kullu State: H.P	200 KW		HIMURJA	Completed
8.	Jalimghagh-II	Dist : State: Bihar	200 KW		BHPC	Incomplete
9.	Nindighagh-II	Dist : State: Bihar	200 KW		BHPC	Incomplete
10.	Pussimbing	Dist:Darjeeling State: West Bengal	200 KW		Sycotta Tea Estate (Private)	Completed but not functioning
11.	Chamong	Dist:Darjeeling State : West Bengal	150 KW		Bio Tea Estate (Private)	Completed
12.	Gangotri	Dist: State:Uttaranchal	100 KW		UREDA	Completed but not commissioned
13.	Kanvashram	Dist: State:Uttaranchal	100 KW		UREDA	Completed
14.	Juthed	Dist :Chamba State : H.P	100 KW		HIMURJA	Completed
15.	Purthi	Dist: State: H.P	100 KW		HIMURJA	Completed
16.	Sural	Dist: State: H.P	100 KW		HIMURJA	Completed
17.	Yakla	Dist: State: Sikkim	100 KW		Defence	Completed
18.	Kalmoni	Dist: Kamrup State: Assam	100 KW		MKB Pvt.Ltd (Private)	Completed

19.	Daragaon	Dist: State:West Bengal	20 KW		WBREDA	Completed
20.	Nazirakhat	Dist: Kamrup State: Assam	10 KW		ASTEC	Completed

ANNEXURE 7.2

LIST OF UNDP/GEF HILLY HYDRO DEMONSTRATION PROJECTS VISITED BY THE IIPA STUDY TEAM

1	2	3	4	5	6	7
S.No	**Name**	**Location**	**Capacity**	**Cost**	**Developer**	**Status & Date of Commissioning**
1.	Solang	Dist: Kullu State : H.P	1000KW		A.Power Himalayas (Private)	Completed
2.	Raskat	Dist: Kullu State : H.P	800 KW		Indu Sree Power (Private)	Completed
3.	Titang	Dist: Kinnaur State: H.P	800 KW		Sai Eng. Foundation (NGO)	Completed
4.	Soneprayag	Dist: Rudraprayag State: Uttaranchal	500 KW		UJVN	Completed
5.	Lingti	Dist: Lahoul & Spiti State : H.P	400 KW		HIMURJA	Completed but not functioning
6.	Kothi	Dist: Kullu State: H.P	200 KW		HIMURJA	Completed
7.	Pussimbing	Dist:Darjeeling State: West Bengal	200 KW		Sycotta Tea Estate (Private)	Completed but not functioning
8.	Chamong	Dist:Darjeeling State : West Bengal	150 KW		Bio Tea Estate (Private)	Completed
9.	Juthed	Dist :Chamba State : H.P	100 KW		HIMURJA	Completed
10.	Kalmoni	Dist: Kamrup State: Assam	100 KW		MKB Pvt.Ltd (Private)	Completed

ANNEXURE 7.3

ESTIMATES OF FUEL WOOD AND DIESEL SAVING THROUGH SHP OPERATIONS AND CORRESPONDING GHG EMISSION REDUCTIONS

	SHP DETAILS	Total Installed Capacity (KW)	Expected Annual Fuel Wood Saving from C&H applications (Tonnes/ Year)	Expected Annual GHG Reductions through wood saving (Tonnes/ Year)	Expected Annual Diesel savings (Litres/ Year)	Expected Annual GHG Reduction through Diesel saving (Tonnes/ Year)
A-1	Hilly Hydro Demonstration Projects in the Hilly Areas (Fuel Wood Saving Projects) Total 12 of 20 based on Field Study Assumptions *	4700	1111.644	500.2398		
B-1	Hilly Hydro Demonstration Projects in the Hilly Areas (Fuel Wood Saving Projects) Total 12 of 20 based on Project Document Assumption **	4700	6669.864	3001.4388		
A-2	Hilly Hydro Demonstration Projects in Plantation Areas (Diesel Saving Projects, Total 6 of 20) based on Field Study Assumption ***	580			508080	1387.0584
B-2	Hilly Hydro Demonstration Projects in Plantation Areas (Diesel Saving Projects, Total 6 of 20) based on Project Document Assumption ****	580			763120	2080.5876
A-3	Small Hydro Projects in Hilly States till 2003 based on Field Study Assumptions	543300	128501.316	57825.5922		
B-3	Small Hydro Projects in Hilly States till 2003 based on Project Document Assumptions	543300	771007.896	346953.5532		

Annexure 7.3 Contd….

	SHP DETAILS	Total Installed Capacity (KW)	Expected Annual Fuel Wood Saving from C&H applications (Tonnes/ Year)	Expected Annual GHG Reductions through wood saving (Tonnes/ Year)	Expected Annual Diesel savings (Litres/ Year)	Expected Annual GHG Reduction through Diesel saving (Tonnes/ Year)
A-4	Small Hydro Projects in Non Hilly Areas set up till July, 2003, Diesel Saving Locations, Based on Field Study Assumptions	987100			864699600	2360629.908
A-5	Small Hydro Projects in Non Hilly Areas set up till July, 2003, Diesel Saving Locations, Based on Project Document Assumptions	987100			1297049400	3540944.862

* The Field Study assumptions are as follows (a) SHPs are operating at 40% PLF; (b) Only 12.5 % of electricity generated is utilised for cooking and heating applications which would replace fuel wood.

** The Project Document assumptions are as follows : (a) SHPs are generating at 60% PLF; (b) As much as 50% of electricity generated is utilised for cooking and heating applications which would replace fuel wood.

*** The Field Study assumptions are that SHPs operate at 40% PLF and there is 100% utilisation of electricity for diesel substitution.

**** The Project Document assumptions are that SHPs operate at 60% PLF and there is 100% utilisation of electricity for diesel substitution the GHG emission reduction for 1 Litre of Diesel is 2.73 Kg. of GHG (as in TERI Report)

Note : 1 Kwh leads to a saving of fuel wood to the tonne of 5.4 kgs.
1 tonne of fuel wood in turn produces 0.45 tonnes of GHG (as in Project Document)

ANNEXURE 7.4

List of Selected Sites for Demonstration - Technology Matrix

North States

S.No	State	Pr.	Site	Distt.	Capacity (kw)	Gross Head (m)	Civil Works					
							Intake	Water Conveyance System	D/Tank	F/Tank	Penstock	Gate/ Valve
1.	Jammu & Kashmir	1	Thusgam	Kargil	2x150	19.6	Bush Boulder	GRP/RCC Pipe/Channel	Yes	Yes	Steel	Gate
		2	Hanu	Leh	2xl000	240	Trench	Channel	Yes	Yes/BR	Steel	Gate
		3	Bazgo Optimisation	Leh	2x150	58	Bush Boulder	Covered Channel	Yes	BR	Steel	Gate
2.	Himachal Pradesh	1	Lingti	Lahul Spiti	2x200	30	Coanda	Hume Pipe/Channel	Combined with forebay Tank	-	Steel	Gate
		2	Raskat	Kullu	lx800	250.11	Coanda	Steel/RCC hume pipe	Combined with forebay	-	Steel	Valve
		3	Solang	Kullu	2x500	80	Trench	RCC box	Yes	Yes	Steel	Valve
		4	Kothi	Kullu	2xl00	87	Inflatable rubber dam/ Coanda	Pipe/Channel	Yes	Yes	Steel	Valve
		5	Juthed	Chamba	2x50	60	Coanda	Pipe/Channel	Combined wih Forebay	-	Steel	Valve
		6	Titang	Kinnaur	2x400	230	Trench	Steel pipe/Channel	Combined with forebay	-	Steel	Valve
3.	Uttar Pradesh	1	Soneprayag	Chamoli	2x250	47.86	Trench	Open channel	Yes	Yes	Steel	Valve
		2	Kanvashram	Pauri	Ix50+1x50	14.66/8.75	Existing weir	Open channel	No	Yes	Steel	Valve
		3	Gangotri-II	Uttarkashi	2x50 Phase I	28.55	Gravity	Box Section	Yes	Yes	Steel	Valve
		4	Bhikurigad	Pithoragarh	2x250	59.19	Trench	Open channel/Pipe	Yes	Yes	Steel	Valve
		5	J ankichatti Optimisati on	Uttarkashi	2xl00	32	Bush Boulder	Open channel	Yes	Yes	Steel	Valve
4.	Bihar	1	Nindighagh	Lohardaga	1x200	94	Coanda	O. Channel on right bank	Yes	Yes	Steel	Valve
		2	Jalimghah	Gumla	lx200	138	Gravity	Pipe/Channel	Yes	Yes	Steel	Valve

(Turbine F=Francis, P=Pelton, P-MJ=Pelton with Multi Jet, Pr=Propeller),(Generator S=Synchronous, I=Induction),(power Evacuation G=Grid,. I=Isolated, LG=Local Grid, WG=Weak Grid, *=Capacity overrated, R=Renovation & uprating, N=New)

All general equipment will be-designed & developed for * auto shut down * manual start * with capability of remote monitoring in future, + Sign indicates second phase development,

! Discharge will be improved on the receipt of DPRs.

