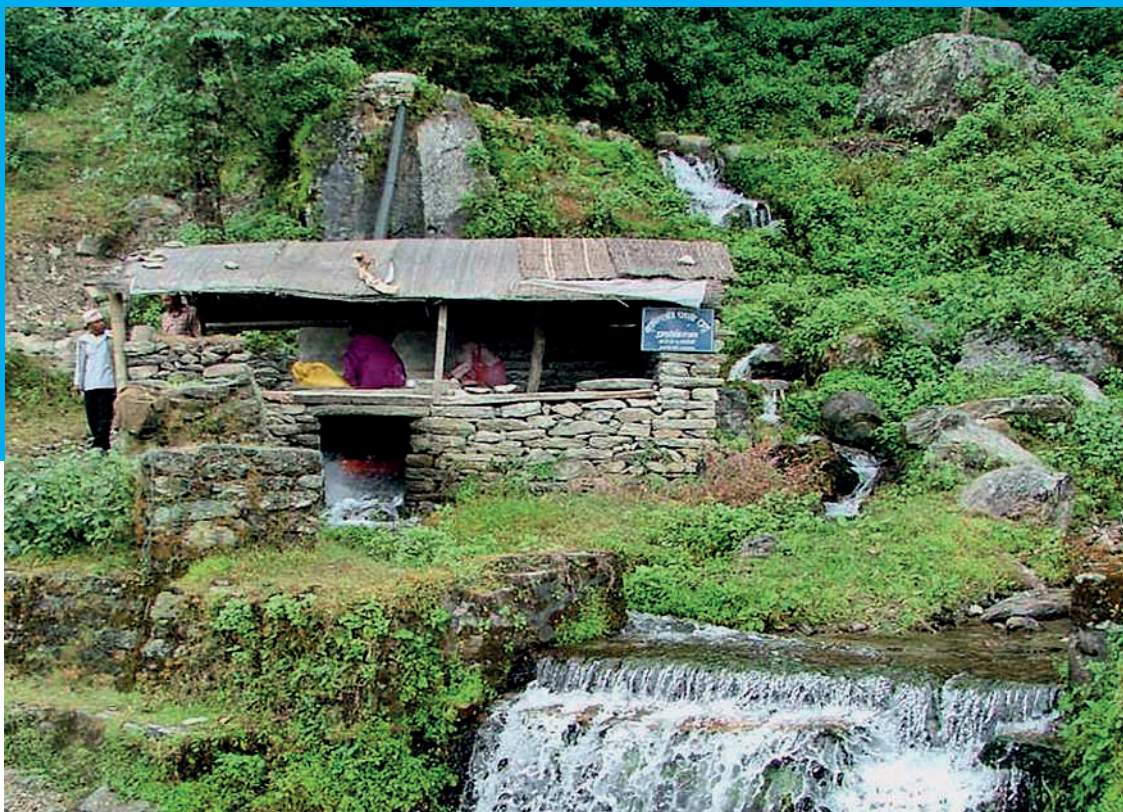
Alternative Energy Promotion Centre

Centre for Rural Technology, Nepal

SNV Netherlands Development Organisation

Improved Water Mill Development in Nepal

A STATUS REVIEW

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Centre for Rural Technology, Nepal

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Message

Alternative Energy Promotion Centre (AEPC) is the nodal agency of the Government of Nepal for promotion and dissemination of Renewable Energy Technologies (RETs) in Nepal. AEPC has been implementing National Rural and Renewable Energy Programme (NRREP) since July 16, 2012 with the support from Government of Nepal and various external development partners. The development objective of NRREP is to improve the living standard of rural women and men, increase employment of women and men as well as productivity, reduce dependency on traditional energy and attain sustainable development through integrating the alternative energy with the socioeconomic activities of women and men in rural communities. Community Electrification Sub-Component (CESC) is one of the NRREP programme components which is responsible for coordination and implementation of community electrification activities including Improved Water Mill (IWM) technology throughout the country in demand driven and public-private-partnership approach. The Component aims to install 25MW of Mini/Micro Hydropower to provide electricity to 150,000 rural households and 4000 IWMs during the period from mid 2012 to mid 2017.

As the Government has given high priority for up-scaling of IWM technology, AEPC has been continuously working to create favorable policy environment for IWM technology promotion. In this regard, AEPC has taken initiative to put into place a credit mechanism for IWM in collaboration with Clean Energy Development Bank (CEDBL) and has been working on other investment possibilities through Development and Commercial Bank. As IWM stakeholders have vital role in implementation of IWM technology at field level, the NRREP programme has given high priority for capacity building of the stakeholders. Technological innovation is equally important in order the IWM technology to make appropriate for different geographical regions and diversifying end-use applications.

We are happy to acknowledge that Centre for Rural Technology, Nepal (CRT/N) is publishing "**Improved Water Mill Development in Nepal: A Status Review**" highlighting historical events and experiences of the IWM sub-sector. We hope this publication will be useful to learn about the facts and figures of IWM technology as well as its development trend. We would like to convey our sincerest gratitude to all the development partners, the government, non-government and private sector partner organizations who played crucial role in brining the sub-sector up to current height. Special thanks goes to CRT/N for taking key role in implementing different projects and programmes on IWM at different time periods and bringing out this historical document.

Prof. Dr. Govind Raj Pokharel
Executive Director

January 22, 2014

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Your reference
Our reference

January 27, 2014

Dear Reader,

At various stages over the past three decades, the German Development Cooperation via GIZ has been an active member of the team supporting the development of water powered milling technology in Nepal. In many remote parts of the country, where water powered milling has been widespread for generations, these innovations have had a significant impact on rural development.

This past year, funded through the multi-donor energy access program Energising Development (EnDev), the joint efforts have tried to take another step towards market maturity of IWM Electrification. When successful, this pico-hydropower application with its inherent productive use component could be a sustainable way of providing access to electricity for some of Nepal's most remote and marginalized communities.

We are happy to see this compiled work of IWM lessons and experiences from Nepal. May it have a positive impact on the development of improved watermills for mechanical as well as electrical energy in Nepal and elsewhere. After all: knowledge is power!

Dr. Roland F. Steurer
Country Director, GIZ Nepal

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Director's Message

Modern energy services are crucial to human well-being and to a country's economic development. Access to modern energy is essential for the provision of clean water, sanitation and for the provision of reliable and efficient lighting, heating, cooking, and mechanical power. It is an alarming fact that today billions of people lack access to the most basic energy services: as *World Energy Outlook 2013* shows nearly 1.3 billion people are without access to electricity and more than 2.6 billion people rely on the traditional use of biomass for cooking, which causes harmful indoor air pollution. These people are mainly in either developing Asia or sub-Saharan Africa, and in rural areas.

In Nepal, a little over half (56%) of households have access to electricity (including off-grid solutions). It is apparent that renewable energy development and localised solutions form a critical part of the overall strategy to combat the energy crisis in Nepal. Renewable energy development continues to be a high priority of the government as it provides a low cost solution to remote, sparsely populated areas unviable for grid extension, while being clean, safe and environmentally friendly.

From this development perspective, SNV Nepal has been working closely with the Alternative Energy Promotion Centre (AEPC) and its local partners Centre for Rural Technology, Nepal (CRT/N) to develop the improved water mill program since 2005 to 2010 and with the funding of GIZ/Energising Development (EnDev), SNV made a come back again to the sector in 2013.

SNV believes that IWM electrification can be significantly up-scaled in rural Nepal, to provide electricity to households for lighting purposes but also for micro-enterprise development to contribute to a sustainable rural economy. There is a strong nexus between energy and other important development factors such as education, health, gender, environment, economic growth, food security, and water. Sustainable access to modern energy services and in case of Improved Water Mill sub-sector, providing access to clean lighting solution along with mechanical power from water mills is considered as a critical input and catalyst for improving the productive capacities and welfare of rural isolated communities, leading to poverty eradication and sustainable development.

I am glad to note that Centre for Rural Technology, Nepal is publishing a book as a status review of the IWM sub-sector, which encompasses the different lessons learned, development impacts and future prospects of IWM technology.

I am sure that this publication will be useful for the development practitioners and energy professionals to act SMART in contributing towards the renewable energy sector development in Nepal.

