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Final Report:

Micro Hydro Power Resource & Services Center in Chitral, Pakistan (MRSC)

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In cooperation with

Micro Hydro Power Resource & Services Center in Chitral, Pakistan (MRSC)

Pakistan

Final Report

March 2019

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Abbreviations

ADB	Asian Development Bank
AKRSP	Aga Khan Rural Support Program
ELC	Electronic Load Controllers
EU	European Union
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
HYCOM	Hydropower Competence Centre in Bandung, Indonesia
KPK	Khyber Pukhtoon Khwa (province in northwest Pakistan)
MHP	Micro Hydro Power
MRSC	Micro Hydro Resource and Service Center
MSU	Mobile Service Unit
O&M	Operation and Maintenance
PPAF	Pakistan Poverty Alleviation Fund
REPIC	Renewable Energy & Energy Efficiency Promotion in Intl. Cooperation
SRSP	Sarhad Rural Support Program

1. Summary

Chitral is Pakistan's most land locked district with a population of about 500,000. The district has been suffering from very limited access to basic services. In the past 25 years efforts have been made to develop Chitral's huge hydropower potential. In this period more than 500 micro hydro power plants (MHP) have been built. Most MHPs built prior to 2009, are poorly designed, are operated by barely trained personnel, and, as a consequence, are characterized by frequent down times and unreliable electricity supply. Systematic maintenance and repair services were not locally available prior to this project. The objective of this project was therefore **to improve the reliability and sustainability of power production from MHPs through the introduction of locally available systematic training and Operation and Maintenance (O&M) services.**

The concept developed to attain the objective consisted of the setting up a MHP Resource and Service Center (MRSC) in Chitral town. The MRSC consists of a mechanical workshop for major repair and overhaul works and hosts training facilities for regular operator trainings. For on-site repair works the MRSC was to be equipped with a mobile service unit. To achieve financial sustainability independent from donor funding, a commercial business model was chosen. Communities operating MHPs were expected to pay appropriate fees for training and service products. Prior to the project, the national project partner had already invested in a workshop and a spare parts shop and made these assets available as its own contribution and basis to develop MRSC.

The project has delivered a technical study of 50 MHPs based on which a detailed business plan for MRSC was elaborated, the infrastructure of the MRSC was extended, training materials were developed, and several information and awareness raising events were carried out. Unfortunately, the local project partner withdrew most of its resources from Chitral after winning a tender to build 99 MHPs in Mansehra, Abbottabad and Battagram districts of KPK. As a result, the objective of establishing an economically sustainable network of maintenance and repair services in Chitral was not achieved. However, similar objectives were achieved in the project region of the aforementioned 99 MHPs: The training materials are being used to train MHP operators; and for O&M, a system based on the MRSC concept was set up.

The main sustainable impact the project is that it has increased the awareness about the usefulness of O&M services which triggered a momentum that may eventually lead to sustainable service provision for MHPs in Chitral and other regions.

The main lesson learned is that **O&M networks should be managed by companies specialized on maintenance services.** MHP developing companies/contractors seem not be the right stakeholders to operate a maintenance network. Their corporate culture is different: they spend most energy on acquiring and implementing new projects. Although they wished to also operate a maintenance network, reality shows that they always give priority to MHP development when their work capacity becomes tight. For the operation of a service network it will therefore be better to partner with companies whose main product is maintenance (existing or new service companies, mechanical/electronics repair workshops).

GFA Entec has put a lot of effort into finding a replacement partner for the implementation of a service network. Fortunately an MHP trainer, who was also involved in this project, decided to start his own business and open a workshop in Chitral for the maintenance of cars and MHPs. We believe we have found the right person and find the combination with car maintenance to be very promising business model. Provided we could acquire additional funding, we would be interested to accompany the courageous young entrepreneur in setting up his company and support him both technically and financially.

For more impacts, lessons learned and interesting project opportunities kindly refer to the other chapters of this report.

2. Starting Point

Background and Problems Faced

Chitral is Pakistan's most land locked district. The total population is about 500,000. The district has been suffering from very limited access to basic services like education, health, road access and electricity. Since the 1990s more than 250 micro hydropower (MHP) plants have been constructed. In recent years, construction activities accelerated with more than 100 projects currently being implemented.

Most MHPs built prior to 2009, are poorly designed, are operated by barely trained personnel, and, as a consequence, are characterized by frequent down times and unreliable electricity supply. Systematic maintenance and repair services did not exist and carrying out repairs could take weeks or even months.

3. Objectives

The objective of the Micro Hydro Resource and Service Center (MRSC) was to establish a service and training infrastructure which can be used by communities to fill the gaps required for sustainable O&M. MRSC specifically aimed at **improving the sustainable operation of MHP plants by providing economically sustainable maintenance and repair services**. To achieve financial sustainability independent from donor funding, a business-like management setup was chosen for MRSC which was expected to provide its services on a commercial basis. Communities operating MHPs were expected to pay appropriate fees for training and service products. Services were to be priced competitively and provided in a professional way to be attractive for MHP communities.

4. Project review

4.1. Project Implementation

Approach

The core of this project was the setting up a MHP Resource and Service Center in Chitral (MRSC). The MRSC consists of a fully equipped workshop required for major repair and overhaul works of MHP equipment. The center also hosts training facilities for regular operator trainings and refresher courses. Besides trained technicians at the MRSC, it was planned to establish 6 to 8 remote service points from where local technicians would provide preventive maintenance and basic repair services in a defined sub-district. MRSC manages a stock of key spare parts to significantly reduce downtimes. For on-site repair works the MRSC was to be equipped with a mobile service unit to be called in from remote service points based on requirement. Operator trainings and services were to be provided on a financially self-sustaining basis. Figure 1 visualizes this approach.

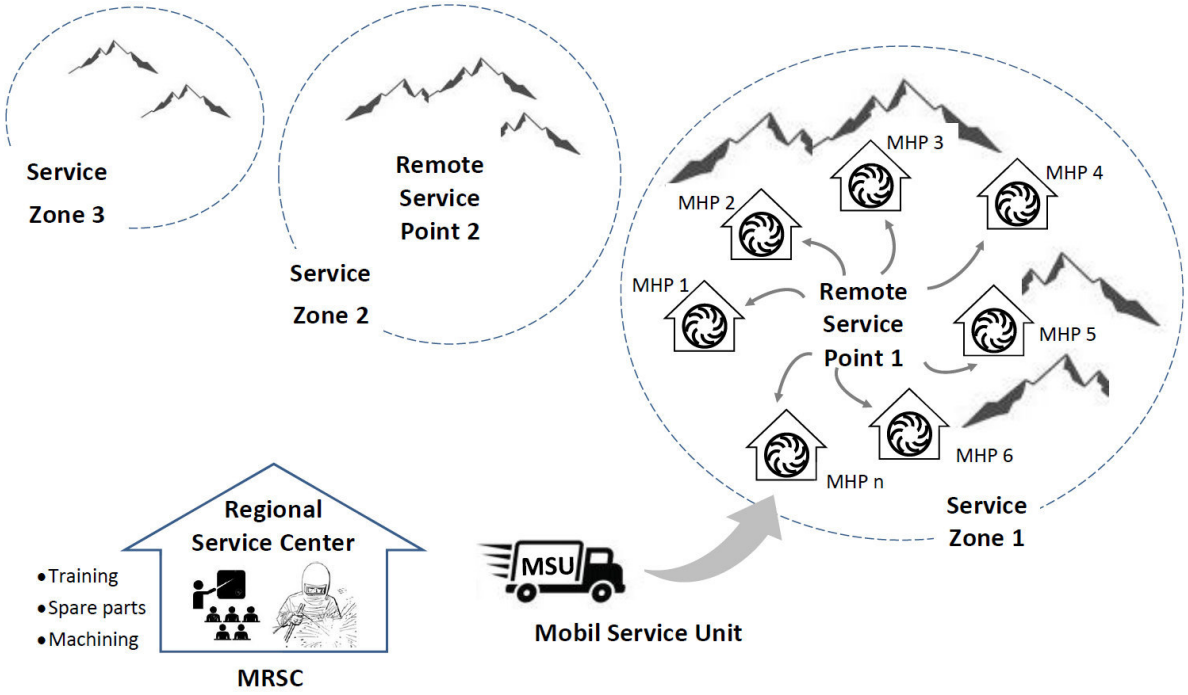
Partners

The project was implemented by GFA Entec and Hydrolink Engineering & Equipment (Hydrolink), a turbine manufacturing company located near Islamabad.

GFA-Entec had been involved in developing Pakistan's MHP sector by providing technology transfer services since 2009. Hydrolink was one of the beneficiaries in those technology transfer measures. Until, today Hydrolink has emerged as the most productive MHP equipment manufacturer in Northern Pakistan.

GFA Entec was in charge to provide technical support and conceptual advice, to support the development of a business plan, contract templates and training modules. Hydrolink was in charge to coordinate local project implementation, translate training modules in Urdu and to operate MRSC.

Figure 1 The Private Sector Operated MHP Service Network in Chitral Pakistan



(Source: own diagram)

Figure 2 Hydrolink's existing Infrastructure in Chitral Town

Project Financing

The project received financial contributions from REPIC and WISIONS and in-kind contributions from Hydrolink. The building to host MRSC was already constructed by Hydrolink prior to this project and the largest part of the workshop machinery and the stock of spare parts had been purchased. Under the project, additional workshop machinery was to be purchased and the furnishing of the training room to be carried out including computers and audio visual facilities. GFA Entec also contributed in the form of unpaid working days. The original budget included 35 international expert days. One additional unplanned field visit to Pakistan and the search for new partners required 25 additional expert days.

Main steps in project implementation

The project implementation was divided into 7 different steps as shown in Table 1. The project sponsors, REPIC and WISIONS, grouped these step under different milestones or phases, respectively. To avoid any confusion the reporting about achievements in the next Chapter will follow the Project Implementation Steps and not the different milestones.