Remark:

1. All conveyance system should be designed for extra water(1O-15%) for social forestry & domestic use. Inlets should be installed.
2. Deeper forebay channel to allow alter for freezing of surface water. Accordingly trash racks should be submerged.
3. Plastic trash rack may be used in cold region. .
4. Avoid ducting in power house.
5. Pipes to be coded for colour in Power House. .
6. All generating equipment will be designed and developed for auto shut down, manual start and with capability of remote monitoring in future.

7. Type of meters will depend upon on the nos. & type of consumers. .

Annexure 7.4 Contd….

North East States

S. No.	State	Pr.	Site	District	Capacity (kW)	Gross Head (m)	Civil Works					
							Intake	Water Conveyance System	D-Tank	F Tank	Penstock	Gate/ valve
1	Assam	1	Kalmoni	Kamrup	2x50	24.2	Gravity	O.Channel/Pipe	Yes	Yes/BR	Steel	Valve
		2	Nazirakhat	Guwahati	2x5	12	Gravity	O.Channel/Pipe	Yes	Yes	Steel	Valve
2	Arunachal Pradesh	1	Sissiri -Optimisation	D. Valley	2x250+2x500	20	Bush/Boulder	O.Channel	Yes	Yes	--	Gate
3	Meghalaya	1	UmIei	Ribhoi	2x50	85	Coanda	RCC/RCR	N/R	Yes	Steel	Valve
4	Mizoram	1	U Tuiphal	Aizwal	3x250	24.55	Trench	O.Channel	Yes	Yes	Steel	Valve
5	Sikkim	1	Yakla-Renovation	North Sikkim	1x75	144.5	Trench	Closed Steel Channel	No	Steel Tank	Steel	Valve
	Sikkim	2	Chaten II	North Sikkim	2xI50	117	-	O. Channel	-	Yes	Steel	Valve
6	West Bengal	1	Pussimbing	Darjling	2x75	55	Bush Boulder	O.Channel	Yes	Yes	Steel	Valve
		2	Chamong	Darjling	200+2x100	120	Trench / Trench/Coanda	O.Channel	Yes	Yes	Steel	Valve

(Turbine F=Francis, P=PeIton, P-MJ=PeIton with Multi Jet, Pr-Propeller),(Generator S=Synchronous, I=Induction),(power Evacuation G=Grid, I=Isolated, LG=Local Grid, WG=Weak Grid, *=Capacity ovulated, R=Renovation & uprdating, N=New)

All general equipment will be designed & developed for * auto shut down * manual start * with capability of remote monitoring in future, Sign indicates second phase development, Discharge will be improved on the receipt of DPRs.

Remark:

1. All conveyance system should be designed for extra water(1O-I5%) for social forestry & domestic use. Inlets should be installed.
2. Deeper forebay channel to allow alter for freezing of surface water. Accordingly trash racks should be submerged.
3. Plastic trash rack may be used in cold region.
4. Avoid ducting in power house.
5. Pipes to be coded for colour in Power House.
6. All generating equipment will be designed and developed for auto shut down, manual start and with capability of remote monitoring in future.
7. Type of meters will depend upon on the nos. & type of consumers.

Annexure 7.4 Contd….

North States

E &M Works											End Use	Remarks
Turbine	Generator	Coupling	Control	Power House	Handling System	Gen Village Voltage	Transmission kV and Type of Poles	Distribution Details				
								Poles	**Conductor**	Service Connector		
Francis	**Synchronous**	Direct	ELC	Port. Cabin	C.P.Block on Rails	415V	II kV on C/T Poles	C/T	AAC	N.M	Domestic, Agro, Pumping	Silt
Pelton - 2 Jet	Synchronous	Direct	Digital	Concrete	OHT	-do-	upto 33 kV	T	AAC	N.M	Domestic, Agro, Pumping	
Turgo Impulse (Existing)	Synchronous	Direct	ELC	RCC	C.P.Block on Rails	-do-	-do-	C/T	AAC	N.M/STM	Domestic, Agro, Pumping	Existing Station B/R to increase its working during lean flows.
Francis/Cross Flow	Synchronous	Direct	ELC	S.Masonry/Port cabin	C.P.Block on Rails	415 V	Existing	Existing	Existing	NM/STM	Domestic, Agro, Pumping	
Pelton Impulse	Synchronous	Direct	Digital	S.Masonry	C.P.Block on Rails	415 V	Existing	Existing	Existing	NM/STM	Domestic, Agro, Pumping	
Francis	Synchronous	Direct	Digital	S.Masonry	C.P.Block on Rails	3.3kV	Existing	T	AAC	NM/STM	Domestic, Agro, Pumping	
H.Francis/Pelton/Cross Flow	Synchronous	Direct	ELC	S.Masonry	C.P.Block on Rails	415 V	Existing	T	AAC	NM/STM	Domestic, Agro, Pumping	
H. Francis	Synchronous	Direct	ELC	S.Masonry/Port cabin	C.P.Block on Rails	**415 V**	Existing	T	AAC	NM/STM	Domestic, Agro, Pumping	
Pelton	Synchronous	Direct	Digital	S.Masonry	C.P .Block on Rails	415V	Existing	Existing	Existing	NM/STM	Domestic, Agro, Pumping	
Francis	Synchronous	Direct	ELC	R.C.C/S.M	C.P. Block on Rails	415V	11 kV on CIT Poles	T	ABC	DTM/N.M	Domestic, Agro.	
Kaplan/Cross Flow	Synchronous	Direct	ELC	S.M.	C.P .Block on Rails	-do-	Existing	T	ABC	STM/DTM	Domestic, Agro, Pumping	
Francis/Cross Flow	Synchronous	Direct	ELC	R.C.C/S.M.	C.P.Block on Rails	-do-	II kV on CIT Poles	T	ABC	DTM/STM	Domestic, Agro	
Francis	Synchronous	Direct	ELC	RCC/S.M.	C.P.Block on Rails	-do-	Existing	T	ABC	N.M/STM	Domestic, Agro	
Francis	Synchronous	Direct	ELC	RCC/S.M. .	C.P.Block on Rails	-do-	Existing	T	ABC	N.M/STM	Domestic, Agro	Existing Station, Load development activity station
H.Francis	Synchronous	Direct	ELC	R.C.C./S.N	C.P.Block on Rails	415V	I I kV on CT Poles	'T	AAC	DTM/N.M	Mining Industry/Domestic	No Grid line available within 25 Km. HINDALCO mines are 10 Km from site
Francis	Synchronous	Direct	ELC	S.Masonry	C.P.Block on Rails	415V	-do-	T	AAC	-do-	-do-	No Grid line available within 25 Km. HINDALCO mines are 10 Km from site

Distribution Details

Meter	Conductor	Poles
1. N.M - No meter (cutout only)	1. AAC - All Aluminum Conductor	**C- Concrete** **T.- Steel Tubular Poles**
		Poles
2. D.T.M. - Dual Tariff meter	2. ABC - Aerial bunched cables (Insulated)	L- Lattice Poles

3. S.T.M. - Single Tariff meter

Annexure 7.4 Contd….