Rem Neeffes
Country Director Nepal
SNV Netherlands Development Organisation

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Foreword

Established in 1989, the Centre for Rural Technology, Nepal (CRT/N) has been playing important role in the promotion and development of appropriate rural technologies in Nepal, including improved water mills. The installation and application of rural technologies like improved water mill, improved cooking stoves and solar cookers have immensely helped the rural communities, particularly women and girl children in proving their lifestyles through the reduction of drudgery, labour, indoor smoke inhalation and increase in their income and employment options. These technologies have provided opportunities to initiate various income generating activities through the availability of dependable and affordable energy services, particularly in rural areas.

It gives me immense pleasure to recall that CRT/N had the opportunity to be involved and contribute in a number of Improved Water Mills (IWM) promotional programmes including the IWM Support Programme for many years. We are satisfied that our efforts have had some contribution in initiation of National Programmes on the development of IWM technology. Thus, CRT/N has been a part of the overall development history of the renewable energy sector in Nepal.

The purpose of this publication is to present a snapshot picture of IWM sub-sector with its historical context so that it would facilitate conceiving future path of its development for increasing access to rural energy services for socio-economic development of the rural communities in Nepal.

I take this opportunity to greatly acknowledge the cooperation and support extended by the support organisations and individuals who extend their support to CRT/N so that it could contribute to IWM development in Nepal. I am particularly grateful to Alternative Energy Promotion Centre (AEPC), SNV Netherlands Development Organisation, German Development Cooperation (GIZ), and other national and international organizations who extended their support for promotion of IWM in various years.

I acknowledge the inputs given by various personalities in preparing this Status Review. I am particularly thankful to Mr. Jagadish Kumar Khoju, Programme Manager, and Mr. Madan Thapaliya, Programme Officer of AEPC/NRREP, Dr. Keshav C Das, Senior Advisor, SNV, Mr. Subarna Prasad Kapali, Mr. Lumin Kumar Shrestha, Directors and Mr. Biplav Kafle, Programme Officer of CRT/N for their efforts in producing this Status Review. Last but not least, I would like to extend my thanks to Mr. Bhupendra Shakya, (then) Programme Manager, IWM Programme, Mr. Mahendra Chudal, (then) Programme Manager, IWM Programme, Ms. Lachana Shresthacharya, Programme Officer, and Mr. Milan Shrestha, Programme Assistant who had supported the Editorial Team at various stages of development of this publication.

Ganesh Ram Shrestha
Executive Director
Centre for Rural Technology, Nepal

Preface

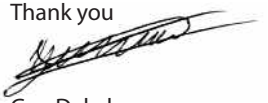
Improved Water Mills (IWM) are one of the clean technologies being promoted by the Government of Nepal in cooperation with external development partners for about half a century. The local endeavour of replacing the wooden shaft turbine with an improved metallic one was supported by GIZ in the eighties. SNV Netherlands Development Organisation, on behalf of the Dutch Directorate General of International Cooperation (DGIS), supported the Government of Nepal (GoN) (2003-10) to develop and proliferate the Improved Water Mill sector under the Alternate Energy Promotion Center (AEPC)'s Renewable Energy Sector Support (RESS) Programme, installing more than 7000 IWM units in the hilly and mountainous pockets of Nepal.

With energy poverty to remain a challenge in the coming decades, SNV continues to provide access to clean cooking and lighting solutions for people living in poverty. At the same time we look into opportunities for rural electrification and the use of renewable energy for productive end uses for households and entrepreneurs. In that context, SNV, with the support of EnDev, got re-involved with Improved Water Mill Development in 2013, by focusing on the electrification component both for electrifying households and for the development of micro-enterprises. As with the other Renewable Energy Technologies we focus on, we strive for impact at scale, by establishing a national IWM-Electrification market. In doing so, we go one step beyond earlier engagements in the sector, where the focus has been on IWM market expansion. Through the introduced productive end uses, the community is empowered with the ability to generate income and to sustain the systems independently.

With the history of IWM development in Nepal dating back to the early eighties, it may be clear, there is a wealth of knowledge available on the subject. In that context, the world wide web doesn't lie, a search on Improved Water Mills yields over five million hits, with all of the top hits being linked to experiences in Nepal. This publication Improved Water Mill Development in Nepal: A Status Review sets out to compile the available, yet dispersed, information on IWM into an easy to read reference document, with a specific focus on market characteristics. We believe this compendium will help the reader to get a feel of what the sector entails and what is to come in the near to medium term, allowing for realistic planning and further fine-tuning of business cases, eventually leading to a decrease in energy poverty.

For now, I stand to thank all those who have been involved to bring the sector to its current status.

Thank you



Guy Dekelver
Sector Leader, Renewable Energy
SNV Netherlands Development Organisation

Editor's Note

The Improved Water Mill Development in Nepal: A Status Review is an attempt to document critical historical events of the sectoral development of IWM, in many of which events Centre for Rural Technology, Nepal, SNV Netherlands Development Organisation and Alternative Energy Promotion Centre can be recognised as the key players. Of course, the critical roles played by others have also been duly highlighted in the report, the German Technical Cooperation (GTZ) and Research Centre for Applied Science and Technology being most important of them.

Although significant amount of original write up has taken place in developing this Review, the Editorial Team believes that this report is basically a compilation of already existing information. In fact, a lot of information have been extracted from published and unpublished reports. The data have also been compiled from the Improved Water Mill Programme records.

Given that the status of IWM sub-sector in terms of technology, policy environment and programme implementation is widely understood and also the benefits of IWM are widely acknowledged, this Review has attempted to highlight market characteristics of IWM in the country. This effort has been made with a belief that the IWM market is now heading towards commercialisation phase after successful completion of pioneering, market development and market expansion phases, all of which were driven to a large extent by development players rather than the free market players.

The Editorial Team hope that this Review will be an interesting reading for general readers and useful to practitioners as well as the planners.

All the errors and shortcomings in this report are responsibility of Centre for Rural Technology, Nepal and the Editorial Team, particularly, the Principal Editor.

Any corrections/comments on the Review are always welcome, preferably, substantiated by evidences.

Subarna Prasad Kapali
Principal Editor

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Abbreviations and Acronyms

AEPC	Alternative Energy Promotion Centre
CDM	Clean Development Mechanism
CESC	Community Electrification Sub-Component of AEPC/NRREP
CREF	Central Renewable Energy Fund
CRT/N	Centre for Rural Technology, Nepal
EnDev	Energizing Development
ESAP	Energy Sector Assistance Programme
GHG	Greenhouse Gas
GIZ	German Development Corporation
GOA	Ghatta Owners Association
GOG	Ghatta Owners Group
GTZ	German Technical Cooperation
ICIMOD	International Centre for Integrated Mountain Development
IWM	Improved Water Mill
KMI	Kathmandu Metal Industries
LPO	Local Partner Organisation
MDGs	Millennium Development Goals
MoLD	Ministry of Local Development
MPPU	Multi-Purpose Power Unit
I/NGO	International/Non-Governmental Organisation
NPC	National Planning Commission
NPR	Nepali rupees
NRREP	National Rural and Renewable Energy Programme
RECAST	Research Centre for Applied Science and Technology
RETSC	Rural Energy and Technology Service Centre
RSC	Regional Service Centre
SC	Service Centre
SNV	Netherlands Development Organisation
TU	Tribhuvan University
TWM	Traditional Water Mill
VDC	Village Development Committee
WDD	Women Development Division/Government of Nepal

1. History of Improved Water Mill Development

Although the origin of the use of water mills in Nepal is not identified, history of water mills in Nepal is said to be centuries long. These mills found across the country, operating from the power of rivers and rivulets, are catering thousands of settlements for the rural energy and agro-processing needs.

These traditional water mills with an operational efficiency of less than 25 percent and a typical mechanical output of around 0.2 – 0.5 kW have the capability to grind between 10 and 20 kg of maize per hour. However with the increasing demand of agro-processing these mills were found incapable to satisfy the demands of grain processing circa 1970s and 1980s.

1.1 Pioneering Phase

The history of development of Improved Water Mill (IWM) in Nepal dates back to the early 1980s, when the Research Centre for Applied Science and Technology (RECAST), a research and development wing of Tribhuvan University (TU), developed a prototype of an improved version of water mill. In the prototype wooden paddles were replaced by hydraulically more efficient metallic blades, and a new bottom bearing. This prototype with a closed chute and a covered chamber was tested in a mill at Godavari, Lalitpur.

The technology was subsequently promoted among the farmers with involvement of a manufacturing company, the Kathmandu Metal Industries (KMI). The unit was called Multi-Purpose Power Unit (MPPU). A number of farmers adopted the technology; the experience of this effort was critical in further improving the technology and gain experience on its social acceptance.