Table 1 Project Implementation Steps

Implementation Steps	REPIC *Milestone*	WISIONS *Phase*
1. Project Launching Workshop	-	-
2. MHPs Technical and Economic Assessment	1	1
3. Developing a Business Plan for MHP Resource and Service Center (MRSC)	1	1
4. Setting up MRSC Infrastructure	2	1
5. Development of MHP Resource Materials	2	1/2
6. Training of MHP Operators and Technicians	2/3	2/3
7. Installation and Operationalization of Electronic Load Controllers (ELCs)	2	2
8. Project Successes and Lessons Dissemination Workshop	3	3

The MRSC project officially started in March 2016 when contracts were signed with the co-funding institutions REPIC and WISIONS. New visa requirement by Pakistan delayed the first field visit by Thomas Meier which finally took place from Sept. 1 to 6, 2016. The visit marked the start of the project.

1. Project Launching Workshop

The planned project launching ceremony in Chitral was postponed until MRSC was operational. It took place in on October 16, 2017 at Injigan Hotel in Garam Chashma.

The launching workshop was attended by around 40 people consisting of MHP operators, Leaders of MHP management committees, and village elders. The concept of MRSC and its services were explained which was highly welcomed by the participants as reflecting a real need. A young local entrepreneur operating a small workshop in Garam Chashma also participated and offered himself as Service Point Technician.

Figure 3 Project Launching Workshop in Garam Chashma

2. MHPs Technical and Economic Assessment

The preparation works and questionnaire development took place during the first field visit of Thomas Meier. In October 2016, the study manager, Mr. Sajad Ahmad, together with local enumerators conducted interviews at 50 MHP locations. The results from the questionnaires were carefully transcribed and entered into an excel database. The field data were then analyzed by Thomas Meier and interpreted in a study report. The draft report was revised and improved based on the results of several skype conferences between Thomas Meier and Sajad Ahmad.

The technical study has shown that the proposed preventive service package is relevant. Respondents would all be willing to buy a subscription and found the prices appropriate. Due to low fluctuations among MHP operators, the demand for basic operators training from existing MHPs was found to be limited in terms of numbers of trainings needed. The income perspective of MRSC from such services therefore had to be lowered. The need for training, however, is still imperative.

The assessment of technical issues and how these were handled by MHP committees showed that most funds had to be spent on repairing civil works. Suggestions provided by MHP committees therefore also emphasized improvements/reinforcements of civil works but also other fields such as improved billing systems and administrative training of management committees.

The Technical Study report is attached to this progress report in Annex A.

3. Developing a Business Plan for MHP Resource and Service Center (MRSC)

Based on the results of the Technical Study, a business plan was compiled. The technical study provided the required market information to fine-tune service packages. Detailed market size and cost calculations were made to define appropriate product and service prices. Sales forecasts were made for each product using pessimistic assumptions. Based on the sales forecast and a possible staffing plan an income statement was prepared for the first three years of operation.

4. Setting up MRSC Infrastructure

As mentioned earlier, the MRSC building, including workshop and spare parts shop already existed at the beginning of the project. It was planned to purchase additional machinery, a mobile service unit and to furnish the training room including computers and audio visual facilities.

Training facilities

The office and training room have been fully furnished and, computers, printers, and audio-visual equipment have been installed. The project contributed to the furniture, equipment, and the completion of the training rooms (which were still bare brickwork at the beginning of the project).

Figure 4 Office and Training Room on second floor of MRSC

Mobile Service Unit

For on-site repair works, the MRSC has been equipped with a Mobile Service Unit (MSU) built on the chassis of a four-wheel-drive vehicle capable of reaching the remotest MHP location. For this purpose an old vehicle was purchased and was completely refurbished in a specialized workshop near Islamabad. The project contributed a part of the cost of purchasing the vehicle and refurbishment works.

Figure 5 Mobile Service Unit before and after refurbishment

Welding Plant

Since the machining workshop could not have been put in operation due to insufficient electric power, the purchase of a milling machine was cancelled. The available funds were reallocated to support the establishment of a welding plant next to the MRSC building which was not part of the original budget.

Figure 6 MRSC Welding plant

5. Development of MHP Resource Materials

In the course of the project two essential training manuals were developed for:

i) **Basic Operator Training** - a one-week training consisting of theoretical and practical learning units for future MHP operators. The training imparts basic knowledge about hydropower, the components of a power plant, starting and shutting down a plant, key factors to monitor during operation, basic maintenance and repair works. Based on the English version of the manual, an Urdu version was prepared.

ii) a training for advanced MHP operators and technicians on the subject of **Business Operations**. This training manual focuses on the time after commissioning of a MHP, i.e. the operational phase which is expected to continue for several decades. Operating a MHP has similarities to operating a small business. This training manual therefore addresses the following topics:

- MHP Management Institutional set up
- Key Personnel
- Tariff Policy & Cash Flow Analysis
- Payment & Rate Collection Schemes
- Accounting
- Technical Options for Productive use
- Marketing of Products & Challenges

MHP technicians having a good understanding of these non-technical issues will contribute to more sustainable plant operation.

6. Training of MHP Operators and Technicians

The training manuals are regularly being used in MHP operators training. The following list shows where the training sessions took place and how many operators participated.

-Mastuj (Chitral)	September, 2017	5 Participants
-Swat (Buner, KPK)	July, 2017	4 Participants
-Swat (Ashuran, KPK)	March, 2017	8 Participants
-Abbotabad (Punjab)	October, 2016	63 Participants
-Taxila (Punjab)	September, 2016	16 Participants
-Dir (KPK)	August, 2016	21 Participants

The above trainings were mainly implemented and financed under different MHP projects funded by the Pakhtunkhwa Energy Development Organization (PEDO) of the Government of Khyber Pakhtunkhwa. Hydrolink also trained five Technicians at its central workshop location in Taxila. These technicians have the capacity to work as service point technicians as foreseen in the MRSC concept. But these trainings were also financed from PEDO programs.

In the course of the project, no financial resources were spent on the planned operator and technician trainings to operationalize the service network. For an explanation see chapter 4.2.

7. Installation and Operationalization of Electronic Load Controllers (ELCs)

An ELC was installed in a MHP located in Reshun Village having a installed capacity of 200 kW. The MHP is situated at a distance of 35 km from the MRSC Training center in Chitral town. The MHP is suitable to be visited for practical training since is easy accessible by road and is located in a safe environment.

8. Project Successes and Lessons Dissemination Workshop

A specific workshop to inform about project successes and lessons learned did not take place, but six workshops were conducted in the remote valleys of Chitral during the second visit of Thomas Meier in October 2017 to promote the idea of MRSC and the services offered. Everywhere, similar experiences were made as during the launching workshop. Village representatives expressed their gratitude that we have established and service network which would very much make their lives easier by saving them much time and money.

Figure 7 Impressions from MRSC Promotion Workshops

4.2. Disappointing and encouraging developments

The implementation of MRSC was strongly affected by a number of changes in 2018. The national project coordinator and the Master Trainer for MHP operator trainings resigned from Hydrolink. Hydrolink in turn won a tender for the construction of 99 MHPs in Mansehra (26), Battagram (38) and Abbottabad (35) districts of Northern Pakistan which has completely absorbed their personnel capacities. Hydrolink was not able to replace the outgoing staff with new personnel to finalize the MRSC project.

We were informed that Hydrolink is under severe time pressure to complete the 99 MHPs on time to avoid penalties. For this reason, virtually all of the Chitral personnel were withdrawn and transferred to various MHP construction sites in stated districts. The only facility which is currently operational at MRSC is the spare parts shop.

The training manuals developed under this project and the refurbished mobile service unit are being used by Hydrolink in this large scale MHP development project. Hydrolink informed us that 65 of 99 MHPs had already been commissioned at the end of 2018. They said they are applying an O&M concept similar to MRSC. Because of the proximity to the project region, their own workshop in Taxila can function as a resources and service center.

Hydrolink has agreed that a different partner should be selected to establish and operate the service network in Chitral since their capacities will remain absorbed for a longer period. GFA Entec has spent considerable time to identify alternative partners that would be suitable to take over the role of Hydrolink. At first, we were in direct contact with Aga Khan Foundation (AKRSP), which has built most MHPs in Chitral since the 1990s. Initially, they were highly interested in cooperating with us but later it turned out that they have some ongoing business relationship with Hydrolink which is why they did not want to take over an operational function. However, they would be interested to buy the services form MRSC.

Since several months we have been in contact with the above mentioned Master trainer, Mr. Umar Ali Shah. He had resigned from Hydrolink because he wanted to start his own company in Chitral town focusing or servicing different kinds of machinery, including also MHP equipment. Mr. Shah has worked for Hydrolink for six years as MHP design and production engineer as well as supervisor for testing and commissioning of MHPs. He regularly delivers lectures and conducts practical sessions during MHP Operator Training workshops. In 2016, he participated in a Teachers' training for MHP technicians at HYCOM[1], Indonesia organized by GFA Entec. Since then he has given block courses for future MHP technicians at the vocational training center in Mingora, KPK.

Mr. Shah's workshop in Chitral is a joint initiative with a friend who is doing repairs and maintenance of automobiles. He believes that this broader focus on car and MHP maintenance will offer more continuity and has therefore a greater chance of success and sustainability. He has already completed several repair missions to remote MHP sites in Chitral and received payment directly from the communities. In Garam Chashma he is cooperating with a local technician involved in local repairs and maintenance of MHPs in different valleys.

We take a positive view of recent developments. It seems that the current constellation with a workshop specialized in maintenance managed by a well experienced and motivated MHP Technician and Trainer offers the better foundation for implementing the MRSC concept as compared to a MHP turbine manufacturer and site developer (see also lessons learned).

[1] The establishment of HYCOM was co-funded by REPIC and impleted by Entec. GFA Entec is a shareholder of HYCOM.