North East States

E&M Works											End Use	Remarks
Turbine	Generator	Coupling	Control	Power House	Handling System	T &D Works						
						Gen Voltage V	**Transmission** on kV/Type of Poles	**Distribution**				
								Poles	Conductor	Service Connector		
Francis	Synchronous	Direct	ELC	Port Cabin	C.P. Block on Rails	415	11/T	C/T	AAC	NM/STM	Tea Industry	Existing hydro mechanical drive is there
Cross Flow	Synchronous	Direct	ELC	Port Cabin	C.P.Block on Rails	415	11/T	C/T	AAC	NM/STM	Forest Camp	
Tubular/Kaplan	Synchronous	Direct	ELC	RCC/SM	C.P.Block on Rails	3300	33/T	C/T	AAC	STM/NM	Domestic/ Agri/Ind.	--
Pelton MJ/Francis/Turgo	Synchronous	Direct	ELC	Port Cabin	C.P.Block on Rails	415	Existing	C/T	AAC	DTM/STM	Domestic/Ind.	Accessibility by all weather Road
H.Francis	Synchronous	Direct	ELC	RCC/SM	C.P.Block on Rails	415	33/T	T	AAC	DTM/STM	Domestic	Isolated to serve nearby villages
Impulse/Cross Flow	Synchronous	Speed Increaser	ELC	RCC/SM	C.P. Block on Rails	415	Existing	C/T	AAC	DTM/STM	Domestic/Ind.	It is old project owned by Army at high altitude
Francis	Synchronous	Direct	ELC	SM/Port Cabin	C.P. Block on Rails	415	Existing	C/T	AAC	DTM/STM	Domestic/Ind.	Proposed to utilise tail race discharge of Stage- I
Pelton-MJ/Cross flow/Francis	Synchronous	Direct	ELC	RCC/SM	C.P.Block on Rails	415	11/T	T	AAC	STM/NM	Domestic/Tea Industry	Existing station need to be reimbursed
Pelton/ Francis	Synchronous	Direct	ELC	RCC/SM	C.P.Block on Rails	415		T	AAC	STM/NM	Domestic/T ea Industry	Isolated to serve nearby villages

Distribution Details

Meter
1. N.M - No meter (cutout only)
2. D.T.M. - Dual Tariff meter

Conductor
1. AAC - All Aluminum Conductor
2. ABC - Aerial bunched cables (Insulated)

Poles
C- Concrete Poles
L- Lattice Poles
T.- Steel Tubular Poles

3. S.T.M. - Single Tariff meter

Annexure 7.5

POLICIES INTRODUCED/INCENTIVES OFFERED IN STATES FOR PRIVATE SECTOR COMMERCIAL SMALL HYDRO POWER PROJECTS

Sl. No.	State	Coordinating Agency	Wheeling	Banking	TP Sale	Buy-back by SEB	Annual Escalation	Water Royalty	Remarks
1.	A.P.	NEDCAP	**2% of energy generated**	2%; 8 -12 Months	Allowed but not< HTT	Rs. 2.25/Unit	5% upto 2000	As fixed	
2.	W.B.	WBREDA	- do -	6 Months	Not Allowed	On case basis	Case basis	Exempted	
3.	Karnataka	KREDL	20% of energy generated	1 water yr	Allowed	Rs. 2.60/unit	5%	Exempted	• Capital Subsidy as extended to other industries • 5 years exemption from electricity tax on captive use
4.	U.P.	NEDA/UPJVN	2% of energy generated	1 year	Allowed	Rs. 2.25/Unit	-	10% of energy generated	
5.	Uttaranchal	UJVNL	**To be determined by ERCU; 10% Free if soled to UPCL or rural distribution**	2 Months monetised at average pooled price	Allowed to HT consumer, rural areas, out side State	Mutually negotiated	-	Exempted for 15 years ; after 15 years 18%	• Bids to be invited for premium to GOU • Minimum bid Rs. 5.0 /MW
6.	M.P.	MPEB	**2% of energy generated**	Not Allowed	Allowed	Rs. 2.25/Unit	-	Exempted	• Capital Subsidy as extended to other industries • 5 years exemption from electricity duty • Sales tax exemption on plant & m/c installed for generation • Exemption from demand cut
7.	Punjab	PEDA	2% of energy generated	1 year	Allowed	Rs. 2.73/unit (98-99)	5%	Exempted	• Exemption from demand cut • Sales tax benefit for owner
8.	Kerala	KEB	15% of energy generated	Not Allowed	Not Allowed	On case basis	-	Chargeable Rate	• Capital Subsidy as extended to other industries
9.	T.N.	TNEB	**5% of energy generated**	Not Allowed	Not Allowed	At mutually agreed rate	-	Exempted	
10.	Orissa	Energy Dept./ GRIDCO	• Upto 100KW : 2% of energy charge • 100-200KW : 3% of energy charge • 2 MW to 15 MW: 2% of energy charge	1 year	Allowed	At mutually agreed rate	-	Exempted	
11.	H.P.	HIMURJA	2% of energy generated	Allowed with additional charges	Not Allowed	Rs. 2.50/unit	-	Exempted for 15 years upto 3 MW	

Continue Annexure 7.5 ……

Sl. No.	State	Co-ordinating Agency	Wheeling	Banking	TP Sale	Buy-back by SEB	Annual Escalation	Water Royalty	Remarks
12.	Haryana	HAREDA	**2% of energy generated**	Allowed	Allowed	Rs. 2.25/unit (94-95)	5%	Rate as announced	• Capital Subsidy as extended to other industries • Sale tax benefit for project owner
13.	Rajasthan	RSEB	**2% of energy generated**	Allowed	Allowed	Rs. 2.75/unit (98-99)	5%	10% of prevailing tariff	• Capital Subsidy as extended to other industries • Sale tax benefit for eligible producer • 5 years exemption from electricity duty
14.	Maharashtra	Irrigation Dept.	Allowed with no charges for first 3 years and 1% after that	Allowed	Allowed	Rs. 2.25/unit (99-2000)	5%	Rs. 05/kwh/yr	• Concessions in excise duty, sales tax & turn-over tax • Exemption in octroi/entry tax • Part protection against exchange rate variation in case of foreign investment
15	Jammu & Kashmir	J&K PDC	10% now, to be decided by SCRC. No charges for sale to PDD or local grid	Allowed for 2 months	Allowed HT consumers	Negotiable	-	10% first 15 years, 15% after that	• No sales tax on equipment • SHP as industry • No Income tax

Annexure 7.6

TRAINING PROGRAMMES / STUDY TOURS ORGANISED UNDER UNDP-GEF HILLY HYDRO PROJECT

S.No	Name of Course	Schedule	No. of Participants
1.	Fellowship to China	10-25 April 1995	3
2.	Study Tour to Switzerland, US & UK	July 16 - August 04 1995	1
3.	Orientation course on SHP at MeSEB, Shillong	Dec. 1-3,1995	37
4.	Study tour to Australia and Newzeland	Feb8-25, 1996	6
5.	Fellowship, China	6-25 May 1996	3
6.	Study tour to UK, Germany and Switzerland	May 19- June 2, 1996	12
7.	Refresher course on SHP, Nainital	June 3-9,1996	20
8.	Study tour, USA	June 16- July 2 1996	6
	Study tour to US & Canada	27 July – 17 Aug. 1996	7
9.	Study tour to UK, Germany and Switzerland	Aug.18-Sept.9, 1996	10
10.	Trainees Training Course, Itanagar	Feb. 27-Mar 2 1997	18
11.	Water Mill Training, Roorkee	Jan. 15-17,1998	33
	Water Mill Training, Guwahati	Dec. 15-17,1998	43
12.	Workshop Training of GIS based Identification of SHP sites at Roorkee	Jan. 30-31,1998	20
13	Workshop Training of GIS based Identification of SHP sites at Guwahati	Feb. 20-21,1998	18
14	Study tour to UK, Norway, Czech Republic	June 4-20,2000	5
15	Onsite training –watermills Arunachal Pradesh	Aug.2000	40
16	Study tour to UK, Norway, Switzerland	Nov 13- Dec. 1,2000	5
17	Onsite training - watermills Uttaranchal	May 2001	70
18	Study tour to Bangkok	July 22 –5 Aug. 2002	2

CHAPTER VIII
THE LESSONS LEARNED FROM THE UNDP/GEF HILLY HYDRO PROJECT

The project having been concluded in December, 2003 it may take some more time for the substantial results of the project to emerge. However, it is possible to list out some of the significant early lessons that have been learned through the project, which would be useful in the proper planning and initiation of other projects of a similar nature in the days to come.

1. The project has correctly identified and articulated the felt needs of the remote hilly regions of the country and have demonstrated that it has a strong direct relationship with future sustainable regional development and prosperity of these regions.

2. The project has actively and strongly renewed the governments attention to the small hydel sector and has substantially strengthened the confidence and perception of various participating agencies towards the relevance and utility of small hydel projects in remote hilly areas. Renewed support by the Central Government is thus vital for sustaining the Small Hydel Sector through effective policies and programmes to strengthen SNAs, NGOs and Private Developers.