1.2 Market Development

The activities in the pioneering phase demonstrated that IWM could be a viable technology to address rural energy needs and thus rural poverty. In a bid to develop market for IWM, the German Technical Cooperation (GTZ) came up with a programme to promote IWM in rural areas in 1984. The programme aimed at expanding market for IWM through provision of financial incentives. Although there was some gap in the late 1980s, GTZ continued its support in the 1990s. Involvement of the Centre for Rural Technology, Nepal (CRT/N) as the implementer of the GTZ supported programme marked the beginning of an institutional growth in IWM.

The market development for IWM continued even without donor support from 1993-96 when CRT/N continued to promote the technology on its own. Support from GTZ resumed in 1996 attracting range of institutions including development oriented and financing agencies towards IWM promotion. CRT/N was able to develop collaborative partnerships with the Women Development Division (WDD) of the Ministry of Local Development (MoLD), some national and international non-government organisations, banks and local manufacturers.

By end of the phase, IWM was a technology that attracted attention of the policy makers as reflected in the Subsidy Policy 2000. Moreover, IWM got international recognition as the GTZ supported project was selected and approved by the International Selection Commission of EXPO 2000 Hannover, Germany.

1.3 Market Expansion

In 2002 the Alternative Energy Promotion Centre (AEPC), the apex body on renewable energy under the Ministry of Science, Technology and Environment, together with the SNV Netherlands Development Organisation initiated the inception phase of the Improved Water Mill Programme which marked the beginning of the market expansion phase. This phase extends to 2010 until when CRT/N was the main implementer of the Programme and includes the later period from 2011 onwards when the Programme was integrated with the Energy Sector Assistance Programme (ESAP) and subsequently National Rural and Renewable Energy Programme (NRREP) of AEPC. This phase is characterised by increased involvement of the private sector in manufacturing and service delivery, institutional development of IWM owners, diversification of end uses of IWM, power and regulatory efforts to streamline the development efforts, and quality control.

The landmark improvements in the policy environment during the phase include promulgation of the Rural Energy Policy 2006, Subsidy Policy 2006 and its subsequent revisions[1] and the Three Year Interim Plans. A significant moral thrust was provided by the Ashden Awards 2007 that recognised the role of IWM in poverty reduction.

Table 1.1: Major Historical Events of Improved Water Mill Development in Nepal

Stages of Development	Year	Institutional Aspect	Programme/Policy	Technological Aspect
Pioneering and research • Technology introduction		RECAST/TU		Prototype of an IWM replacing the wooden paddles by hydraulically more efficient wooden blades, and a new bottom bearing. The prototype with closed chute and a covered chamber was tested in a mill at Godavari, Lalitpur.

1 The latest revision is the Subsidy Policy for Renewable Energy 2069 BS in effect from February 2013.

• Internalization and expansion		KMI		Low scale Multi-Purpose Power Unit (MPPU) consisting of a metal runner, a metal axle and bearings
Market development	1984-1988	GTZ/GATE	"Activating Traditional Indigenous Techniques" mainly in Dhading; 80 mills improved; Financial support up to 50%+25%	IWM
	1991-1993	CRT/N	"Dissemination of Improved Water Mill in Rural Villages of Nepal" supported by GTZ in Kabhrepalanchok and Sindhupalchok; 54 mills improved	IWM
	1993-1996	CRT/N	211 mills improved in various districts with support from various development agencies	IWM
	1996-1999	CRT/N with collaborative efforts of WDD/ MoLD, NGOs, INGOs, banks and local manufacturers	Supported by GTZ; 287 mills improved; target was 275 mills	IWM
Market expansion and regulation	2002 - 2010	AEPC, SNV and CRT/N; Accredited kit manufacturing firms, GOAs, SCs	IWM Programme; By December 2010, a total of 6,349 IWMs have been promoted	IWM, IWM electrification
	2011-2013	ESAP/AEPC and CRT/N	By 15 July 2013, additional 2,144 IWMs have been promoted	IWM, IWM electrification

Source: Data for market development phase from CRT/N (2000). Data for later years are from IWM Programme.

2. Improved Water Mill Technology

2.1 Traditional Water Mill

The basic principle in operation of any water mill is the conversion of kinetic energy of falling water into mechanical energy. After the diversion of stream water through simple construction of stones or brush wood weirs, earthen channel (20-200 m) carrying about 40-100 litre per second (lps) water is extended and led towards the water mill. In a traditional water mill (TWM) the water is then fed through a wooden chute (made out of hollow trunk of tree) which is inclined at an angle of 40-50 degree to the horizontal axis with a vertical head of 3-7 m. There is a gate (made of piece of flat stone) for safety overflow which is opened when the mill is to be stopped. When the gate is opened the water is diverted away from the water mill. A wedge is inserted at the end of the chute to direct the water to the runner. The centre-piece of the turbine runner is a massive boss in which a forged steel tip is driven into the lower cone. The sketch of a TWM is given in Fig. 2.1.

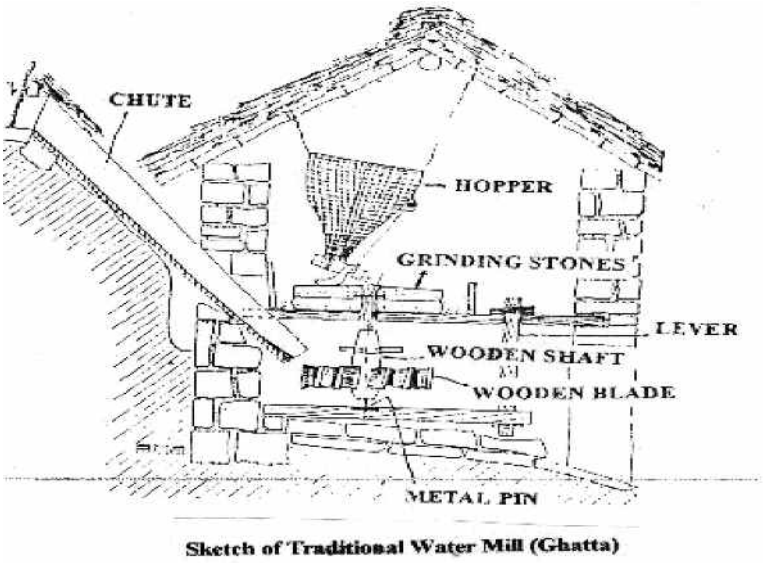


Fig. 2.1: Traditional Water Mill

The wooden blades of the turbine runner measuring approximately 18 cm by 25 cm and having 6 cm by 6 cm peg on the other side are driven in the boss tightly. The boss is coupled to its counterpart with a wooden wedge and then led to the shaft and key at the top. The whole runner rests on a steel plate with conic depression. The shaft of the runner projects above the bottom of the grinding stone in which the key is inserted. The key exactly fits in the slot on the upper grinding stone and runs the mill. The grinding stone is made locally which is grooved from time to time as per the requirement. The revolution per minute (rpm) of the shaft is around 120 to 160 rpm and the power output ranges from 0.2 kW to 0.5 kW.

The grinding capacity of a TWM ranges from 10-20 kg maize per hour while its frequency of repair and maintenance is considerable.

There exist about 25,000 traditional water mills across the country which have been in use for centuries by the communities in the hill and mountain regions of Nepal. TWMs have been a major source of rural energy for agro-processing.

2.2 Improvements on the Water Mill

The Research Centre for Applied Science and Technology (RECAST) developed a prototype of an Improved Water Mill in which the wooden paddles were replaced by hydraulically more efficient metallic blades along with a new bottom bearing. The prototype with closed chute and a covered chamber was tested in a mill at Godavari in Lalitpur district.

Kathmandu Metal Industries, a private establishment, further developed the technology in the form of a low scale Multi-Purpose Power Unit (MPPU). It consisted of a metal runner, a metal axle and bearings which were supplied to the millers to assemble and install at the site. Most of the components including the machineries were of metal, which increased the cost of the system.

Major efforts towards the improvement of water mill were initiated by GTZ/GATE under "Activating Traditional Indigenous Techniques" programme in which the traditional water mills were improved by using local materials and skills of village craftsmen. While the metal parts mainly the kit runner, shaft/axle, and belt/pulley were improved the other parts of the water mill such as chute, framework, stone grinder, canal and intake were kept intact without any change. This provided the interested entrepreneurs an opportunity to install IWM with low investment.