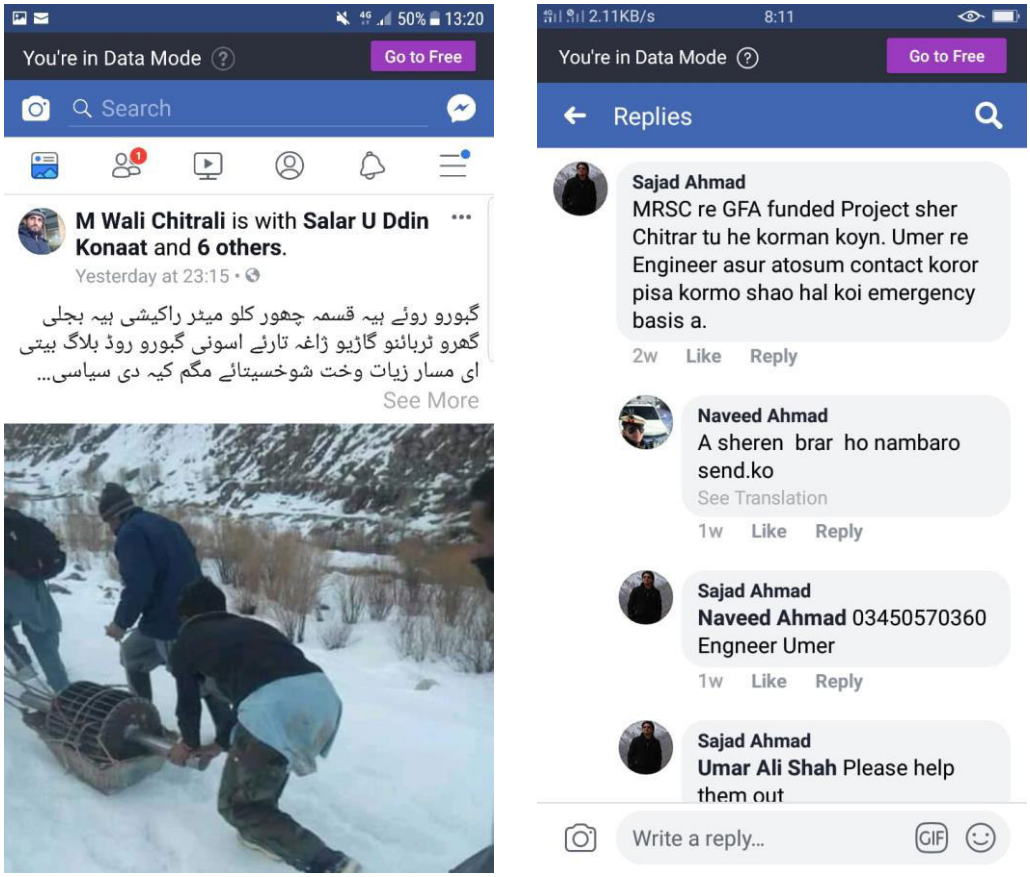
4.3. Achievements of Objectives and Results

The project has delivered the individual outputs of the project: A technical study and a business plan were elaborated, the infrastructure of the MRSC was extended, training materials were developed, and several information and awareness raising events were carried out. However, the project did not manage to have the business plan implemented by the project partner in Chitral. As a result, the objective of establishing an economically sustainable network of maintenance and repair services in Chitral was not achieved.

However, similar objectives were achieved in another region, which was not intended: The project partner withdrew most of its resources from Chitral to build 99 MHPs in Mansehra, Abbottabad and Battagram districts of KPK. The training materials are used to train MHP operators; and for O&M, a system based on the MRSC concept was set up.

The awareness raising events in Chitral also seem to have had an effect. The remote valleys are nowadays well covered by mobile phone networks. There is a lively exchange via social media about operational problems with MHPs. MHP communities complain about poor performance by contractors and demand O&M services. Via social media, service providers (such as Mr. Shah described above) can contact the communities directly and organize the necessary repair work.

Figure 8 Social Media facilitating access to MHP O&M services



4.4. Multiplication / Replication Preparation

As mentioned in the previous chapter, the approach has been implemented in Manshera, Abbottabad and Battagram districts of KPK.

We were informed that the Sarhad Rural Support Program (SRSP) which recently completed 46 MHPs in the District Upper Dir (funded by EU, PPAF and other donors), would be interested to apply the MRSC concept for O&M of their MHPs. In order to pursue this opportunity seriously, however, we would have to arrange another visit to Pakistan, for which we have no funds.

Thomas Meier presented the MRSC concept at two events in Afghanistan organized by ADB and GIZ, respectively. These presentations raised the attention on sustainability issues of MHP and other renewable energy schemes. GIZ contracted Thomas Meier to conduct large scale studies to investigate into sustainability issues of 600 MHPs in Badakhshan and to develop a sustainability plans to improve the current situation. Based on this study GIZ has prepared a project proposal for the rehabilitation of 100 MHPs and the introduction of sustainable O&M services. The funding decision, however, has not yet been taken by GIZ headquarters.

4.5. Impact / Sustainability

Which impacts were already noticeable up to the end of the project?

Increased awareness about O&M services and concepts

From our point of view, the project has achieved the greatest impact in the area of awareness raising, both among the MHP communities and on the donor side. The O&M issue was often bemoaned in Chitral and other regions, but there were no clear concepts on how to address the problem. The various information and promotion events under this project have contributed to bringing our concept for sustainable O&M services closer to a broad and directly affected section of the population. As it turned out, this information has quickly spread throughout the region via the emerging social media. In this way, a direct link between MHP communities and service providers could also be established. This exchange of information will not flatten out again, but on the contrary will increase in intensity and involve more and more MHP communities in the future.

In addition to this, Thomas Meier also participated in the REPIC-Community of Practice on Mini-Grids where he presented the MRSC concept and prepared a publication about the topic (see NEXUS Brief, No.4/3027).

In conclusion, we are confident that the project has made an important contribution as it has increased the awareness about the usefulness of O&M services which triggered a momentum that may eventually lead to sustainable service provision for MHPs in Chitral and other regions.

Suitable Training materials are available and being used

The training materials developed under this project are currently mainly used outside the project region in Chitral. However, the manuals are meanwhile also known to most local and international donor organizations in Pakistan's MHP sector. Mr. Umar Ali Shah, who acts as MHP Service Provider in Chitral, was involved in the development of the manuals and has in mind to use them when he gets training assignments. We are therefore convinced that in the future the manuals will be used more and more in the Chitral region as well as in other regions in Northern Pakistan.

The MSU is being used diligently for MHP Development and O&M in other districts

The MSU which was refurbished under MRSC is well equipped with MHP related tools and equipment. It is in daily use, providing services to 65 MHPs constructed by Hydrolink in the above stated 03 districts of KPK.

5. Lessons learned / Conclusions

O&M networks should be managed by companies specialized on maintenance services

This is one of the most important lessons learned in this project: MHP developing companies/contractors (such as. Hydrolink) seem not be the right stakeholders to operate a maintenance network. Their corporate culture is different: they spend most energy on acquiring and implementing new projects. Although they wished to also operate a maintenance network, reality shows that they always give priority to MHP development when their work capacity becomes tight. For the operation of a service network it will therefore be better to partner with companies whose main product is maintenance (existing or new service companies, mechanical/electronics repair workshops).

The introduction of commercial services for MHP communities is not easy in a market strongly distorted by subsidies

A sustainable O&M service network can only be achieved if sustainable financing is available for these services. For this reason, the MRSC concept is based on commercially provided services, which allows services to be provided independently of donor financing.

The Chitral region has a high presence of national and international donors who provide practically all services free of charge for the recipients. Our concept, where MHP communities should pay for O&M and training services, was therefore initially incomprehensible to many. The easiest part was to convince people that repair services should be paid for, as there has been little donor support in the past. In the area of training services, however, it is hardly possible to establish a self-financed system. Especially when the training in the classical sense is carried out in a centralised training location far away from the villages. The MHP communities are usually not in a position to cover the associated high logistical costs. Training services must therefore be brought to the MHP communities if they are to be provided sustainably, for example embedded in a regular O&M visit by a MHP technician.

MHP projects should pay more attention to the demand side

The field visits have shown that rural electrification in Chitral is still strongly supply-oriented. The design of the mini-grids takes the aspects of electricity use either not at all or too little into account. Training measures in which the topic could be dealt with are usually budgeted, but are rarely actually carried out.

In some villages it turned out that apart from lighting, mobile phone charging and the operation of irons, practically all other applications were prohibited. The available capacity of the equipment was therefore not exploited in many cases. In general, the focus is too much on MHP development and too little on rural electrification including productive end-use.

Building a small hydropower plant is easier than making sure that the electricity is used wisely. In the future, the donor community should devote more attention to the difficult questions of electricity end-uses.

Social media can increasingly be used in isolated areas

At the beginning of the project, the isolated valleys in Chitral were not well connected to the mobile network. However, this coverage has steadily improved over the last two years, and the use of smartphones has increased considerably. Since many MHP communities struggle with similar problems, chat groups have formed to discuss these problems. This enables donor projects today to reach more representatives of target groups much more directly and quickly. For future projects, the use of social media can be increasingly taken into account in the project strategy.

7. Annex A Technical Study Report

Micro Hydro Power Resource & Services Center in Chitral, Pakistan (MRSC)

Techncial Study of 50 Micro Hydro Power Plants in Chitral

Study prepared by

Sajad Ahmad, Hydrolink

Dr. Thomas Meier, GFA Entec AG

Intikhab Alam, Hydrolink

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ACRONYMS

AKRSP	Aga Khan Rural Support Program
MRSC	Micro Hydro Resource and Service Center
CPI	Consumer Price Index
FEX	Foreign Exchange Rate
LED	Light Emitting Diode
kW	Kilowatt
kWh	Kilowatthours
MHP	Mini Hydropower Plant
NGO	Non-Governmental Organization
PKR	Pakistani Rupee
SRSP	Sarhad Rural Support Programme
LSO	Local Support Organization
T&D	Transmission and Distribution
VO	Village Organization
WO	Women Organization

1 INTRODUCTION

The present study is a first step in a series of activities related to the setting up of MRSC in Chitral town. The objective of the study is to get an overview of the current status and operational issues at existing MHPs in Chitral. The study results will be used as a basis to prepare a business plan for MRSC.