3. The project has significantly helped in creating and developing the required database for evolving future programmes by the participating States particularly through the formulation of a comprehensive Master Plan and Zonal Plans. These would hopefully be built upon and refined by the participating States and additional resources needed for updating and refining these efforts by the State Governments should be provided to sustain the momentum gained in this regard.

4. The project has gradually but certainly created a ‘core’ group of trained and experienced personnel, which would prove to be a vital national asset in ensuring the continued and sustained development of this vital energy sector in the country. This core group provides the human resource for further training in future projects.

5. Projects in the Small Hydel sector should specifically stress the importance of the strengthening of transmission and distribution infrastructure in the target areas. Clear and adequate financial provisions should be made and earmarked for this purpose so that the State Electricity utilities are not further burdened but are enabled to actively participate willingly in the Small Hydel initiatives in the future.

6. A project of this nature, which involves a multiplicity of inputs from and the concurrence and coordination of several Agencies should be attempted in two distinct phases namely a preparatory phase and implementation phase. Moreover there is the need for a realistic time horizon for both phases.

7. The project, which involves the active participation and involvement of the local population both in the implementation and for deriving tangible benefits needs concerted efforts in mobilization of the local population right from the start. Such an effort, which should form a part of the preparatory phase will enhance the speed of implementation and increase the impact of the project by ensuring that the local population evolve as active stakeholders and also develop a real sense of ownership in the project.

8. Our study also indicates that such projects need to be integrated with other Rural Development Programmes being taken up in the impact area by the district and block administration in order to ensure complimentarily and back up support in various forms. While the small hydel projects provides stable power in the area various farm and non-farm activities that use power as a necessary input could be initiated. Concerted efforts are needed to take full advantage and realize these inter project linkages in order to ensure a bigger and speedier impact on employment and livelihood in the target areas.

9. Our study also points to the importance of constant monitoring and timely follow up action by the project-monitoring cell. For carrying out its functions the PMC should be enabled to collect timely and accurate information from distant and isolated project locations which most-often is a challenging task. Future projects should thus pay greater attention in creating the necessary communication and manpower systems for effective monitoring. The connectivity among project sites within a participating State with a State level PMC which in turn can regularly feed the national level PMC with necessary information is a must in all future projects of this kind. Adequate financial and administrative provisions must be made for putting in place at least a VHF communication network in each project cluster in order to ensure effective monitoring.

10. With the projects explicit emphasis an improving techniques and adaptive transfer of appropriate technologies, international consultants are usually deployed. However one has to carefully choose those consultants who actually have adequate

experience in working with and in developing countries. This is necessary in order to ensure sustainable and viable solutions to problems specifically arising in the context of developing countries.

11. The training component of such projects requires a balanced selection and involvement of competent International and National Consultants. Moreover these should be deployed till the full completion of the project in order to enable the fine-tuning and improved effectiveness of the training context as the project progresses. Much greater interaction of these consultants with the Technical Institutions needs to be ensured for better results in this regard. Greater emphasis of hands on or shop floor training and apprenticeships at the sub project level is vital for building capacities at the operational level and this should be ensured in future projects.

12. Formal mechanisms should be created in future projects for the regular and active interaction among project consultants who are drawn from different disciplines and functional areas. The timely exchange of ideas and views would go a long way in improving and enriching the implementation process.

13. Early identification of 'drop outs' or 'defaulters' among the participating States as well as among the selected Technical Institutions is possible only if the 'preparatory' phase is followed by an implementation phase. The actual involvement and commitment of the States and TIs should be assessed during the preparatory phase and necessary timely follow up action initiated so that the implementation phase is not delayed or disrupted.

14. Strong and mutually supportive Centre-State relationships are vital ingredients for the success of such projects. Future projects should thus ensure strong Centre-State supportive linkages by enlisting and ensuring the formal commitment of the Power Secretaries in all participating States, insist on the appointment of a Senior Officer from the concerned States as the State Level Project Coordinator, and also enter into an unambiguous and clearly articulated MOU with the concerned State Government appending therein the Implementation Agreement and Power Purchase Agreements.

15. And finally since the project lays particular emphasis on women in Development and as women constitute a substantial part of the local population sought to be benefited by the project, their active participation and involvement should be ensured by the Project Authorities. Future projects of this kind must involve a significant number of

women consultants, womens NGOs and Self Help Groups, particularly during the preparatory phase of the project.

ANNEXURE I

TERMS OF REFERENCE

IMPACT ASSESSMENT STUDY-
UNDP/GEF PROJECT IND/91/G31 – OPTIMIZING DEVELOPMENT OF SMALL HYDEL RESOURCES IN THE HILLY REGIONS OF INDIA

PURPOSE OF THE STUDY :

The above project is at an advanced stage of completion with its duration extended till 31 December 2003 to ensure commissioning of all the envisaged 20 demonstration projects and to have an impact assessment study of the project. The findings of the study will assist UNDP/GEF and the Government of India to assess exhaustively the success of the project in meeting its objectives and its impact on beneficiaries. The study will also enable UNDP/GEF and the Government of India to document the lessons learnt/ best practices followed for sharing the experience within and outside the country.

The study will analyze the effectiveness of the assistance provided, technical or otherwise, in achieving the objectives and building capacities at local and national level. The study will also review the institutional, organizational and policy factors as well as human resources used for implementing and sustaining the results of the project.

PROJECT BACKGROUND/ OBJECTIVES :

The project deals with a comprehensive approach to national planning for formulating sectoral strategies and demonstrating clean technology under micro-hilly hydel sector. This approach is adopted by creating an institutional mechanism for environmentally sustainable development with a focus on enhanced productivity and income potential of the poor, especially the artisans and the women in remote areas.

The project primarily focuses to contribute to following objectives :

1) Reduction in global warming through use of renewable non-fossil fuel based energy source, i.e. small hydro energy, and emission of hydro-carbons released into the atmosphere in the hilly regions of India.

2) Controlling and reducing deforestation by providing alternate renewable energy through small hydro electric schemes in the hills ; and

The project is designed to assist the Government of India in optimum utilization of small hydel resources in the Himalayan and sub-Himalayan regions. This is to be done through setting up 20 commercially-viable small hydel demonstration projects, by upgrading the institutional and human resource capabilities from the local to national levels and finally formulating a national strategy and a master plan in this sector by developing a package of appropriate technologies and management and ownership models which are people-centred and environmentally sound. This is to be achieved by ensuring usage by the local people, of electricity for cooking, heating and other purposes instead of fuel-wood.

100 water mills in different regions are envisaged to be upgraded and developed with new technology, with add-on multi-purpose devices for electricity generation. These are to serve as prototype for upgrading the water mills in those areas.

ISSUES TO BE ADDRESSED/ EXPECTED OUTCOMES :

While assessing and reporting on the following aspects, the impact should be assessed at two distinct levels (1) sub-project or pilot level ; and (2) the overall project level. The overall impact of these activities should be categorized into areas like – economic, environment, market, social and policy. The various indicators may then be established (after pre-discussing with MNES/ UNDP) against which the impacts may be measured, e.g. (1) the environment impact would cover deforestation,. GHG emission; (2) social impacts could include the time saved, and (3) the markets could include technology and private developers.

Since there is no baseline defined in the project document for each sub-project, the baseline for each sub-project needs to be established before the impact assessment is to be undertaken.

The areas of coverage of the study are :

1) Physical progress of each sub-project, the likely dates of full commissioning, the geographic coverage of the project and to assess the feeling of ownership and sustainability of each sub-project. How successful each demonstration sub-project has been in evincing interest from the other developers, especially the private sector who can play a major role in the sector?

2) The production data of electricity in kilowatts in relation to the installed capacity of each of the sub-project and total carbon emission reduction (CER) achieved compared to the GHG emission reduction envisaged in the project document. The information should also include the quantity of CER by replacement of diesel generators, wherever applicable.

The actual electricity generated v/s. fuel-wood saving achieved should be measured using different parameters for each sub-project as defined in the Project Document. In addition, the future projections of fuel-wood saving, if any viewed and assessed on the fuel-wood usage pattern of the users (possible change in cooking habits – switch-over to electric cooking and heating) to be provided based on authenticated information.

3) Revenue generated by the demonstration sub-projects. How much revenue was generated by each sub-project and how successful would they be as an investment project? What additional barriers exist to the pilot activities being replicated on a large scale through private sector investment. Did the electricity boards make agreed upon payments in a timely way according to the contracts negotiated? If not, why not and what will be done about it post project to ensure future sustainability ?