2.3 Improved Water Mill Technology

The Improved Water Mill (IWM) is a modified version of traditional water mill. IWM is an intermediate technology that increases the efficiency of the traditional water mill resulting in increased energy output thus helping both the millers and its users. The improvement covers basically the replacement of wooden parts (rotor, shaft and chute) with metallic parts. This increases its operational efficiency as well as making it more useful with additional machines for hulling, electricity

Fig. 2.2: Metallic Runner of an Improved Water Mill

generation and so on. The rotations per minute (rpm) of the shaft range around 200-300 rpm while the power output ranges from 0.5 kW to 3 kW. The grinding capacity ranges from 20-50 kg maize per hour. The frequency of repair/maintenance of IWM is low in comparison to TWMs while the life span is around 10 years. The chute is mostly wooden, sometimes however are found also of polyethylene or of tin sheet. The metallic runner of an IWM is shown in Fig. 2.2.

The basic functional features of a TWM and an IWM are compared in Table 2.1.

Table 2.1: Basic Functional Features of Traditional and Improved Water Mills

Comparison Parameters	Traditional Water Mill	Improved Water Mill
Length of canal, meter	20-200	20-200
Working head (H), meter	3-7 (max.)	2-7
Water discharge (Q), lps	40-100	30-100
Speed, rpm	60-90	110-210
Inclination to chute (degree)	40-50	30-40
Output power capacity (kW)	0.2-0.5	0.5-3.0
Grinding stone	Local	Local
Thickness of grinding stone (inch)	3-10	5-15
Diameter of grinding stone (inch)	24-34	24-34
Operational efficiency (%)	Below 25	30-50
Functions and capacity	Grinding cereals grains only (maize, millet, wheat, rice, etc.), 10-20 kg/hr	Grinding of cereals (maize, millet, wheat, rice etc), 20-50 kg/hr
		Dehusking/partial polishing of paddy (50-70 kg/hr)
		Expelling oil from oilseeds (10-15 kg/hr)
		Generation of electricity (12V-DC, 220V-AC, 1-3 kW)
Repair/maintenance	High	Low
Life span	2 years	10 years

The IWM now exists in two versions: first, IWM with a short shaft, and second, IWM with a long shaft. The shaft length is measured from the takkar (pivot) to the phali (key) of the system. The length of a short shaft is 4 feet whereas the length of a long shaft is 6 feet. A short shaft IWM is used for grinding only whereas a long shaft IWM has diverse uses of its power. Having a longer shaft, the long shaft IWM can run a number of machineries

transferring its power through suitable couplings. Thus, with a longer shaft, IWM has great versatility in its final delivery of services. Though the installation cost increases, a long shaft IWM provides opportunity for the investor to diversify his/her business. The selection of whether to install a short shaft or a long shaft also depends on the availability of water power. To run a long shaft IWM and consequently other machineries coupled to it, the site needs suitable power input. A list of power requirement for various rural applications is given in Table 2.2.

A range of potential end uses have been tested and promoted. They include huller, husker/polisher, flattened rice beater, oil expeller, saw milling, *lokta* beater, water pumping, spice grinding, electrification, and battery charging. Lately, experiments are going on with sugarcane crusher and tea squeezer. Among all the end uses, possibility of electrification through long shaft IWM has attracted the interest of professionals and concerned agencies as well as the end users. It has opened the possibility of providing electricity to the most neglected sections of rural communities at a reasonable price.

IWM technology can generate up to 3 kW of electricity sufficient for lighting and operating small electric and electronic devices such as television, radio, computer, battery charging stations, and other small electric home appliances. Research and field tests are being carried out to increase the capacity of IWM system up to 5 kW with support from SNV, German Development Corporation (GIZ) and AEPC and with direct involvement of CRT/N and Rural Energy and Technology Service Centre Pvt. Ltd. (RETSC). The expected outcomes of this capacity enhancement effort will ensure better coverage of households, diversification of different end use ranges and opening up of possibility for new enterprises (e.g. IWM power run micro enterprises, etc.).

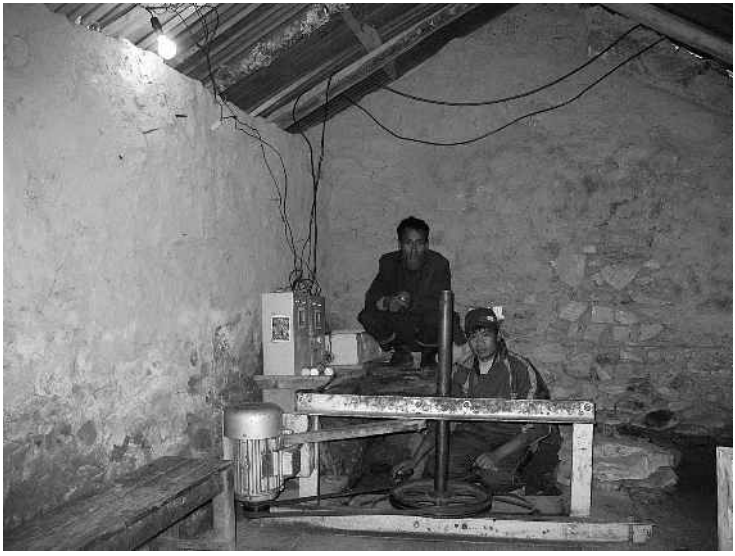


Fig. 2.3: Generation of Electricity from a Long Shaft Improved Water Mill

Table 2.2: Power Requirements for Various Rural Applications

SN	Mill Machinery	Power Required (kW)
1	Grinder (maximum 40 kg/hour)	0.7-1 kW
2	Grinder (maximum 80 kg/hour	1.75-3.5 kW
3	Rice huller no 4 (175 kg/hour)	3.7 kW
4	Rice huller no 5 (80 kg/hour)	2.2 kW
5	Rice huller no 6 (350 kg/hour)	5.1 kW
6	*Allo* processing	0.3 kW
7	Bitten rice mill	4.1 kW
8	Tea squeezer	1.5 kW
9	Coffee pulper (roller)	0.37 kW
10	Coffee pulper (drum)	0.76 kW
11	Oil expeller 4 bolt	3.7 kW
12	Oil expeller 6 bolt	3.7-5.1 kW
13	Wheat thresher	0.74 kW
14	*Lokta* beater	2.2- 3.7 kW
15	Saw mill	1.5 kW
16	Sugarcane crusher	1-1.5 kW
17	Water pump	1.5 kW
18	Electricity generation (3kW)	3-5 kW

3. Policy Environment

Although Improved Water Mill (IWM) was promoted in a planned way since 1984, it took more than one and a half decade to draw attention of policy makers/planners towards it. While subsidy incentive was already in place for installation of other renewable energy technologies like biogas plant, micro-hydro plant and solar home systems, IWM has been in exclusive focus since the promulgation of the Subsidy Policy (AEPC, 2000) in 2000 only. It received more specific recognition in the Rural Energy Policy 2006 and subsequent revisions of the subsidy policy. The financial support on IWM from the Government's side became a reality after initiation of the IWM Programme with support from SNV Netherlands Development Organisation in 2002. IWM has got policy prominence in the periodic plans starting from the Tenth Plan (2002-2007). The Water and Energy Commission Secretariat (WECS) exclusively highlighted contribution of IWM in energy supply of Nepal in its 'Energy Sector Synopsis Report Nepal 2010' (WECS, 2010).

Following sections briefly explore importance given to IWM at periodic plans and other relevant policy document.

3.1 Periodic Plans

The Ninth Plan (1997-2002) did not mention about IWM. Nonetheless, the long-term concept and policy and implementation strategy were set broadly such that they did not restrict IWM to be promoted under the framework of alternative energy. In fact, the Subsidy Policy 2000 which was promulgated during the Ninth Plan period had clear provision of subsidy for electrification through IWM.

After 2002, the potential role that IWM could play in poverty reduction has been well acknowledged at policy level. The Tenth Plan (2002-2007) mentioned IWM categorically for the first time. It set a physical target of 4,000 IWM installations during the Plan period (NPC, 2002). The Plan had a long-term vision of "accelerating economic development, improving living standard of the rural people, increasing the employment opportunities, and maintaining environmental sustainability through the development of rural energy systems." The relevant policies set in the Plan were:

- Promotion and expansion of micro hydropower, solar power, wind power, and improved cook stoves in the rural areas.
- Expansion and development of alternative energy to uplift life standard of rural people.
- Attracting community and private sector in the development and promotion of alternative energy.