1.1 The Sample

Regarding the sample to be analysed, it was decided to focus data collection on areas around designated remote service points. These service points have been selected based on intensive discussions with Hydrolink and local NGOs involved in MHP implementation. The service points were selected in areas from where at least 20 MHP can be served (see Figure 1).

A total of 50 MHPs were visited in the period from September 15 until the end of October 2016. For the purpose of data collection, a study manager was recruited in Chitral town. The study manager is well experienced in conducting similar studies in rural areas and prepared a draft questionnaire prior to the first field visit. In cooperation with GFA Entec that questionnaire was improved before being applied in the field. The final version used can be found in Annex 1.

Figure 1 MRSC Service Point Location Map

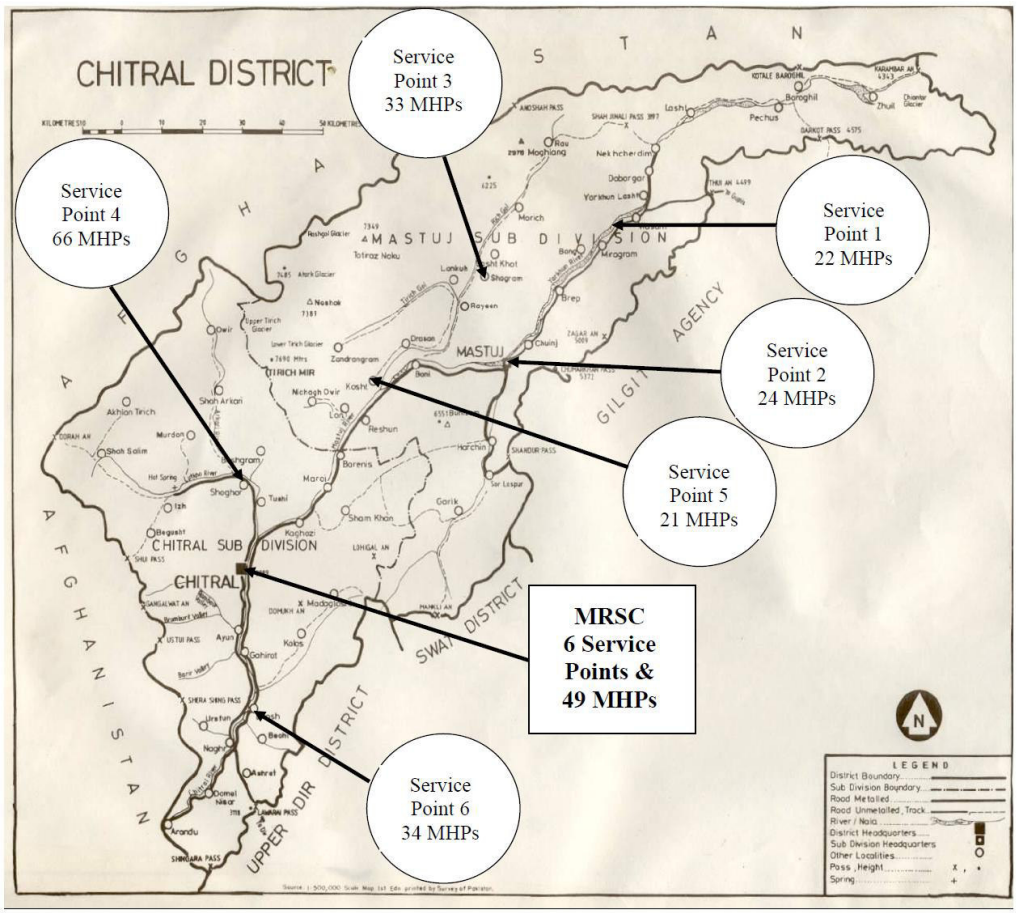


Figure 2 shows the number of MHPs visited grouped into Union Councils.

Figure 2 Number of MHPs visited as per Union Council

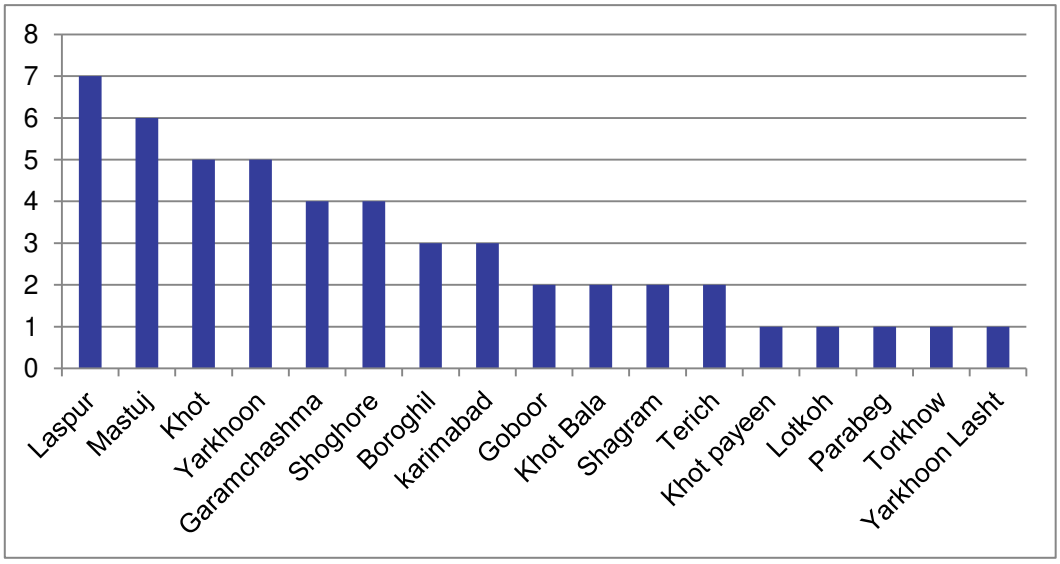


Figure 3 shows that the majority of MHP visited were in the capacity range of 41 to 50 kW. Most of 80% of these plants were built in the 1990s when the main electrification objective was to provide lighting for households and shops. 50kW seemed sufficient for that purpose. Later on, there was a growing demand for electric heating and cooking. Therefore, after the year 2000 we can observe a tendency to install larger capacities.

Thanks to the growing know-how and experience of turbine manufacturers and plant developers that demand for larger MHPs could also be satisfied. The largest MHP included in the sample had a capacity of 240 kW. The pipeline project of national turbine manufacturers indicate that increasingly larger plants will be developed in the near future. However, the actual capacity of MHPs is often considerably lower due to inefficient elements in the plant set up, acting like bottlenecks (see Chapter 3 below).

Figure 3 Installed Capacity of MHPs Visited

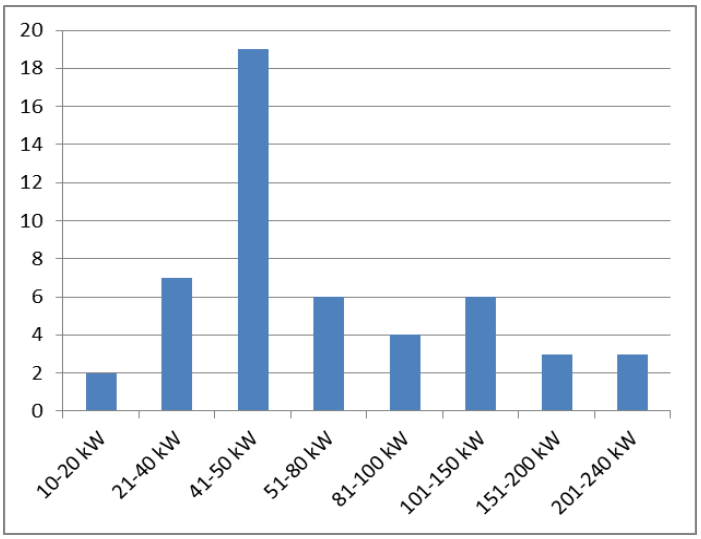
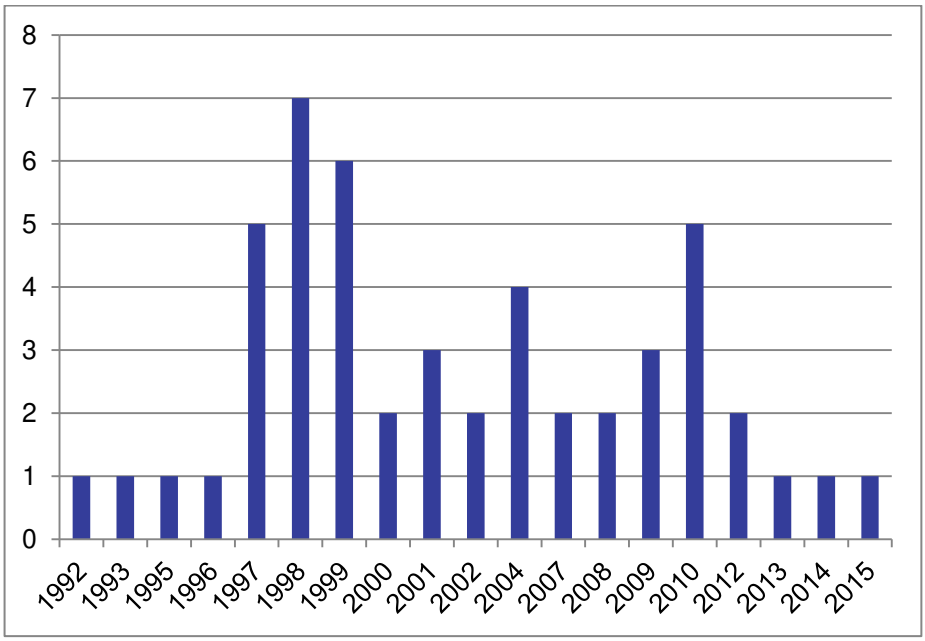


Figure 4 shows the in which years the MHPs visited were completed. The MHPs studied became operational between 1992 and 2015.