4) Deforestation trends noticed as a result of the sub-projects and use of electricity generated from SHP for pumping of water for irrigation, with the area covered.

5) Extent of benefits derived by the number of house-holds, villages, commercial/ construction units (including diesel generating sets replacement activity), cooperatives and community units, etc. compared to the scenario before each of the sub-project started and the extent of their involvement. The general acceptance of the outputs by the beneficiaries/ local communities to be assessed.

6) Potential and number of food and wool processing units and other light industries and any specific units put up, including their impact on CER.

7) Employment generation (including persons employed in operation and maintenance of SHP) and reduction in the migration of local population (in terms of number of persons) to urban areas.

8) Advantages and impact of 3 projects (Raskat, Solang and Titang) funded out of the revolving fund. Provide full details of the outlays and payments into the revolving fund, including the default rate. How can the revolving fund be made to be fully sustainable after project completion.

9) Impact of water mills, including electricity-generating water mills. Their potential, acceptance and future usage.

10) Impact of low-wattage appliances and its potential.

11) Extent of local expertise (by gender) and indigenous technologies and resources used.

12) Project impact on the life of women by supporting and reducing the need to collect fuel-wood and other drudgery, their employment (full or part-time) and the amount of improvement in their living standards.

13) Suitability of technology selection (any innovations and adaptations taken up) in each sub-project.

14) Impact of electricity tariff charged and mechanism for collection of revenue (if and where applicable), in terms of commercial viability of each-project.

15) Environmental impact (positive and negative) and remedial action taken at each sub-project site.

16) Capacity development of key local partners, if done in a structured manner, in planning, design, construction, maintenance, operation and management of SHP in the country.

17) Awareness raising, training and workshops conducted and information sharing done to bring in replication impact.

18) Total installed capacity created of SHP in the hilly regions of the country through the above sub-projects and country as a whole, through replication activities.

19) Awareness and usage of Zonal Plan by the State Government authorities and its impact, if any, on State planning for SHP development.

20) State policy initiatives on Power Purchase Agreements and overall SHP development.

21) Feedback of developers and local implementing agencies in support of SHP development, bottlenecks and facilitation of funding support/ subsidies by the States.

22) Potential interest of donor organizations by way of commitment of funds in each participating State for the projects identified under the Zonal Plan and for SHP development in general. The details on long term sustainable funding from Central/ State Governments should also be elaborated.

23) Any underlying factors, beyond control, that influenced the outcome for each sub-project.

LESSONS LEARNT :

Significant lessons that can be drawn concerning best and worst practices in producing results, in particular anything that worked well and than can be applied to other sub-projects and anything that has not worked so well and should be avoided in future.

Any corrective actions required, if any, for the design, implementation, monitoring and evaluation of similar projects.

SCHEDULE OF STUDY :

The study will comprise of 60 days and a schedule of visits to selected sub-projects will be provided. At the end of this period, the consultant will debrief UNDP and MNES and present his/her draft report. The final report will be submitted within one month after the field work has been completed.

The consultant is open to consult all reports, files, manuals, guidelines and resource people he/she feels necessary, to make the most effective findings, conclusions and recommendations.

METHODS/ APPROACH FOR THE STUDY :

The consultant should provide details in respect of :

- Documents reviewed;
- Interviews;
- Field visits;
- Questionnaires, if any;
- Participatory techniques and other approaches for gathering and analysis of data; and
- Participation of stakeholders and/ or partners.

CONSULTATIONS :

During the period of the study, the consultant will liaise closely with the UNDP Resident Representative/ her staff, the concerned agencies of the Government, and the counterpart staff assigned to the project. The consultant can raise or discuss any issue or topic it deems necessary to fulfill his/ her tasks. The consultant, however, is not authorized to make any commitments to any party on behalf of UNDP/GEF or the Government.

REPORTING :

While the consultant is free to use any detailed method of reporting, the report must include the following :

1) Executive Summary;

2) Introduction
3) Contents;
4) Observations on the issues addressed;
5) Findings and conclusions;
6) Recommendations;
7) Lessons learnt;
8) Annexes/ documents attached;
9) List of persons met; and
10) Copy of the approved TOR.

At the end of the sixty days of study, the consultant will submit and present his/ her draft report jointly to the Department of Economic Affairs (DEA), MNES, Ministry of Environment & Forests and UNDP. Based on the discussions during the meeting, the consultant will finalize and submit the final report to UNDP, New Delhi within two weeks of presentation of the draft report.

ANNEXURE II

PERSONS MET BY IIPA TEAM DURING FIELD VISITS

PLACE VISITED	ORGANISATION VISITED	DESIGNATION OF PERSON MET BY TEAM
Shimla, Himachal Pradesh	1. HIMURJA	1. Director
		2. Other Concerned Senior Officers
	2. Sai Eng. Foundation	1. Chief Executive Officer
		2. Heads of Divisions.
Recong Peo (Kinnaur Dist. H.Q.)	1. Collectorate	1. Deputy Commissioner
		2. District Statistical Officer
Pooh Sub Division (Kinnaur Dist.)	1. Sub Divisional Office	1. ADM & PD (Watershed Project)
	2. Block Development Office	1. Block Development Officer
	3. Sub Divisional Office of HSEB	1. Sub Divisional Officer
Titang Village, Pooh Block (Kinnaur Dist.)	1. Titang SHP	1. Junior Engineer (Civil)
		2. Junior Engineer (Elect.)
		3. Operating Staff.

Kullu, Himachal Pradesh	1. Collectorate	1. Deputy Commissioner
		2. District Supply Officer
		3. District Statistical Officer
	2. District Office, HIMURJA	1. Project Officer, Himurja
Manikaran Panchayat, Kullu	1. Sub Divisional Office of HSEB	1. Sub Divisional Officer
Raskat Village, Kullu	1. Raskat SHP	1. Junior Engineer (Elect.)
		2. Junior Engineer (Mech.)
		3. Operating Staff
Manali Kullu	1. Indian Oil Corporation	1. Regional Manager
	2. Sub Divisional Officer of HSEB	1. Sub Divisional Officer
Kothi Panchayat Kullu	1. Kothi SHP & Project Office	1. Project Officer (Himurja)
		2. Junior Engineer (Elect.)
		3. Operating Staff
Dehradun, Uttaranchal	1. Department of Power	1. Secretary, Power, Uttaranchal
	2. Uttaranchal Renewable Energy Development Agency (UJVN)	1. Project Officer, (Water Mill), UREDA
	3. Uttaranchal Jal Vidyut Nigam (UJVN)	1. General Manager
Srinagar, Uttaranchal	1. Uttaranchal Jal Vidyut Nigam (UJVN)	1. Junior Engineer, UJVN
PLACE VISITED	**ORGANISATION VISITED**	**DESIGNATION OF PERSON MET BY TEAM**
Rudraprayag, Uttaranchal	1. Deputy Commissioner's Office	1. Deputy Commissioner
	2. UREDA (District Office)	1. District Project Officer, UREDA, Rudraprayag
Guptkashi, Rudraprayag Dist., Uttaranchal	1. Uttaranchal Power Corporation (UPC)	1. Junior Engineer
	2. Civil Supplies Dept. Office	1. Supply Inspector
Soneprayag Rudraprayag Dist., Uttaranchal	1. Soneprayag SHP	1. Junior Engineer (Elect.)
		2. Junior Engineer (Civil)
		3.Operating Staff
		4. Line Man (UPC) (in charge of project area)

Guwahati, Assam	1. Kalmoni SHP	1. Chief Executive MBT
		2. Junior Engineer (Elect.) Kalmoni Project
Darjeeling, West Bengal	1. Planters Club	1. Chief Executive Sycotta Tea Estate
Pussimbing, Darjeeling Dist., W.B.	1. Sycotta Tea Estate Pussimbing and SHP	1. Estate Manager
Chamong Darjeeling Dist., W.B.	1. Sycotta Tea Estate and SHP	1. Estate Manager
Solang Village	1. Solang SHP	1. Junior Engineer (Elect.)
		2. Operating Staff
Kaza, Lahul Spiti District	1. Project Office, Himurja	1. Project Officer (Himurja)
	2. Sub Divisional Office, HSEB, Kaza	1. Sub Divisional Officer
	3. Indian Oil Corporation, Kaza	1. Deputy Manager, IOC, Kaza
Lingti Village Kaza (Sub Div) Lahaul & Spiti District, H.P.	1. Lingti SHP	1. Project Officer (Himurja)
		2. Junior Engineer (Elect.)
		3. Junior Engineer (Civil)
		4. Operating Staff
Chamba Dist., H.Q., H.P.	1. Project Office, Himurja, Chamba	1. Project Officer, Himurja
		2. Accounts Officer, Himurja
	2. Dist. Supply Office	1. Superintendent, District Supply Office, Chamba
Tisa, (Sub Division) Chamba District, H.P.	1. HSEB Office	1. Executive Engineer, HSEB, Tisa Sub Division
		2. Sub Divisional Officer, HSEB, Tisa
Juthed Village Chamba District, H.P.	1. Juthed SHP	1. Jr. Engineer (Himurja)
		2. Operating Staff