Also Alternative (Rural) Energy Subsidy Policy and Subsidy Implementation Work Plan were developed and brought to implementation within the framework of the objectives and policies set for the alternative energy sector. For the development of alternative energy together with rural electrification supported from large hydropower projects, the Rural Energy Policy was also approved.

The Three Year Interim Plan (2007-2010) has considered alternative energy to contribute

towards rural development, enhance rural economy and quality of rural life, increase employment opportunities and contribute towards sustainability of the environment. The objective of alternative energy development and promotion, as set in the Plan, is to develop environment friendly energy technologies used on local resources and integrate it to the social and economic activities that will eventually contribute towards poverty alleviation and towards improving the livelihood through enhanced productivity and increased employment opportunities (NPC, 2007).

Although the Plan has not exclusively stated strategies and working policy for IWM, it has broadly included IWM in the small and micro-hydropower category. It has set a quantitative target of installation of 4,000 units of IWM in 40 districts. The Plan strategy has given priority to development of small and micro-hydropower, which includes IWM. The corresponding working policy states that "in order to make the development programme of small and micro-hydropower effective, and to support in effective operation, repair and maintenance of completed hydropower project, Regional Service Centres shall be established besides expanding the Rural Energy Development Branch." The Plan has also encouraged the community and the private sector in the development and expansion of IWM as well as other alternative energy sources.

The Three Year Plan Approach Paper (2010-2013) has emphasised that the majority of the households in the country should have greater access to modern energy sources. With respect to alternative energy, the Plan has an objective to improve the living standard of rural people, increase employment and productivity, reduce dependency on traditional energy and attain sustainable development through integrating the alternative energy with the socioeconomic activities of rural communities. As in the Three Year Interim Plan (2007-2010), the Three Year Plan Approach Paper (2010-2013) has not exclusively stated strategies and working policy for IWM, it has broadly included IWM in the small and micro-hydropower category and has set a target of installing 4,500 IWMs in 40 districts. The Plan has proposed establishment of micro-hydro revolving fund for ensuring the sustainable investment in micro and small hydro projects (NPC, 2010).

The Thirteenth Plan Approach Paper (2013-2016) has acknowledged the promotion of IWM in the past. As in the preceding three year plans, the Thirteenth Plan has emphasized promotion of micro and small hydropower which presumably includes IWM as well (NPC, 2013).

3.2 Policy Documents

The relevant policy documents having relevance to IWM include the Rural Energy Policy 2006 and various revisions of the Subsidy Policy promulgated in 2000.

The Rural Energy Policy 2006 promulgated for the first time in 2006 has a separate section on IWM. It has reiterated the emphasis on improving traditional water mills for grinding and hulling. It has also encouraged participation of private sector for production of IWM kits at local level. Moreover, it has encouraged electrification through IWM (MoEST, 2006).

Acknowledging that an IWM can generate electricity, the Subsidy Policy 2000 for the first time made a provision of subsidy for electrification from IWM which was based upon total

electrical power output (AEPC, 2000). The Subsidy Policy 2006 has continued the provision of subsidy for electrification through IWM. However, the basis for subsidy allocation has been modified. The subsidy is provided on the basis of number of households electrified with a ceiling in the upper end on per kilo watt basis (AEPC, 2006). The policy also formalised the provision of subsidy provided to IWM for grinding and hulling. Moreover, the policy has a provision of additional subsidy for grinding and hulling through IWM in remote districts and specified districts not connected by roads.

The Government of Nepal has replaced the Subsidy Policy 2006 by Subsidy Policy 2008, which gives continuation to the subsidy scheme with increased subsidies (AEPC, 2008). The intention is to accommodate swift price hikes in recent times. Moreover, the policy has a new provision of extra subsidy for remote districts not yet connected to a motorable road, namely Dolpa, Humla and Mugu.

The Subsidy Policy 2008 has been replaced by Subsidy Policy for Renewable Energy 2013 from February 2013. The policy has addressed the different market segments in terms of remoteness and type of services e.g. mechanical applications and electrification. The market for mechanical applications has been further subdivided considering intensity of the financing needs services provided by short and long shaft IWMs.

Table 3.1 highlights subsidy provisions for IWM under various policy documents mentioned above. As can be noted, in the later years, different levels of subsidy have been provisioned for different market segments.

Table 3.1: Financial Support/Subsidy under Various Programmes/Policies

Programme/Policy	Subsidy Provision	Purpose
"Activating Traditional Indigenous Techniques" supported by GTZ/GATE, 1984-88	Financial support up to 50% in the beginning up to 25% in the later phase of the programme	Installation of IWM
Subsidy Policy 2000	NPR 27,000 per kW	If electrification from IWM
Subsidy Policy 2006	NPR 4,000 per household but not exceeding NPR 40,000 per kW NPR 9,000 for grinding and NPR 18,000 for hulling and grinding; Additional NPR 1,500 for grinding and NPR 3,000 for hulling and grinding in specified remote districts	If electrification from IWM Installation of IWM for grinding or hulling and grinding purpose

Subsidy Policy 2008	NPR 6,000 per household but not exceeding NPR 60,000 per kW NPR 12,000 for grinding and NPR 27,000 for additional end uses; Additional NPR 2,000 for grinding and NPR 3,500 for other end uses in specified remote districts Extra NPR 3,000 for grinding and NPR 4,500 for other end uses in Dolpa, Humla and Mugu districts	If electrification from IWM Installation of IWM for grinding or hulling and grinding purpose
Subsidy Policy 2013	In case of short shaft IWM: NPR 20,000 for category A VDCs; NPR 18,000 for category B VDCs; NPR 16,000 category C VDCs. In case of long shaft IWM: NPR 40,000 for category A VDCs; NPR 38,000 category B VDCs; NPR 35,000 category C VDCs NPR 8,000 per household and NPR 20,000 per kW transportation subsidy for category A VDCs; NPR 7,000 per household and NPR 10,000 per kW transportation subsidy for category B VDCs; NPR 6,000 per household and NPR 5,000 per kW transportation subsidy for category C VDCs. But, the maximum subsidy amount per kW will not exceed NPR 90,000, NPR 80,000 and NPR 70,000 in category "A", category "B" and category "C" VDCs respectively.	For mechanical applications For community owned IWMs, if it is electrifying

4. Quality Assurance Systems in Place

After initiation of the Improved Water Mill Programme supported by SNV Netherlands Development Organisation, the IWM sub-sector entered into market expansion phase. As the number of stakeholders grew and the installation rate increased, the need for quality control and other operational systems became more pertinent. In response, Alternative Energy Promotion Centre (AEPC) has developed and put into place the systems for assuring quality in products and service delivery.

The main mechanisms for quality assurance in place are:

- Pre-qualification of kit manufacturers, IWM electrification installers and Local Partner Organisations (LPOs),
- Application of standard and guidelines,
- Third party monitoring, and
- Training.

4.1 Pre-qualification of Kit Manufacturers and Local Partner Organisations

The kit manufacturing companies are required to be pre-qualified by AEPC to be eligible to participate in the IWM promotion activities. The basic requirements for the companies include human resource, availability of production machineries, investment capacity etc. There were 17 pre-qualified IWM kit manufacturers in 2010, the final year of SNV's direct engagement in the IWM Programme. In 2013, AEPC has pre-qualified 14 IWM kit manufacturing companies.

Likewise, locally based private sector entities and non-government organisations are pre-qualified by AEPC and are considered as LPOs to be involved in IWM promotion activities.

4.2 Application of Standard and Guidelines

As implementer of the IWM Programme, Centre for Rural Technology, Nepal (CRT/N) has developed a quality control guideline with the help of SNV and in close consultation with the IWM kit manufacturers. The quality standards for IWM components was formalised in September 2006 and circulated to the manufacturers for implementation (CRT/N, 2006). The guideline is intended for ensuring quality by setting standards for IWM. The main aspects covered in the quality control guidelines are mentioned in Table 4.1.