Figure 4 Year of Completion of MHPs visited



2 CONSTRUCTION COST OF MHPS VISITED

All of the MHPs visited were constructed by AKRSP. It was therefore possible to obtain the total construction cost of each MHP. The absolute values are not of interest but the construction cost per kW. This is an important benchmark for preliminary cost calculations of MHPs as well as to compare costs with different plant designs.

Costs were analysed with two methods: 1) PKR values were calculated into US dollars using the average exchange rate in the year of completion. 2) For the plants constructed in the year 2001 to 2015 it was also possible to compare the cost according to the Consumer Price Index (CPI) in that period. In both methods the results were calculated in dollar values for the year 2008. Some extraordinary high and low figures were excluded from the statistical calculations. The first method resulted in a higher average of 969 $/kW compared to 825 $/kW for the second method. The values were in a broad range from 129$/kW to 4875$/kW. The difference may be explained by the fact that the first method used more values from the period 1992 to 2000, which were initially on a higher level and then decreased over time.

In any case, the figures are considerably lower than in other countries (even when taking into account that 20 to 30% of total costs were contributed by the community in the form of labor and materials). As a comparison, a recent assessment by GFA Entec showed that MHP cost in Indonesia ranged from 3000 to 15,000 $/kW.

Table 1 MHP construction cost per kW installed capacity

Productive Uses	**$/kW**
Average cost per kW (FEX adjusted)	969 $/kW
Average cost per kW (CPI adjusted)	825 $/kW
Minimum cost per kW	129 $/kW
Maximum cost per kW	4875 $/kW

80% of the plants were equipped with so-called ‘simple cross-flow’ Turbines as opposed to the recently introduced T-15 Turbines which are more efficient but also probably more expensive. However, there are no obvious impacts of the turbine type on the total cost of the plant. It was neither possible to identify a possible impact on the kind of civil structure. Whether these structures were said to be ‘earthen’, semi-concrete’, or ‘concrete’ there was no obvious impact on the cost per kW.

3 AVAILABLE MHP CAPACITY

The number of households in the villages visited ranged from 75 to 610. This corresponds to village populations ranging from 500 to 4100[1].

Figure 5 compares the number of households at villages visited with the installed capacity of MHPs. The diagram clearly shows that the installed capacity of MHPs is not correlated with the population size. In fact the available power per household decreases with increasing village size. This means that MHPs design was not made in relation to the population to be served.

Figure 5 Installed Capacity vs. Number of Households at MHP locations

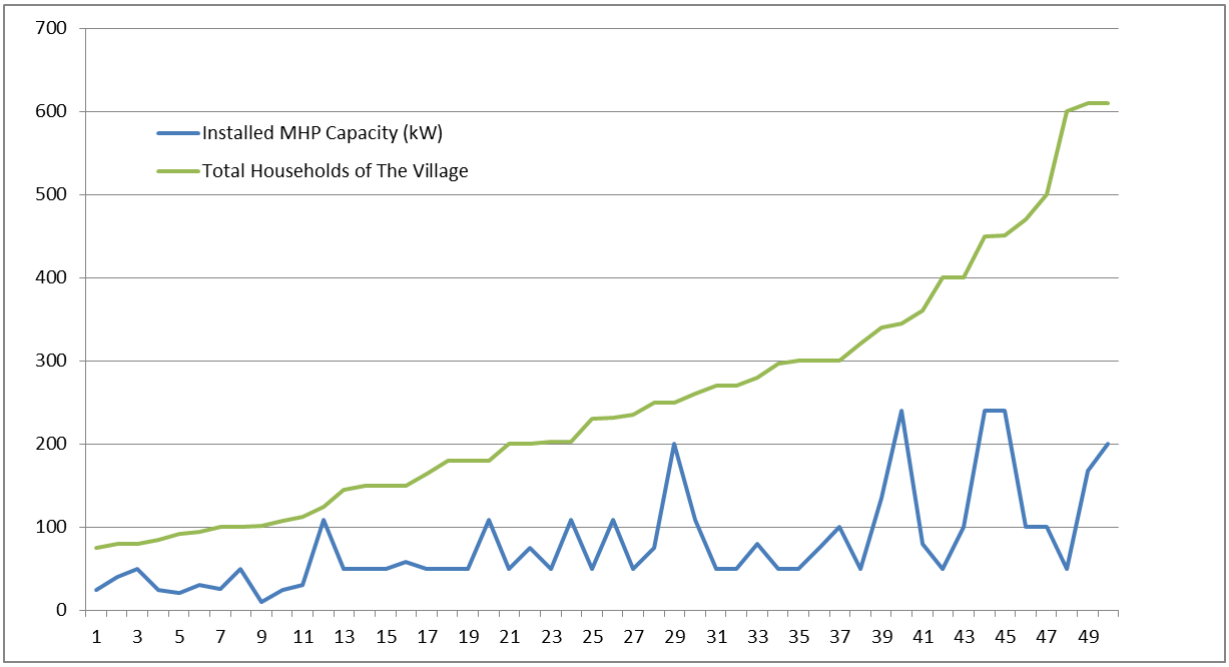
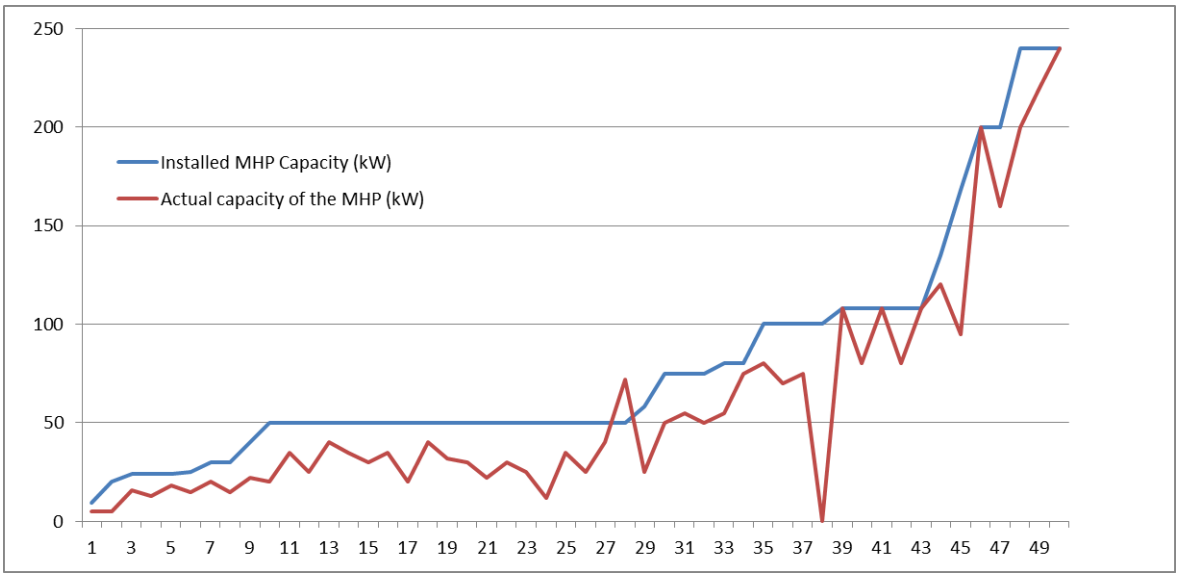


Figure 6 shows that the actual power output maxima at each MHP location are considerable below the nominally installed capacity. The actual power output is in average only 68% of the installed capacity. This means that there is much room to increase the efficiency of existing power plants. MRSC could offer such services by identifying the inefficient parts of a MHP and provide solution to upgrade the equipment. In such a way the available capacity can be easily increased by 20 to 25% in a cost-efficient way.

[1] The average number of members per rural household in Pakistan was 6.72 in 2008.

(http://www.pbs.gov.pk/sites/default/files/social_statistics/publications/hies07_08/table1.pdf).

Figure 6 Installed Capacity vs. Actual Capacity of MHPs visited

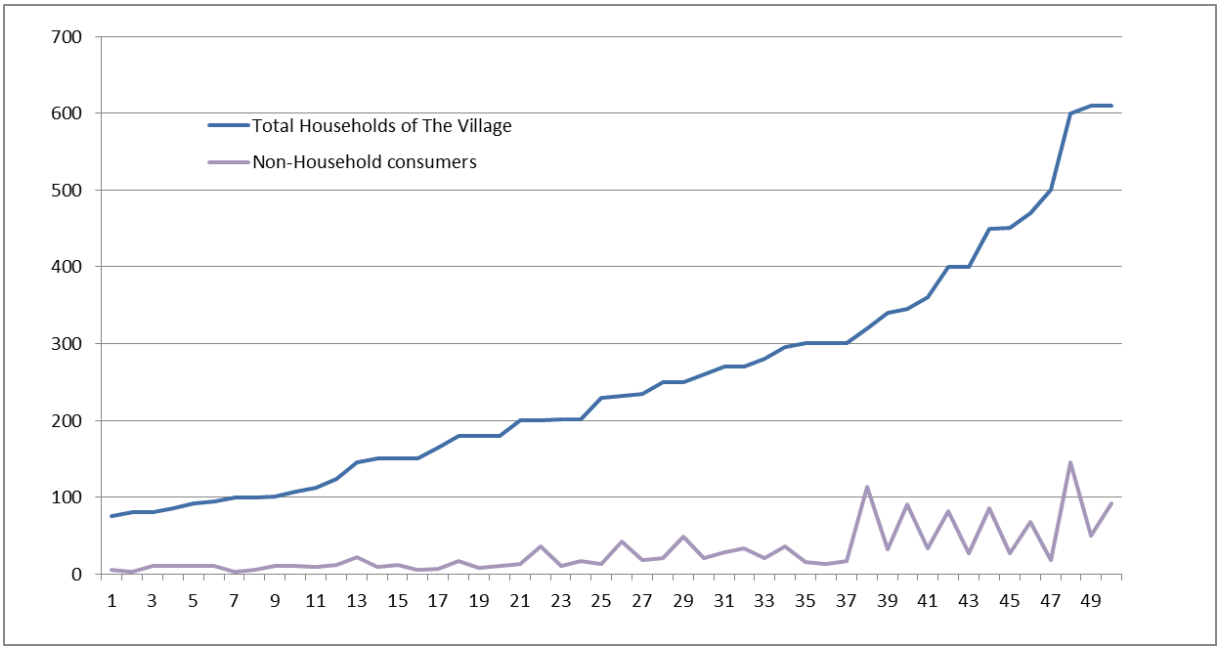


4 ELETCRICITY USE

Figure 7 shows that at each MHP location there are also non-Household customers such as schools, hospitals, religious institutions, commercial enterprises. In average 65% of these are commercial enterprises. There is a significant increase in the number and share of non-Household clients in villages with more than 300 households (2000 people). This is most likely due to economic reasons: Larger villages are often also locations of regional markets. It is more promising to establish a commercial enterprise, in a larger village as compared to a small village, in particular retail shops and personal services. The number of non-household connections may easily reach 25 to 30% in such locations.