ANNEXURE III

LIST OF DOCUMENTS CONSULTED BY THE STUDY TEAM

1. Project Document, UNDP-GEF Hilly Hydro Project, New Delhi,
2. Master Plan of Small Hydro Development in 13 Himalayan States, prepared by CES (Vol. I and Executive Summary), October, 2001

3. Zonal Plans of Hilly Hydro development prepared by AHEC, Roorkee, Vol. I, II & III, April, 2002.
4. Detailed Projects Reports :

a) **Solang** Project, HP (2X500 KW) prepared by Regency Hydro Engineers & Consultants, Poanta Sahib,
b) **Titang** Project, HP (900 KW) prepared by Sai Engineering Foundation, Shimla,
c) **Raskat** Project, HP (800 KW) prepared by Indusree Power Pvt. Ltd.,
d) **Lingti** Project, HP (3X200 KW) prepared by AHEC, Roorkee, February, 1997.
e) **Soneprayag** Project, Uttaranchal (500 KW) prepared by U.P.Jal Vidyut Nigam Ltd., Srinagar (Garhwal), Dec., 1999.
f) **Kalmoni** Project, Assam (2X100 KW) prepared by M. K. Bhattacharjee & Co. (P) Ltd., September, 1996
g) **Pussimbing** Project, West Bengal, (150 KW) prepared by Small Hydro Engineers Consultants (P) Ltd., Delhi, Dehradun
h) **Juthed** Project, HP (2X50 KW) prepared by Sai Engineering Foundation, Shimla
5. Sixth Monitoring Report (5-Oct-99) of Demonstration Projects prepared by AHEC, Roorkee and its latest updated version.
6. Environment Assessment Reports :

a) **Raskat** Project, HP (800 KW) prepared by Consulting Engineering Services, New Delhi, March, 2001.
b) **Titang** Project, HP (900 KW) prepared by Consulting Engineering Services, New Delhi, March, 2001.
c) **Soneprayag** Project, Uttaranchal (500 KW) prepared by Consulting Engineering Services, New Delhi, December, 2000.
d) **Kothi** Project, HP (200 KW) prepared by Consulting Engineering Services, New Delhi, March, 2001.
e) **Pussimbing** Project, West Bengal (200 KW) prepared by Consulting Engineering Services, New Delhi, March, 2001.
f) **Juthed** Project, HP (2X50 KW) prepared by Consulting Engineering Services, New Delhi, March, 2001.
g) **Soneprayag** Project, Uttaranchal (2X250 KW) prepared by Consulting Engineering Services, New Delhi, December, 2000
h) **Purthi** Project H.P. (2X50 KW), prepared by Consulting Engineering Services, New Delhi, December, 2000
i) **Sural** Project H.P. (2X50 KW), prepared by Consulting Engineering Services, New Delhi, December, 2000
j) **Kanavashram** Project, Uttar Pradesh (2X50 KW) prepared by Consulting Engineering Services, New Delhi, September, 2000
7. Pre-feasibility Reports for :

a) **Kothi** Project, HP (200 KW), prepared by Sai Engineering Foundation, Shimla
b) **Kalmoni** Project, Assam (2X100 KW) prepared by Shri S.N.Phukan Consultant, Shillong, April, 1996
c) **Chamong** Project, West Bengal(150 KW) prepared by AHEC, Roorkee, January, 1996
8. Reports on Water Mills prepared by AHEC, Roorkee :
a) Final Report on Water Mills prepared by AHEC, Roorkee, July, 2001
b) Optimizing Watermills technology in the Himalayan region of the country prepared by TERI, April, 2000
c) Progress Report on Activity Block Water Mills (Extension) prepared by AHEC, Roorkee, July, 2001
9. Capability Assessment of Indian Himalayan states for small hydro power development, prepared by TERI, March, 1996.
10. Technology Selection prepared by AHEC, Roorkee, March, 2004
11. Training, Research & Consultancy Review prepared by AHEC, Roorkee, 22nd April, 97.

12. Status Report on projects taken up in HP under UNDP-GEF Hilly Hydro Project by Himurja, Shimla.
13. Ninth Five Year Plan 1997-2002, Planning Commission, Govt. of India
14. Tenth Five Year Plan 2002-2007, Planning Commission, Govt. of India.
15. Policy on Hydro Power Development, Govt. of India, Aug., 1998
16. Detailed Product Concept Notes on Load Development, MNES, May, 1997
17. GEF Project in India, Ministry of Environment & Forest, Govt. of India
18. GEF-UNDP Guidebook, June, 1999
19. World Development Report 1999/2000, The World Bank
20. Small Hydro Power Potential in India by CEA, June, 1997
21. Draft Report on the Mid-Term Evaluation Mission, Submitted by the Mr. I.M Sahai & Dr. B.S.K. Naidu December, 1999
22. Small Hydro Power : Initiatives and Private Sector Participation, 3rd Edition, AHEC, Roorkee, 2003.
23. Work Plan : 1998 – 2003, M.N.E.S, Government of India.
24. Report on Monitoring of Execution Status of Demonstration Projects under UNDP-GEF Hilly Hydro Project prepared by AHEC, Roorkee, 20th February, 2000.

ANNEXURE IV-A

(ELECTRICITY CONSUMPTION SCHEDULE)

NO. OF UNITS CONSUMED BY SUB STATION ______________
(IN CORE AREA)

Month/Year	No. of Units Consumed by Sub Station			
	Domestic	Institutional	Commercial	Total
APRIL 1999				
MAY 1999				
JUNE 1999				
JULY 1999				
AUG 1999				
SEPT 1999				
OCT 1999				
NOV 1999				
DEC 1999				
JAN 2000				
FEB 2000				
MAR 2000				
APRIL 2000				
MAY 2000				
JUNE 2000				
JULY 2000				
AUG 2000				
SEPT 2000				
OCT 2000				

NOV 2000				
DEC 2000				
JAN 2001				
FEB 2001				
MAR 2001				
APRIL 2001				
MAY 2001				
JUNE 2001				
JULY 2001				
AUG 2001				
SEPT 2001				
OCT 2001				
NOV 2001				
DEC 2001				

Month/Year	No. of Units Consumed by Sub Station			
	Domestic	Institutional	Commercial	Total
JAN 2002				
FEB 2002				
MAR 2002				
APRIL 2002				
MAY 2002				
JUNE 2002				
JULY 2002				
AUG 2002				
SEPT 2002				
OCT 2002				
NOV 2002				
DEC 2002				
JAN 2003				
FEB 2003				
MAR 2003				
APRIL 2003				
MAY 2003				
JUNE 2003				
JULY 2003				
AUG 2003				
SEPT 2003				

NO. OF CONSUMERS/ METERS BY SUB STATION ________________

Month/Year	No. of Connections Installed by Sub Station							
	Domestic		Institutional		Commercial		Total	
	Meters	KVA	Meters	KVA	Meters	KVA	Meters	KVA
APRIL 1999								
SEPT 1999								
MARCH 2000								
APRIL 2000								
SEPT 2000								
MARCH 2001								
APRIL 2001								
SEPT 2001								
MARCH 2002								
APRIL 2002								
SEPT 2002								
MARCH 2003								

ANNEXURE IV-B

(DEVELOPER SCHEDULE)

NAME OF SUB-PROJECT -

LOCATION : STATE -

DISTRICT -

BLOCK -

VILLAGE -

1. DATE OF COMMISSIONING :

____

2. DATE OF GRID CONNECTIVITY : _________________

3(a) TOTAL COST OF PROJECT (As in DPR) :

3(b) TOTAL COST OF PROJECT (Actually Incurred):

3. Loan Taken :

i) Agency :

ii) Amount :

d) Interest rate of loan taken :

e) Time period of repayment :

f) Subsidy given by Government :

g) Private investment :
(in case of NGO or private
developer :

4. CATCHMENT AREA

No. of villages	No. of villages electrified	Total population likely to be benefited

5. Rate at which electricity is sold

a) to villagers _____________ Rs. / unit

b) to the grid ____________ Rs. / unit

6. Is there any defect in the technical devices used ?

Name of manufacturer	Defective Devices	Purchasing cost	Nature of defect

7. Number of Workers Employed in operation :

Name	Designation	Qualification	Wages paid monthly	Years of service	Local or Outside	
					L	O

Note: Local means those belonging to Project Core Area (Panchayat in which project located)

8. (a) Any awareness programmes, training, workshop conducted.