Table 4.1: Quality Standards of Improved Water Mill

Activity Components	Issues Covered
Programme management	Identification of ownership, knowledge of operation, guarantee
Feasibility of the site	Plant location, available flow, net head, water discharge
Civil construction	Canal construction, base frame
Approved design of *Ghatta*	Specifications are fixed for fabrication of various components of the *Ghatta*
Installation of the *Ghatta*	Alignment of the shaft, installing and positioning of various components
Power transmission	Placing of the pulley
Superstructure	Shed suited for accommodating the *Ghatta* as well the end use device and movement of the operator and customers, ensuring their safety
Power measurement	Power output verification

Necessary formats have been developed for checking the quality at various stages. As the implementer of the IWM Programme, CRT/N checks all the IWM kits manufactured under these guidelines before dispatching to the sites. This enables correction of shortcomings in the product in its initial phase.

Once installation of IWM is completed, an initial check is carried out for each IWM installed by the concerned service centre and the subsequent recommendation is forwarded to CRT/N. CRT/N on its part verifies the IWM sites on a random basis through its field staff.

Since July 2013, nine Regional Service Centres (RSCs) and pre-qualified LPOs[2] have undertaken the above responsibilities under the framework of National Rural and Renewable Energy Programme (NRREP) of AEPC.

4.3 Quality Standards for Improved Water Mill Components

The quality control guideline prepared by the IWM Programme in March 2006, has set standards for IWM kits (CRT/N, 2006). It provides guidelines for the kit manufacturers to follow during fabrication of the components. Along with the specifications of the components, the materials to be used, and quality control process have been discussed. The document has covered the following components:

- *Fali* (welded model)
- Shaft (short model)
- Shaft (long model)
- Runner (NYS model)
- Runner (Bhagawati metal model)

2 Service Centres are now recognized as LPOs for IWM promotion by Community Electrification Sub-Component (CESC) of NRREP/ AEPC.

- Runner (Banepa model)
- *Takkar* (Pivot model)
- *Takkar* (Ball model)
- *Chakati* (Pivot model)
- *Chakati* (Ball model)

4.4 Monitoring

Establishment of quality management system is one of the important activities under IWM Programme needed to fulfil the targeted objectives. The field facilitators of the Programme monitor 25 percent of the total installation during survey and installation process by random sampling basis. Similarly, the Programme team also monitors the IWM sites frequently during field visits. After July 2013, the IWM sub-engineers of the RSCs have been involved in monitoring 30 percent of the total IWMs installed during a given period of time.

4.5 Capacity Building

The technicians working in LPOs are trained aiming at ensuring delivery of quality service to the local investors. The scope of the trainings includes feasibility study, installation, repair and maintenance as well as business planning. Basic trainings on such topics have been provided to the staffs working in LPOs as well as to some *Ghatta* Owners Associations (GOAs). Refresher trainings have also been organised. Targeting to IWM electrification schemes, AEPC provides additional training for the electricity operators. Moreover, some capacity building training focusing on gender and social inclusion aspects are also organised for IWM owners and users.

The increased technical and managerial capabilities of the service providers and millers have contributed towards sustainability of the IWM systems.

5. Institutional Development

Over time the Improved Water Mill (IWM) sub-sector has grown with the involvement of different players from public as well as private sectors. These institutions have been contributing at various scales and capacities for the promotion of IWM. The emerging cooperation between these institutions exemplifies what one can call a best practice in public-private-civil society partnership in community development.

The public sector institutions include the Alternative Energy Promotion Centre (AEPC) and the National Planning Commission (NPC). AEPC is the main executing agency of IWM Programme and is responsible for providing policy, coordination and monitoring support to execute the programme. NPC, on the other hand, is more involved in policy development.

Among the civil society organisations, Centre for Rural Technology, Nepal (CRT/N) has been the major promoter of IWM. CRT/N has been promoting IWM since 1991, which it did even without donor-support during 1993-1996. Until 2010, it was the main implementer of the IWM Programme, executed by AEPC with support from SNV Netherlands Development Organisation. Thereafter till mid 2013, it implemented the programme in the capacity of the technical service provider. Until 2010, it was responsible for overall management of the programme. It coordinated with the programme partners, facilitated to ensure quality management system, monitored the programme activities and facilitated for the required flow of information. In addition, it also provided support to service providers such as local Service Centres (SCs), manufacturers, Ghatta Owners Groups (GOGs), Ghatta Owners Associations (GOAs) etc. for their capacity development.

From 2002-2010, SNV provided financial and management expertise for the implementation of IWM Programme. It also monitored/evaluated the programme activities.

In the private sector, at least four different categories of institutions have emerged. They are: the kit manufacturing companies, SCs, GOAs and consulting firms.

The relationship between the major stakeholders is shown Fig. 5.1 (the line of support or line of service delivery).

In 2010, there were 17 manufacturing companies located in city centres in different parts of the country. Currently, there are 14 manufacturing companies engaged in manufacturing and supply of standard IWM kits. SCs procure kits from them. For most of the manufacturing companies, manufacturing IWM kit is an ancillary business. Though the IWM kit business adds to their income their sustainability is ensured by other major businesses. They are pre-qualified by the IWM Programme to participate in the subsidy scheme.

There existed 16 SCs in 16 programme districts in 2010 and were mostly based in district centres and owned by local investors. Currently, there are 27 SCs now called Local Partner Organisations (LPOs) in different districts. While in some districts, GOAs have been recognised as LPOs, in other districts private companies and civil society organisations have also been considered as LPOs. The range of services they deliver includes feasibility study, installation, and after-sales-services. In addition, they are involved in motivating IWM owners for overall improvement of IWM management, facilitating IWM owners for subsidy applications and credit facility from micro financing institutions, technology demonstration, and initiation of the end use diversification.

The SCs have emerged as a result of capacity building support provided by the IWM Programme.

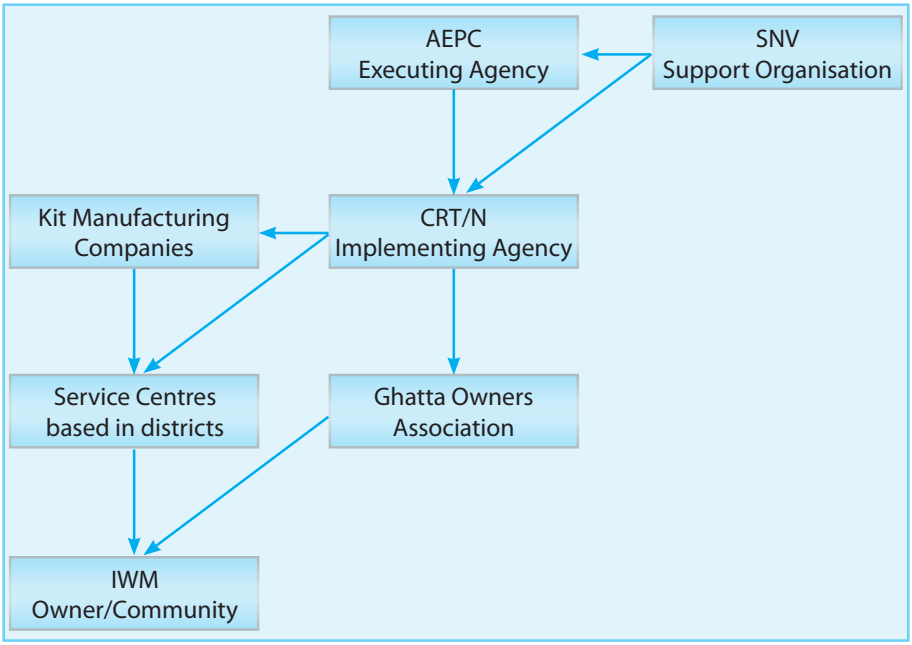


Fig. 5.1: Major Stakeholders in Improved Water Mill Promotion (until December 2010)

The GOAs are private sector institutions, also promoted by the IWM Programme. The concept of GOAs was first pioneered by CRT/N and tested in Kabhrepalanchok and Makawanpur districts under the International Centre for Integrated Mountain Development (ICIMOD) supported **Strengthening Organisational Capacity through Ghatta Owners' Association** project from April-December 2001. GOAs work for the welfare of the IWM owners. Most of the locally organised GOAs are strong enough to advocate for their own benefits and rights. GOAs together with SCs (now LPOs) have been institutional vehicles for raising awareness and promotion of IWM in rural areas. Some of the GOAs also work as LPOs. The well developed local institutions are attributed to the successful implementation of the IWM Programme without disruption even during the conflict era.

Micro financing institutions in some of the programme districts are active in promotion of IWM. They do so in coordination with LPOs and GOAs.