For MRSC, this information is useful since it indicates that the electricity demand in villages above 300 households will be higher. The demands for good quality electricity and related services will also be more pronounced in such locations. Furthermore, these locations will have a load curve with less pronounced peaks, which means that load factors are higher and as result higher kWh sales and thus higher income. In other words, the ability to pay for services by management committees will be higher at such locations.

Figure 7 Non-Household Electricity Clients



At 32 MHP locations (64%) electricity is exclusively used for lighting. In those locations electricity is also used in commercial enterprises, however, these are all small retail shops which also use electricity only for lighting and not for production. At the remaining 18 MHP locations (36%) electricity is also used for cooking and heating in domestic households.

Table 2 Existing Productive Electricity Uses

Productive Uses	Frequency of occurrence[2]
Shops (mainly lighting)	29
Sawmill, Wood Cutting	22
Carpentry	14
Welding	8
Sewing center	2
Hotel business	1
Computer center	1
Flour mill	1

Table 2 shows the existing productive electricity uses. At all locations there was at least one such use. However, as mentioned above, small retail shops usually only use the electricity for lighting purposes. Furthermore these establishments often do not have a separate electricity connection but get their electricity from an adjacent household connection. Although this was the most frequent productive electricity use mentioned it is more or less negligible in terms of revenue generation for the MHP management.

Second and third most frequent uses are related to wood processing in saw mills and carpentry shops. These establishments usually have their own connections and their powerful appliances contribute certainly to revenue generation. The same can be said about welding shops. Such productive uses are highly welcomed since they are usually performed during the daytime when domestic electricity use is low.

Table 3 shows the ideas mentioned by respondents about potential future productive uses. Apart from wood processing and welding, there seems to be a considerable demand for computer centers and the drying of agricultural products. Drying may also be interesting for MRSC as it is a productive use which could be integrated into the design of a MHP by combining a drying plant with a ballast load made of air heaters.

The survey did not reveal other highly potential productive uses which might receive specific attention by MRSC. However, the interpretation of the data also needs to be made with caution, because there was only one interview conducted with the MHP management at each location. To get a more comprehensive picture about possible productive uses a broader survey involving village entrepreneurs would be required.

[2] Multiple answers were possible.

Table 3 Potential Productive Electricity Uses

Potential Productive Uses	Frequency of answers[3]
Sawmill, Wood Cutting	29
Carpentry	24
Welding	24
Computer center	8
Dehydration Plant/ Drying	6
Flour mill	3
Cooking	2
Packaging Shop	2
Hotel business	1
Wool Processing	1
Stone Carving	1
Photo copying	1

[3] Multiple answers were possible

5 TECHNICAL ISSUES

Respondents were asked about what kind of technical problems they encountered in the past while operating their MHPs. The answers showed that every MHP faced technical difficulties in the past. Very often these difficulties were severe and led to down times of several weeks or even months. Only 8 MHPs (16%) reported down times of max. one week. Thus, 84% of MHPs experienced very long down times. This figure, however, needs to be interpreted with caution. While some long down times were caused by lacking repair services in the area, many of these down times are the result of heavy damages caused by natural disasters (see below). The main problems encountered are discussed below and ideas about a possible role of MRSC are developed.

5.1 Generator Problems

One of the most frequent technical problems mentioned were problems with generators. 10 respondents (20%) explicitly reported the burning out of generator windings[4]. The most common cause for this problem is the overloading of generators. This means that the Ampère through the generator winding increases above its design value leading to increased winding temperature until the insulation fails and a short circuit causes the winding to burn. 12 more respondents (24%) mentioned general generator break-down without explicitly mentioning windings burn outs. Thus, in total more than 40% of all MHPs visited have experienced problems with generators and had to replace them.

When looking into the possible reasons for these generator problems, we compared the data with those MHP which did not mention any generator problem. 28 MHPs did not report generator problems but no obvious pattern could be observed to explain that fact. However, when grouping the data according to the available power per connection it became obvious that the 10 MHPs with the highest values above 350W available power per connection did not report any generator problems.

Interpretation:

In the context of Chitral, the value 350W of available power per connection could be seen as a threshold level. The field data suggest that if this value falls below 350W due to load demand growth, the probability of technical problems with current generators will increase. It is therefore advisable to start looking into expanding the generation capacity when the available power per connection falls below 350W and making sure that overload protection devices are working properly, or to pay more attention to load management and improve energy efficiency of devices used (e.g. promotion of LED lamps). MRSC can use this fact in its marketing and communication strategy with village communities and implementing organizations. They need to understand that investing into such measures can prevent them from costly and tiring repairs later on. Appropriately loaded and maintained generators can easily operate for 20 to 30 years. This technical study showed that only almost 50% of generators had to be replaced only after a couple of years of. This is a huge waste of development funds which can be avoided with appropriate measures.

[4] 3 respondents reported that turbines burned out. Assuming that they confused turbines with generators, we counted these as ‚generator burn outs' (because water turbines do not burn).

5.2 Turbine Problems

Compared to the problems with generators, turbines are a minor problem. 10 respondents (20%) mentioned mechanical breakdowns related to turbines over the past two years. In two instances broken shafts were mentioned as reasons for break downs. The other eight did not provide details.

There was a boom in MHP development in the late 1990s. Around 40% of MHPs visited were built in that time. Considering the lower quality and lower efficiency of these turbines as compared to new T-15 models, there is a big potential to upgrade these older MHPs with more efficient new turbines. As shown in Figure 6 the actual power of MHPs is much lower than the installed capacity. Modernizing MHPs will therefore increase the available power per connection which counteracts the generator problem as described above.

5.3 Damages by Natural Disasters

17 MHPs (34%) reported damages caused by natural disasters such as Floods, Earth Slides, Earth quakes, and other extreme weather conditions.

Located in the Upper Indus Basin of Hindu Kush Himalaya, the region of Chitral is often hit by flash floods and landslides caused by torrential rains. A multitude of such disasters happened in the past years while 2010 and 2015 were particularly bad. The flash flood cause always huge damage to social and physical infrastructure, including MHP plants. It is expected that climbing temperatures due to climate change will result in more such events in the future. For new MHPs to be built potential flooding will have to be taken into consideration in particular regarding the design of civil works and the location of power houses and poles carrying the grid lines.

In October 2015 the region was also hit by a heavy earthquake with a magnitude of 7.5 causing additional damage including MHP plants. The design of civil works therefore should consider earthquake-resistant construction methods to reduce the negative impact of future earthquakes.

MRSC should address the problem of natural disasters by including appropriate design and plant layout techniques in its teaching programs.

50% of the MHPs visited had major parts of civil works which were not made in concrete but were simple earthen structures. Amid increasing damages by floods, most respondent expressed the need of concreting channels and spill ways in the near future.

5.4 Problems with Transmission & Distributions Systems

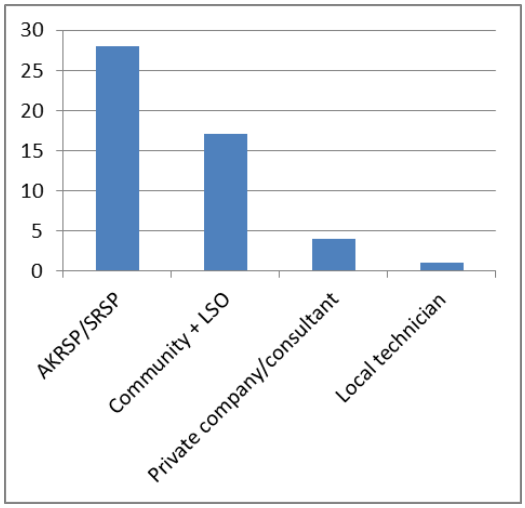
There seem to be no major issues with T&D systems. Six locations (12%) reported from transformer break downs for technical reasons. The T&D system is also affected by natural disasters as mentioned above. This problem can be addressed by redesigning mini grids and relocating pole locations to less flood prone places, if possible.

5.5 How did Communities Solve Technical Problems in the Past?

47 said that they resolved the problem by the community (what does this mean). 3 said that they relied on technicians/consultants from outside the district.

Figure 8 shows the organizations of people are addressed by MHP committees in case of technical problems. More than 50% of operators turn to the NGO which was responsible for the construction of the MHP (AKRSP and SRSP). One third of operators turn to the LSO or address the community to find support. A smaller number (10%) turn to private companies/consultant or local technicians to resolve their problems.