☐ Y ☐ N

(b) If Y, Name of agency/ group :

☐ Local ☐ Private ☐ Govt. ☐ NGO

9. (a) In case of private developers, has in-depth technological and financial guidance been provided ?

☐ Y ☐ N

(b) If Y, name of agency/ group :

10. To what extent are local expertise and indigenous technology and resources been used ?

11.(a) Date of Commencement of Construction (Civil) :_________________

(b) Date of Installation of Electro – Mechanical devices : ____________

(c) Date of Commissioning / First Test Run : ______________________

(d) Date of Final Commissioning : _____________________

12. PPA. (For what period) ________________

Date of Signing of PPA _________________

Cost of generation per unit Rs. _____________________

Payment for power purchased per unit Rs. _____________

13. Measures for environmental improvement

	Measures	Details	Comments
1.			
2.			
3.			
4.			
5.			

14. OPERATING HOURS

Month/ Year	**Actual Operation Hours**		**Total hours Available 24 X(No. of Days in each month)**	**Grid Failure Time**		**No. of Grid Failures (No.)**
	Unit I (Hrs.)	**Unit II (Hrs.)**		**HRS**	**MINS**	
Jan., 2001						
Feb., 2001						
Mar, 2001						
Apr, 2001						
May, 2001						
June, 2001						
July, 2001						
Aug, 2001						
Sept, 2001						

Oct, 2001						
Nov, 2001						
Dec, 2001						
Jan., 2002						
Feb., 2002						
Mar, 2002						
Apr, 2002						
May, 2002						
June, 2002						
July, 2002						
Aug, 2002						
Sept, 2002						
Oct, 2002						
Nov, 2002						
Dec, 2002						
Jan, 2003						
Feb, 2003						
Mar, 2003						
Apr, 2003						
May, 2003						
June, 2003						
July, 2003						
Aug, 2003						
Sept, 2003						

Restart time to be added to grid failure time

The average time taken to restart & synchronize with grid X No. of grid failures.

15. CAUSES OF SHUT DOWN

Month/ Year	Number of Shut Downs due to											
	Grid Failure			**Electrical & Mechanical Snags**			**Water Flow Snags**			**Maintenance**		
	No.	**Duration**		**No.**	**Duration**		**No.**	**Duration**		**No.**	**Duration**	
		HRS	**MINS**		**HRS**	**MINS**		**HRS**	**MINS**		**HRS**	**MINS**
Jan., 2001												
Feb., 2001												
Mar, 2001												
Apr, 2001												
May, 2001												
June, 2001												
July, 2001												
Aug, 2001												
Sept, 2001												
Oct, 2001												
Nov, 2001												
Dec, 2001												
Jan., 2002												
Feb., 2002												
Mar, 2002												

Apr, 2002												
May, 2002												
June, 2002												
July, 2002												
Aug, 2002												
Sept, 2002												
Oct, 2002												
Nov, 2002												
Dec, 2002												
Jan, 2003												
Feb., 2003												
Mar, 2003												
Apr, 2003												
May, 2003												
June, 2003												
July, 2003												
Aug, 2003												
Sept, 2003												

16. UNITS EVACUATED

Month/ Year	Actual Unit Evacuated			Potential Evacuation *	Plant Load Factor** %
	Unit I	Unit II	Total		
Jan., 2001					
Feb., 2001					
Mar, 2001					
Apr, 2001					
May, 2001					
June, 2001					
July, 2001					
Aug, 2001					
Sept, 2001					
Oct, 2001					
Nov, 2001					
Dec, 2001					
Jan., 2002					
Feb., 2002					
Mar, 2002					
Apr, 2002					
May, 2002					
June, 2002					
July, 2002					
Aug, 2002					
Sept, 2002					
Oct, 2002					
Nov, 2002					
Dec, 2002					
Jan, 2003					

Feb., 2003					
Mar, 2003					
Apr, 2003					
May, 2003					
June, 2003					
July, 2003					
Aug, 2003					
Sept, 2003					

* Potential Evacuation : Unit per hour for each turbine/ generator x 24 x No. of days in each month at full capacity in optimal generation.

**** Actual Units Evacuated / Potential Evacuation x 100**

ANNEXURE IV-C

Beneficiary Household Schedule (Both Groups)

1. Name of sub-project :

State:

District:

Block:

Village Panchayat:

Village:

2.

(B) Social Status of family : SC ☐ ST ☐ Others ☐ ☐

(C) Economic Status : Below Poverty line ☐ Above Poverty line ☐

3 (A) Family Profile & Occupation :

Name	Age	Sex	Education	Occupation	
				Primary Occupation	Supplementary Occupation

Code : Sex: (1) =Male (2) = Female

Education: (1) = Illiterate (2) = 0-5 Standards (3) = 5-10 Standards

(4) = Above 10 Standards (5) = Technical Qualifications

Primary & Supplementary Occupation

(1) = Agriculture Labour (2) Non Agriculture Labour (3) Farmer

(4) = Animal Husbandry (5) = Craft/ Artisan (6) Service

(7) = Project Related Service (8) = Unorganized Rural Service

(B) Homestead & Dwelling Profile :

Type of Dwelling	Area	Ownership Of land	Separate Kitchen	Latrine	Is latrine Illuminated

Code:

Type : (1)=Kuccha (2)=Semi –Pucca (3)= Pucca

Area : (1) Small (2) Medium (3) Large

Ownership : (1)=Owned (2)=Leased
Latrine & Kitchen : (1)=Yes (2)=No

(C) Non-farm Activities Income Profile :

Non –Farm Activities	**Earnings/ Year (Rs)**	**Method of Sale ***
Food processing		
Tool making		
Weaving		
Bamboo work		
Carpentry		
Blacksmith		
Fishing		
Bee-Keeping		
Pottery		
Shoe mending		
Tea-Stall / Vegetable Shop		
Kiryana / General store		
Floriculture		
Family wage labour		

Code:
* **(1) Locally sold in village market (2) Exported in distant market**
(3) Self sale (4) Through trader / agencies

4. Agricultural land holding & crop grown :

Total land area for agriculture : ______________(in bighas)

5. Monthly Income of household : ____________ Rs./ Month

6. Monthly Expenditure of household : __________Rs./ Month

Monthly Expenditure Details of Household :

Item	**Expenditure (Rs)**
1. Food (monthly)	
2. Education (monthly)	
3. Medical Exp. (Annually)	
4. Non Durable Consumer Goods (monthly)	
5. Durable Consumer Goods (Annually)	
6. Other Bills Paid (specify period)	
Total	

7. Fuel Consumption Profile :

Name of fuel	Purpose	Monthly Consum-ption	(P) / (C) *	Landed cost per ltr / kg / qt or Imputed cost at Market Price	Time Taken to procure
Fuel wood					
LPG					
Kerosene					

Diesel					
Petrol					

Code :* P= Purchased C=Collected

8. Electricity Consumption Profile :

(A) House Electrified : ☐ Yes ☐ No

(B) Electrical Appliances Used :

Appliances	*Quantity* (in no.)		Total Wattage		Mode of Procure.*	If Subsidised / free (specify by whom)
Bulbs/Tube						
Radio/Tape recorder						
TV (B/W or Colour)						
Cooking Heater						
Immersion Rod/ Water heater/Geyser						
Room Heater						
Electric Iron						
Mixi / Grinder						
Water Pump						

Code: C= Conventional L=Low Wattage
* (1)= Purchased (2) = Subsidised (3) Free

(C) Have you faced any problem during operation of these devices ?