In the city centres, few private firms have taken interest in extending consulting services to AEPC and the IWM Programme. They have been involved in conducting studies and trainings on IWM.

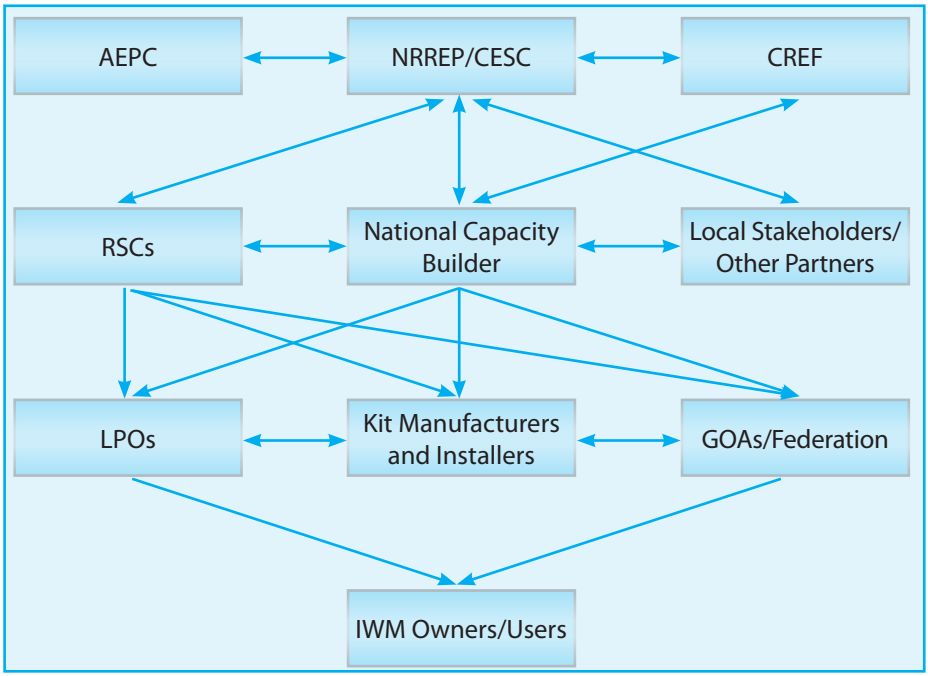


Fig. 5.2: Major Stakeholders in Improved Water Mill Promotion (from July 2013)

Currently, the relationship between key stakeholders involved in the IWM promotion under National Rural and Renewable Energy Programme (NRREP) framework is as shown in Fig. 5.2.

The Community Electrification Sub-Component (CESC) of NRREP provides overall coordination and implementation support to the stakeholders. The Central Renewable Energy Fund (CREF) administers the subsidy for IWMs. The Regional Service Centres (RSCs) of NRREP located in different parts of the country coordinate local level promotional activities while the LPOs extend their services for supply and installation of IWMs. The National Capacity Builder extends technical support to the implementing partners in capacity building and knowledge management.

Apart from the major stakeholders mentioned above, a number of support organisations, civil society organisations, financing as well as academic institutions are contributing with their own scope and in their own capacity for the development of IWM in Nepal. While some of them are directly involved in the promotion in terms of capacity building, financial or social mobilisation support, others are involved in creating an enabling environment or just providing motivation to the main stakeholders.

6. Improved Water Mill Development Programmes

6.1 Pioneering Programmes

The first programme launched to promote Improved Water Mill (IWM) was entitled **Activating Traditional Indigenous Techniques** and was implemented by German Technical Cooperation (GTZ/GATE). The programme was implemented in Dhading district in central Nepal during 1984-88. There was provision of financial support for improvement of the water mills. Altogether 80 mills were improved. This programme helped enhance confidence in the technology.

GTZ again initiated a programme to continue dissemination of IWMs from 1991-93. The Centre for Rural Technology, Nepal (CRT/N) was taken as implementing agency for the programme **Dissemination of Improved Water Mill in Rural Villages of Nepal.** Under this programme, 54 water mills were improved in Kabhrepalanchok and Sindhupalchok districts.

Having gained experience from the programme, CRT/N continued to provide its services to water millers to improve their water mills during next three years. About 211 water millers came forward to improve their water mills during the period. This initiative was important in understanding social acceptance aspect of the technology. The initiative was inspiring as it showed potentiality for the market development for IWM across the country.

Inspired by the local response, GTZ once again supported CRT/N to promote IWMs in rural areas during 1996-99. Under the new initiative CRT/N took the approach of working in partnership with agencies like Women Development Division of the Ministry of Local Development, various local non-government organisations and some international non-government organisations, banks, and local kit manufacturers. This initiative thus marked the beginning of growth of institutions in the promotion of IWMs.

CRT/N continued mobilising resources from various donor agencies for the promotion of IWM. The major focus was on awareness creation, installation, diversification of end uses as well as institutional development. The briefs of the projects undertaken are as below.

CRT/N launched **Promotion and Dissemination of Appropriate Technologies** in Lamjung, Sankhuwasabha and Bhojpur districts with funding support from Rural Development Programme of GTZ Nepal from March 1999-December 2001. The project was aimed at demonstrating, promoting and disseminating new and improved technologies such as IWM. Seventeen IWM were disseminated under the project (CRT/N, 2001). The project was further extended in Lamjung district for a year from March 2002 with changed project heading of **Support Community Initiated Appropriate Rural Technology Dissemination.** Efforts were also made to diversify the end uses of IWM, for instance saw milling and electrification (CRT/N, 2002).

CRT/N with support from Canadian Cooperation Office launched **Lamjung Energy Resource Development through Alternative Technology Project** from October 2000-August 2001. The main purpose of the project was to enhance the capacity of local communities to meet their basic domestic energy needs through promotion of environment friendly alternative technologies in the targeted project areas. Under the project 3 IWMs were promoted along with other appropriate technologies.

With support from International Centre for Integrated Mountain Development (ICIMOD), CRT/N launched **Strengthening Organisational Capacity through Ghatta Owners' Association** in Kabhrepalanchok and Makawanpur districts from April-December 2001. Under the project, 17 Village Development Committee (VDC) level groups of *ghatta* owners were formed with an aim to form district and national level IWM owners associations.

CRT/N launched an electrification project powered by IWM at Daraune Pokhari Village Development Committee in Kabhrepalanchok district in April-October 2002. The project was supported by Light up the World.

The above initiatives were not only important for gaining confidence in the technology, but were also crucial in creating market for the technology and most importantly attracting attention of the donor community and the planners towards the technology. As a result, SNV Netherlands Development Organisation came forward to support the promotion of IWMs. CRT/N was the obvious choice as the implementing agency. Thus, as a preparation for the IWM Programme, the IWM Inception Phase was initiated in March 2002 for a period of about 10 months. Subsequently, the implementation of the IWM Programme was started in four pilot districts, namely, Lalitpur, Ramechhap, Kabhrepalanchok and Makawanpur with support from the Alternative Energy Promotion Centre (AEPC) and SNV. Soon the Programme was extended to 12 more districts, namely, Taplejung, Panchthar, Ilam, Sindhupalchok, Dolakha, Nuwakot, Baglung, Nuwakot, Myagdi, Surkhet, Dadeldhura and Baitadi.

6.2 Improved Water Mill Programme (2002-2010)

The IWM Programme was implemented by CRT/N with support from the Government of Nepal through the AEPC and the Netherlands Government through SNV as part of Nepal's Renewable Energy Sector Support (RESS) Programme from early 2003 to 2010. The pilot phase of the Programme was commenced in 2002.

AEPC has mainly provided policy and monitoring support services while SNV has provided financial and advisory support services on programme management and set-up, institutional development and organisational strengthening, marketing, etc.

The IWM Programme intended to contribute to:

- Increased income for 7,400 traditional water millers through transformation of their traditional water mills to IWMs by December 2010.
- Reduced workload for diversified agro-processing services of about 384,000 households, often women and girls.
- Diversified agro-processing services for about 57,000 rural households.
- A minimum of 50 percent of owners/millers organised into groups and associations and sustained IWM sub-sector as a result of improved institutional and local capacity building.
- 25 percent IWM owners including women and socially excluded involved in income generation activities directly/indirectly linked with IWM and in 10 percent of the cases supported by other Renewable Energy Technologies installed.

- Significantly increased sustainability of IWM sector as a result of improved institutional and local capability.