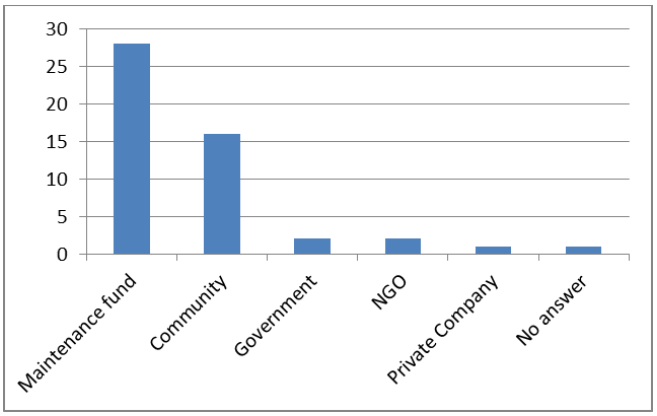
Figure 8 Support Sought in case of Problems



In contrast to the technical support which largely comes from outside the community, the financial sources to pay for maintenance and repairs mainly come from the communities. Either there are MHP specific maintenance funds in place or the community has other savings that can be used. This finding is in contrast to a general assumption that rural communities do not have any such saving. The case in Chitral shows that the communities have a capability to anticipate future financial needs and have sufficient financial resources to accumulate savings.

This fact is also expressed in Figure 9 which shows the origin of funds to pay for the repair works to resolve the technical issues discussed above. 28 respondents (56%) reported that they paid the works from an existing maintenance fund. Another 16 respondents (32%) mentioned that they paid the works from own savings in the community. Thus, it can be said that 88% of the MHP communities interviewed used community own funding sources for repair works. In the cases where governments and NGOs were mentioned as financial contributors this was mainly in cases where MHPs were almost completely destroyed and had to be rebuilt.

Figure 9 Sources of Funds for Repairs



In average, communities spend $ 2,500 (PRR 250,000) to solve the technical issues of their MHPs. In two cases where the civil works were heavily damaged due to flash floods the communities were even able to pay $15,000 and $22,000 (PKR 1,500,000 and PKR 2,200,000) from own funds.

6 TARIFFS AND REVENUES FROM ELECTRICITY SALES

Table 4 shows average and median values of the main Monthly costs and revenues of MHPs. There are two tariff systems applied, flat rates (54%) and metered tariffs (46%). The data show that electricity tariffs are quite low with an average of only $ 1.31 per connection. Due to the recent down times caused by natural disasters, we do not have reliable data about kWh consumption.

An average MHP generates total revenues of $ 330 and a net profit of $192 per month. This shows that despite the low tariffs MHP committees can still make savings, e.g. to be paid into a maintenance fund or other purposes.

The median values are all slightly lower than the averages which reflects the fact that capacities of two thirds of the MHPs visited are smaller than average. Still, the median values show the same pattern, i.e. tariffs are low and savings can be made.

Table 4 Monthly Cost-Revenue Situation

	Average USD	**Median USD**	Average PKR	Median PKR
No. of connections	253	232	253	232
Total revenues per month	**$ 330**	**$230**	33,046	23,000
Revenues per connection	**$ 1.31**	**$ 1.00**	131	100
Monthly expenses for salaries, administration and maintenance	**$ 138**	**$ 120**	13,808	12,000
Monthly Profit	**$192**	**$ 110**	19,238	8,000

94% of respondents found that tariffs charged are low and 84% found that villagers could afford higher tariffs.

In average villagers had to pay an average connection fee of $ 81 (PKR 8102). However, there was a broad range of connection fees from $ 0 (12%) up to $ 220 (PKR 220,000).

7 PLANT MANAGEMENT

Administrative Management

All MHPs visited were managed by the village committees comprising of 3 to 6 members (Manger, accountant, meter readers). The committee members are selected by the Village Organization (VO/Cluster) through a democratic process for a term of one year. At the end of each term, the committee is responsible to show all the records to the VO/Cluster. Once the tenure of the committee ends, the same democratic process is followed for the next committee.

88% of respondents said that there the management committee has a need for training.

Plant Operators

Plant operators also belong to the village committee and, theoretically, they are also selected in a democratic process. In practice, however, it is often the case that plant operators are selected from the family that contributed own land to build the MHP. As such they enjoy a more privileged status as compared to the administrative committee members. The fluctuation rate is very low: 86% of respondents said that there was no change in operators since the plant was installed. The other 14% said that fluctuations only happen every 3 to 5 years. The market to train new operators taking over the position at existing MHPs will therefore be limited.

However, there may be much room to train operators who never had any training at all as well as to provide refresher courses for previously trained operators. Only 50% of plant operators have received operators training. The other 50% were informally introduced into the very basics of MHP operation only.

8 SUGGESTIONS AND RECOMMENDATIONS BY MHP OPERATORS

Table 5 shows the suggestions and recommendations made by MHP operators regarding for the future of the MHPs.

On top of the hit list are improvements of channels and other civil works, including protective structures. It is not surprising that improvements of civil works are at the top because these structures suffered most heavily under recent flash floods and earthquake. There is definitely an opportunity for MRSC to provide expert advice for MHP committees how to improve civil works to make them less vulnerable against natural disasters.

The list also underlines the demand for high quality operators training. This confirms that there is a market for the planned trainings by MRSC.

Many respondents suggested the general upgrade of the MHPs and in particular also the replacement of inefficient turbines. It is very likely that the proximity of MRSC with MHP communities through the service contracts will result in additional business in the field of upgrading equipment of entire MHPs.

Table 5 Fields of improvements mentioned my MHP operators

Field of Improvement	**Frequency of answers**[5]
Improvement of channels and other civil works	21
Operators training	12
General technical upgrade of MHP	10
Upgrade of mechanical parts	8
Replace wooden with iron poles	6
Introduction of computerized billing system	6
Management training	6
Improvement of tariff system	1

The last three fields are related to plant management. There seems to be a pronounced interest in the introduction of improved and efficient billing systems using IT-technology and also bank accounts/transfers. The suggested management training should also in particular address billing systems, rate collection and record keeping.

[5] Multiple answers were possible, 28% of respondents did not make any suggestions.

9 RESPONSE TO THE PROPOSED MRSC SERVICE PACKAGE

Respondents were informed about the intention of MRSC to offer a maintenance service package for MHPs in Chitral. The service package offered includes:

1. Annual maintenance visit by service point technicians.
2. Annual refresher training course at MRSC in Chitral town for one person (including accommodation and meals, not including transport) on need basis.
3. 10% discount on spare parts as compared to non-clients.
4. Free access to telephone hotline for questions related to technical problems and productive use, etc.
5. Repair visit within 48 hours.

The annual subscription fees offered for the maintenance service package were

PKR 15,000 ($150) for MHP up to 30kW

PKR 20,000 ($200) from 31 to 50 kW

PKR 30,000 ($300) from 51 to 100kW

PKR 40,000 ($400) from 101 to 200kW

PKR 50,000 ($500) for above 200kW

Respondents were asked about their impression of the service package and the prices offered, and whether they would be willing to buy a subscription. As shown below the proposed service package was highly welcomed:

- 100% of Respondents said that they find the service package useful for their MHP.
- 100% of Respondents said that they would you be willing to buy a subscription to the service package.
- 98% of respondents said that they find the proposed subscription fees for the service package are affordable for them.

10 CONCLUSIONS

The technical study has shown that the service package as described in previous chapter is relevant. Respondents would all be willing to buy a subscription and find the prices appropriate. The package concentrates on an annual visit by a MRSC technician for preventive maintenance and one refresher training course per year.

MRSC will also offering basic operator courses besides the MHP service package. This will be offered to MHP operators at new locations and replacement operators at existing locations. Due to low fluctuations among MHP operators, the demand for basic operators training from existing MHPs may be limited to the initial training rounds. At a later stage MRSC would better concentrate on refresher courses. These could be topical courses, e.g. preventing generator overload, making plants more disaster resilient, long term flow measurement as precondition for future MHP upgrade, etc.

The assessment of technical issues and how these were handled by MHP committees showed that most funds had to be spent on repairing civil works. Suggestions provided by MHP committees therefore also emphasize improvements/reinforcements of civil works. Based on this and other recommendations made, it can be concluded that there is a range of additional services MRSC could offer such as:

- Auditing of civil works of a power plant and the recommendations how the civil works could be improved by appropriate sizing, additional spill ways, and additional structures for flood protection to make them more resilient against natural disasters.
- Expert advice and introduction of computerized billing systems.
- Training for plant administrators (record keeping, rate collection, efficient billing systems)
- Identification of bottlenecks responsible for low plant efficiency. Develop solutions for cost-efficient capacity increase by eliminating bottlenecks.

The basic service package is a strategic product of MRSC. It will help develop a close relationship with MHP communities. It will create leverage for additional services to be provided by MRSC which will create additional revenues for MRSC and additional benefits for the MHP communities.

ANNEX 1 TECHNICAL PROBLEMS MENTIONED

Study Question B9: What was/were reason/reasons for the technical issues or breakdown?
Generator burnout twice & turbine repair
Technical fault, Transformer fell into water & Shaft broken
Transformer five times replaced
Scatter population-Bushy environment
Channel leakage and gate wall issue
Technical issue, channel issue to breakdown
Transformer are burn out
Channel was damaged due to flood water and earthquake
Over loading issue was the main cause for technical issue
Over loading and resting
Turbine was burn out in 2009 & 2012. Channel is affected due to weather
Due to overloading transformer was fused.
Generator changed + repairing
Channel was affected and washed away by flood
Exiting channel and turbine issue
turbine was replaced, generator was burn out
Channel was washed away by flood water, generator was burn out 5 times
Channel was affected by sliding
Transmission lines poles due to damage of insulators+ turbine due to break down
Step up transfer was fully damaged due to sliding.
Channel was affected by flood, transformer were washed away by flood.
Channel was washed away by flood water, turbine was burn out due to overloading
Turbine was break down
Intake was completely washed away by flood of 2015.
Due to earthquake MHP channel fully damaged & generator burn out.
Shaft was broken due to overload.
pipe was broken due to rust ,generator was break down
Generator was Break down
Generator twice burn out and transformer also burnout last two year.
Turbine is out dated and over loading which causes of shutting down the MHP.