☐ Yes ☐ No

If yes, Please specify ______________________________

(D) Commercial / Occupational usage of electricity : ____

Code: * (1)=yes (2)=NO

(E) **How long is electricity available during a day ? _____ Hrs.**

(F) **Does voltage keep fluctuating ?** ☐ **Yes** ☐ **No**

9 (A). **Billing details of household :**

Is Supply Metered *	**Is meter in Working Condition** *	**Avg. No. of Units Per Month (Check from Bills)**	**If Unmetered Standard Payment (in Rs)**	**If Unpaid** *

Code : * **(1)=Yes** **(2)=No**

(B) **Does anyone come to take the meter reading ?**

(C) **What is the charge of electricity per unit ? Rs/ Paisa.** **Per unit.** ________

(D) **Do you feel that the rate of electricity is :**

Reasonable **High** **Don't Know**

(F) **Do you pay the bills regularly ?** **Yes** **No**

(G) **If no, Why ? (specify)** ____________________

10. **Impact of Electricity :**

(A) **If Household have TV/Radio , Usage of TV / Radio.** ______

Code : * **(1)=Yes** **(2)=No**

(B) **In what way do your children benefit from the use of electricity :**

(I) **Education / Awareness**

Significant **erate** **Insignifica** **dversely**

(ii) **Health**

Significant rate cant Adv

(iii) More Study Time / School Performance

Significant Moderate Insignificant Adversely

(C) In what way do women benefit from the use of electricity (Specify)

(i) Education / Awareness

Signific Mode Insignifi Adverse

(ii) Health

Signif Mode Insignifi Adverse

(iii) More Working Time

ificant *te* *cant* *ly*

(D) Health Problem faced

1. Respiratory Ailments e Mild No Cor
2. Water Borne Ailments e Mild No Cor
3. Eye ailments e Mild No Cor

11(A). Has any member of the family worked on the project site ?

Yes ☐ ☐

(B) If Yes, In what Capacity

Name	Age	Sex	Nature of Work	Permanent/ Temporary *	No. of days	Payment received per day

Code: * (1) Permanent (2) Temporary

		Yes	No
(C)	If worked, any injuries caused on project site ?	☐	☐
(D)	If yes, were you compensated ?	☐	☐

12(A). Have any members of the HH migrated out of village ? Yes ☐ ☐

If yes, No. of Members migrated : _____

(B) Have any members of the HH immigrated out of village ? ☐ ☐

If yes, No. of Members immigrated : _____

ANNEXURE V-A

BRIEF CURRICULUM VITEA

Name : ANIL CHANDY ITTYERAH

Address	:	Indian Institute of Public Administration I.P. Estate, Ring Road, New Delhi.
Telephone	:	Office : 011-23702400 Res : 011-27318974 Mobile : 9868211009
Email	:	ittyerah@bol.net.in
Educational Qualification	:	M.A. (Economics), Ph.D.
Present Designation	:	Professor of Economics
Additional Positions Held	**:**	**Chairman : Centre for Rural Development** Administration, IIPA.
	:	Chairman : Centre for Economics Analysis and Financial Management
Nature of Present Assignment	:	Teaching / Training / Research/ Consultancy Coordination and Direction of National Seminars, Workshops, and Advocacy Programmes.
Year of Research/ Teaching Experience	:	25 years
Areas/ Subjects of Interest	:	Economic Theory; Environmental Economics; Linear Models and Applications; Research Methods; Economic Administration Related to Food Security; Poverty Alleviation; Employment; Agricultural Diversification; Infrastructure Development; Integrated Natural Resource Management,(Fresh Water Reservoirs in India); Non Conventional Energy and Livelihoods;

Major Research Projects Completed :

- National Evaluation of the Public Distribution System (Sponsor : Government of India, Ministry of Food and Civil Supplies)
- Supply Logistics for Essential Commodities: An Impact Study of the Mobile Van Scheme in Rajasthan. (Sponsor : Ministry of Food and Civil Supplies)

- Turnaround Plan for the UP Essential Commodities Corporation.
  (Sponsor : Govt. of Uttar Pradesh, Essential Commodities Corporation Ltd.)
- Integrated Natural Resource Management : A Case Study of the Tawa Matsya Sangh, Kesla, M.P.)
  (Sponsor : IIPA, New Delhi)
- Collective Approaches to Poverty Alleviation : A National Evaluation of the Swarnjayanti Gram Swarozgaris Yojna.
  (Sponsor : Govt. of India, Ministry of Rural Development)
- Impact Assessment of Rural Development Programmes in Kangra District, Himachal Pradesh.
  (Sponsor : Govt. of India, Ministry of Rural Development)
- Impact Assessment of the Hilly Hydro Project of the UNDP/GEF.
  (Sponsor : Govt. of India, Ministry of Non Conventional Energy Sources)
- Concurrent Evaluation of the Swarn Jayanti Grameen Rozgar Yojana (SGRY) : The Functioning of Wage employment Programmes in 15 Districts of Rajasthan.
  (Sponsor : Govt. of India, Ministry of Rural Development)

Research Projects Proposed /Planned and

Under Negotiation :

- **Integrated Natural Resource Management : A Study of Fresh Water Reservoirs in India.**
  (Likely to be Sponsored by Ministry of Water Resources, Govt. of India.)
- National Impact Study : The Implementation of the Drug Control Order
  (Likely to be Sponsored by Govt. of India, Dept. of Chemicals and Petro-Chemicals)
- Impact Study of Rural Development Programmes in Some Selected Districts.
  (Likely to be Sponsored by Ministry of Rural Development, Govt. of India.)
- National Validation Study of Status of Rural Drinking Water Supply Programme of the Govt. of India.
  (Sponsor : Dept. of Drinking Water Supply/ Rajiv Gandhi Mission, Govt. of India)

- Base Line Studies related to the UNDP Programme in Non Conventional Energy and Livelihoods. (Likely to be Sponsored by Ministry of Non Conventional Energy Sources)

Training Programmes Designed and Conducted : Apart from several training programme designed and conducted on subjects related to Food Security, Natural Resource Management, Development Administration and Rural Development, have been teaching regular courses on Economic Theory, Development Economics and Rural Development in the Advanced Professional Programme in Public Administration.

(Prof.(Dr.) Anil Chandy Ittyerah)

24th November, 2004
Indian Institute of Public Administration
New Delhi-110002

ANNEXURE V-B

SUPPORT TEAM CREDENTIALS

NAME	QUALIFICATIONS	RESEARCH EXPERIENCE
1. Ms. Rajni Choudhary	Msc. (Maths), Dip. in Computer Application	3 years as Research Assistant in NCAP, PUSA Institute, New Delhi 3 years as Research Associate in IIPA, New Delhi
2. Mrs. Sangeeta Narang	M.A. (Sociology), Dip. in Computer Application	5 years as personal Assistant to Project Coordinator, MNES 2 years as Research Assistant, IIPA, New Delhi
3. Ms. Shikha Choudhary	M.A. (Economics)	Nil.

ANNEXURE V-C

Prof Subhash Chander F.N.A.E

Tel. (+91 11) 26286516 : (M) 31056611

Date of Birth : 29th April, 1937

Education : B.Tech(Hons)(Civil Engineerimng);M.Tech(water Power and Dam Construction);Ph.D. (Hydrology)

First Stint as Teacher, Researcher, Consultant

Employment record	*Dates*	*Employer*	*Position*
	14 Aug 1961-30 Jun 1997	*IIT Delhi*	*Faculty*
	01 Jul 1997-01 Nov 1997	*IIT Delhi*	*Emeritus Fellow*

Projects	15 Doctoral Projects and 20 Consultancy Projects in Hydrology and Water Resources
Publications	Have published more than 80 papers in proceedings of major journals in the area of Hydrology and water Resources.
Affiliation	Life Member Indian Association Of Hydrologists
Awards, honors, distinctions, membership of important committees, etc.	. 1.Elected Fellow Of Indian National Academy of Engineering in 1990. 2.Bharat Singh Awardee 1995 for outstanding contribution to Research in Hydrology By Ministry Of Water Resources, National Institute Of Hydrology Roorkee 3.Member STAC-WR Min. Of Water Resources for last 10 years. 4.National Representative International Association Of Hydrological Sciences 5.Member Indian National Committee of IUGG

Second Stint as Mentor since 1997

1. Advisor, Teri School of Advanced Studies New-Delhi -A Deemed University
2. Advisor, Interstate Water Resources: Department of I.C &A.D. Govt. Of Andhra Pradesh
3. Member -Expert Group ;Interlinking Of Rivers Project ; Ministry Of Water Resources New-Delhi
4. Member –Coca Cola India Environment Advisory Council