Turbine repaired twice, Transformer burnt
Channel and Powerhouse was swept away by flood of 2015
Flood Severely affected MHP
Generator replaced last year, old alternator was burnout
Turbine and Generator breakdown
Civil work channel repaired twice last year, turbine runner issue
Concreting of channel and turbine breakdown twice
Channel and generator repair twice last year
Transmission poles due to calamities, generator twice repaired
Water channel was affected due to sliding, generator breakdown, transmission lines were damaged due to heavy snowfall
Channel has been mostly repaired and generator too
Only belts are replaced on monthly basis. Rest is in perfect condition
Turbine and Generator breakdown
Turbine and Generator breakdown
Bust out of channel every year at the intake due to extreme weather condition, generator and transformer breakdown
Civil work was swept away by stream water, generator burnout many time
Turbine was repaired
Turbine was burn out, channel was also swept away
Structure was affected due to over flow
Channel issue, Generator repaired 5 times, also transformer issue

ANNEX 2 QUESTIONNAIRE

Serial Number: | | | |

Who is Respondent of the survey?

1. MHP operator 2. President or manager of VO 3. LSO manager/ Chairman
4. Member of VO/LSO

Name of the respondent:

Phone Number of respondent:

Section A: Basic information

A1. Name of the village:

A2. UC name _____

A3. Total households of the village _____

A4. Year of MHP construction start _____

A5. Year of completion _____

A6. The MHP was incepted by;

1. AKRSP 2. SRSP 3. Government 4. If other specify _____

A7. What was the total cost of the project?

A.8 What was the donor share?

A.9 What was the community share?

A.10 Who is the owner of the MHP?

A.11 Was the community consulted before establishing the MHP? 1. Yes 2. No

A12. Was there any survey (feasibility study) conducted before establishing MHP?

1. Yes 2. No

A.13 What is the installed capacity of the MHP? _____

A.14 What is the actual power generation of the MHP? _____

A.15 What is the current capacity of the MHP operating in the area? _____

A.16. Was the MHP upgraded by any other organization?

1. Yes 2. No

Section B: MHP related Information and O&M problems

B.1 Nature of civil structures constructed?

1. Concrete 2. Semi Concrete 3. Earthen

B.2 Type of turbine installed?

1. Simple Cross Flow 2. Cross flow T-15 3. Pelton Wheel

B.3 Type Drive System used?

1. Coupled through belt 2. Coupled on Shaft 3. Coupled through Gear

B.4 Type of Alternator used?

1. Brushless 2. Other Please Specify

B.5 Types of Transmission System used?

1. 11KV Lines. 2.

B.6 Types of Poles used?

1. Wooden 2. MS Tubular. 3. Iron Poles

B7. Did the MHP face any technical issues for the last 2 years?

1. Yes 2. No

B8. If yes, what were they? (Select as many options as you can)

1. Civil work 2. Electro-mechanical 3. Transmission and distribution

B.9 What was/were reason/reasons for the technical issues or breakdown?

_____

_____

B10. How the issue was resolved?

1. Resolved by community 2. Resolved by operators 3. Resolved by technicians/consultants from outside the district 4. If, Other please specify

   _____

B.11 How much time it took to resolve the issue or rehabilitate the MHP project? _____

B.12 How much it cost to resolve the issue?

B.13Wherefrom the cost was met?

B.14 Who do you contact if there is a major technical problem?

B15. How many times over the year has the MHP been shut down for repair and maintenance?

1. 1 to 2 times 2. 2 to 4 times 3. 5 to 10 times 4. Other, specify_____

B.16 Duration for which the MHP remain closed for repair and maintenance?

Section C: Electricity Use

C1. What are the total domestic connections of the MHP? _____

C2. Please provide the numbers of the following institutions that are operational in the area and utilizes electricity of the MHP;

No. of privately owned schools/colleges	No. of Govt owned schools/colleges	No. of hospitals (BHU etc.)	Commercial connections	If other specify_____

C.3 Energy used for cooking and heating? (Select many options as you can)

	Lightning	Cooking	Heating
Electricity			

C.4 Is there any productive use of electricity from the MHP particularly during day timing?

_____

C.5 What types of potentials for the productive use of electricity are available in the village or area?

_____

C.6 . For how many hours/ per day you get access to electricity?

1. 1 to 5 hours 2. 5 to 10 hours 3. 10 to 15 hours 4. If other specify_____

C7. Does the MHP meet the current demand for electricity?

1. Yes 2. No

C.8 . Do you have load shedding?

1. Yes 2. No 3. If yes, since what year

C.9 If yes, for how long?

1. 1 to 5 hours 2. 5 to 10 hours 3. 10 to 15 hours 4. If other specify_____

C.10. Did you experience dimming of lights last month? (due to fluctuation in voltage).

1. Yes 2. No

C.11. If yes, how often did you experience dimming of lights?

Daily	
Weekly	
Monthly	

Section D: Management and Operation

D.1 How many operators do you have?

D.2 How many members are there in the V/WO?

D.3 How many poor household members in the V/WO?

D.4 What is the frequency of meeting of the V/WO?

D.5 What is the total savings of the V/WO?

D.6 Who is managing/operating the MHP system?

1. Community 2. Private Company 3. LSO 4. If other , specify _____

D.7 Are you satisfied with the management system of MHP?

1. Yes 2. No

D.8 Are there any training needs for MHP O&M for you and the other people in the management committee?

D.9. If no, what necessary steps should be made to have a better MHP management system?

_____
_____
_____
_____
_____

D.10 Does the local operator have the capacity to fix the problems?

1. Yes 2. No

D.11 Is the operator trained?

1. Yes 2. No

D.12 Did you have any staff fluctuations among operators? How often?

_____

D.13 Did the replacement operators get trained? by whom? Where? How long?

_____

D.14. Are you satisfied with the way MHP is working?

1. Satisfied 2. Very satisfied 3. Neutral 4. Not satisfied

D.15 What is current status of the MHP Components?

1. Civil 2. Mechanical 3. Electrical and T&D, Give details

D.16 For repairing the MHP, where the fund comes from?

1. Maintenance fund 2. From government 3. From NGO 4. Other specify_____

D.17 Which component of the MHP has so for been repaired most of the time?

1. Civil 2. Mechanical 3. Electrical and T&D, Give details

D.18. Was the MHP affected by any natural calamity?

_____

D.19 If yes, what was the nature of the damage?

1. Partially damaged 2. Fully damaged

D.20 According to your opinion, how the MHP can be prevented from such natural catastrophes in near future?

Section E: Tariffs, Income, Expenses, rate collection

E. 1 What are your average monthly revenues from electricity sales? _____

E.2 Do you have any records? Could you show the records?

E. 3 Who is collecting the rates, who is doing the administration?

_____

E.4 Did the administrator get trained?

E.5. Do you think the electricity is affordable?

Current Tariff	High	Low	Can't say
If increased, will customers be able to afford	Yes	No	Stop using

E.5 Who developed the tariff system?

E.6 Did the customers pay a connection fee? How much?

E.7 Is the consumption metered or do you have flat rates?

E.8 How often are customers supposed to pay the bills?

Weekly	
Monthly	
Yearly	

E.8. To whom are electric bills paid?

1. Operator 2. Village committee 3. LSO 4. Other, specify_____

E.9 What are your monthly expenses for salaries, administration, and maintenance? _____

E.10 Do you make savings to pay for larger maintenance/repairs or eventually replacement/renewal of equipment?

Section F: O&M Services provided by MRSC

Hydrolink in cooperation with the Swiss-based company GFA Entec is developing a service network in Chitral to improve operation and maintenance of existing MHPs, the project is supported by the Swiss Government through REPIC and the German based Wuppertal Institute:

We will set up 6 service points in Chitral from which each MHP can be reached within a short time. The nearest service point for you would be in …….

At each service point there will be a qualified MHP technician who will be capable of troubleshooting and doing repairs which are going beyond the capacity of local MHP operators. The MHP technician can also answer questions related to possible upgrade of MHP, potential productive uses and related

equipment. The service point technician has a phone number and can be contacted by MHP operators in case of problems. In emergency cases a repair visit can take place within 48 hours.

All service point technicians belong to MRSC in Chiral town. For more severe repair works, MRSC can be contacted to visit the MHP location with their Mobile Service Unit (MSU). The MSU has sophisticated tools and equipment to analyze and handle larger technical problems.

The services provided by MRSC are not subsidized by the government, NGO, or donor agency. Therefore, each MHP management committee, V/WO or LSO has to pay for these services. The main objective of the services is to improve the sustainable operation of MHPs in Chitral by providing preventive maintenance and cost effective repair services. It is expected that the savings of a management committee will increase despite the fact that services are provided on a cost basis because of the stable, uninterrupted electric supply and limited breakdown due to the maintenance and repair services.

Of course, the use of the services is voluntarily for each MHP committee.

Services package offered

1. Annual maintenance visit by service point technicians
2. Annual refresher training course at MRSC in Chitral town for one person (including accommodation and meals, not including transport) on need basis.
3. 10% discount on spare parts as compared to non-clients.
4. Free access to telephone hotline for questions related to technical problems and productive use, etc.
5. Repair visit within 48 hours.

Price per year*:

PKR 15,000 for MHP up to 30kW

PKR 20,000 from 31 to 50 kW

PKR 30,000 from 51 to 100kW

PKR 40,000 from 101 to 200kW

PKR 50,000 for above 200kW

* The prices are exclusive of the spare parts costs.

F.1 Do you think the service package will be useful for your MHP?

F.2. Would you be willing to buy a subscription to the service package?

F3. Is the service package affordable for your financial situation?

F4. Do you have any other alternative in your mind?

Suggestions and recommendations if any;