In principle, the IWM Programme included all hill and mountain districts of Nepal. However, it was operational only in 16 districts (Panchthar, Ilam, Makawanpur, Lalitpur, Kabhrepalanchok, Sindhupalchok, Ramechhap, Dolakha, Nuwakot, Dhading, Pyuthan, Surkhet, Jumla, Kalikot, Dadeldhura and Baitadi). The service was extended to additional three districts, namely, Rasuwa, Sindhuli and Mugu with provision of delivery of service form the service centre of adjacent districts.

Fig. 6.1: Efficient Agro-processing from an Improved Water Mill

The IWM Programme was targeted to water millers in the hill and mountain areas of Nepal owning a traditional water mill. Indirectly the IWM Programme addressed the agro-processing and electrification needs of rural communities especially of the women who depend on the services of local traditional water mills, kerosene, and encroaching diesel mills.

The IWM Programme activities included:

- Awareness creation regarding IWM technology through establishment of orientation and demonstration sites, documentary, radio programme and production and distribution of various information brochures and leaflets.
- Inventorying the watermills in the districts.
- Organizing water mill owners by supporting them to create *Ghatta* Owners Group (GOG) and *Ghatta* Owners Association (GOA).
- Establishment of quality management system.
- Capacity building of local service providers.
- Arrangement of credit from local micro finance institution.
- Arrangement of IWM kits from pre-qualified manufacturers.
- Facilitate the pre-qualification of service providers from AEPC.
- Follow-up and monitoring of the installation and programme activities.
- Research and development for innovation.

Providing subsidy for purchasing and installation of the IWM was an inbuilt feature of the programme. For various subsidy provisions, refer to Table 3.1.

The IWM Programme has focused on integrating gender equality and social inclusion into its activities. A Gender and Social Inclusion (GESI) Strategy Paper has been prepared in 2012 to provide a tool for effective mainstreaming of GESI in the IWM Programme, guide the team members to plan, implement, monitor and evaluate GESI-sensitivity of the IWM Programme.

Earlier, CRT/N with support from ENERGIA: International Network on Gender and Sustainable Energy had conducted a gender baseline survey of IWM and piloted gender tools in some IWM sites (CRT/N, 2004).

By December 2010, altogether 6,349 IWM installations have taken place under the IWM Programme thus providing services to 330,000 households. Seventeen of them are electrification projects and are serving 850 households. The IWM Programme has been instrumental in organising water mill owners into GOGs and GOAs. A number of GOAs are in the process of establishment in existing programme districts. These Associations have been officially registered and have a legal status. They have been advocating their rights at all levels and have been successful in playing a pro-active role during conflicts. In December 2010, there existed 16 Service Centres (SCs), 13 GOAs[3] and 17 kit manufacturers. More than 750 people have been directly employed in the IWM sub-sector and the income level of mill owners has been significantly increased (about 25 percent for short shaft and 100 percent for long shaft IWM). The IWM Programme has thus contributed to fulfil various millennium development goals: mainly poverty reduction, access to education, gender empowerment, maternal health, reduction in child mortality and better environment.

6.3 Integration of Improved Water Mill Programme with Energy Sector Assistance Programme

SNV's direct involvement in the IWM Programme ended in December 2010. The Programme was integrated with Energy Sector Assistance Programme (ESAP) of AEPC from 2011, without major alteration in the programme implementation modality. Thus, ESAP assumed the lead role whereas CRT/N continued being the implementer of the Programme. After the integration with ESAP, the Programme extended its working districts from 19 to 33 covering all hilly and mountain districts of Mid-Western and Far-Western Development Regions. However, the subsidy provision was opened for all districts of the country on demand basis. To extend the services of programme in Far-Western Development Region, a regional unit was established in Dadeldhura district.

During the period from January 2011 to June 2012, a total of 1,178 IWMs were installed out of which 1,072 with short shaft only for efficient grinding and 106 with long shaft for grinding as well as other end uses (CRT/N, 2012a).

6.4 Improved Water Mill Technology under National Rural and Renewable Energy Programme

As ESAP has been phased out, the IWM Programme is now executed under the National Rural and Renewable Energy Programme (NRREP) framework of AEPC since January 2013. CRT/N remained as implementer of the Programme until July 2013 with continuation of the earlier programme modality. During the period from mid July 2012 to mid July 2013, a total of 966 IWMs were installed with 896 short shaft and 70 long shaft IWMs (CRT/N, 2013).

From July 2013 onwards, the Community Electrification Sub-Component (CESC) of NRREP is leading the IWM promotional activities with a new implementation modality sown in Fig.

3 Additionally, one *Ghatta* Owners Association is still in the process of registration with the government; 2 others are not active (Ilam and Ramechhap).

5.2. Among others, IWM is considered as one of the options for community electrification. With respect to IWM, CESC has focused on capacity building of stakeholders as a promotional strategy. While the main approach of working through private sector and partner organisations have remained the same, CESC now has fostered the participation of Regional Service Centres (RSCs), Local Partner Organisations (LPOs), GOAs, private sector kit manufacturers and Rural Energy and Technology Service Centre Pvt. Ltd. (RETSC), a private company, as the National Capacity Builder in its implementation. The subsidy support to IWM owners is channelled through CESC by Central Renewable Energy Fund (CREF).

During its timeframe from 2012 to mid 2017, NRREP has a target of promoting 4,000 IWMs

6.5 Promoting Renewable Energy Technologies for Enhanced Rural Livelihood Project

CRT/N has been implementing the **Promoting Renewable Energy Technologies for Enhanced Rural Livelihood Project** in 25 Village Development Committees (VDCs) of districts in Far Western Development Region, namely, Achham, Baitadi, Doti, Dadeldhura and Kailali from December 2011 to November 2013. The project is supported by Nordic Environment Finance Corporation (NEFCO**)** within the framework of Nordic Climate Facility (NCF) through the Finish Consulting Group Ltd. (FCG), Finland. The objective of the project is to reduce greenhouse gas emissions and improve living conditions and economic situation of rural people in remote districts of far western region of Nepal via application of renewable energy technologies. The project has a target of promoting 100 IWMs in the hilly parts of the project area. By July 2013, the project has promoted 13 long shaft and 52 short shaft IWMs.

6.6 Supporting Development of the Improved Water Mill Sector and its Actors

SNV Netherlands Development Organisation once again came forward to contribute towards IWM sector development in 2012 as it entrusted Rural Energy and Technology Service Centre Pvt. Ltd. to carry out a brief project entitled 'Supporting Development of the IWM Sector and its Actors'. A fresh baseline of water mills in Nepal was carried out under the Project. The main objective of this study was to find the baseline situation of water mills of Nepal. Based upon a scientifically designed sample survey, the study estimated total number of existing traditional and IWMs in various districts of the country. The study concluded that as of mid 2012 altogether 22,676 traditional water mills and 7,527 IWMs (short shaft 6,594 and long shaft 933) and 23 IWM electrification schemes existed in 53 districts. The study also confirmed that on an average one IWM can be considered as serving 52 households of the communities.

Apart from the baseline survey, the Project also contributed to capacity building of GOAs and supported them towards establishing their national federation. The Project focus was also on entrepreneurship and enterprise development of IWM owners linking with micro finance provisions. Under the Project some efforts also made for improving efficiency and develop new end-uses including electrification, and lobbied for conducive policy environment for IWM Electrification.

6.7 Rural Community Electrification with Water Mill and Micro Enterprise Development in Nepal (Proof of Concept)

SNV has initiated the **Rural Community Electrification with Water Mill and Micro Enterprise Development in Nepal (Proof of Concept)** with CRT/N as the implementing agency starting from July to December 2013. SNV has partnered with Energizing Development/German Development Corporation (EnDev/GIZ) and AEPC in this pilot initiative. The Project has aimed a number of innovations and an integrated sector development approach starting from Kabhrepalanchok district with the targets of four IWM Electrification projects providing 100 households with electricity for lighting and two micro-entrepreneurs using electricity for productive end use. The Project aims to prove business model for household electrification and productive use with IWM electrification, providing the basis for a well operating loan model and hence a clear potential for up-scaling. An introduction and summary of the Project outcomes and lessons learned is presented in Appendix.

7. Market Potential and Expansion

7.1 Market Potential

A study conducted by Rural Energy and Technology Service Centre Pvt. Ltd. (RETSC) and Centre for Rural Technology, Nepal (CRT/N) with support from SNV Netherlands Development Organisation in 2012 reported existence of 22,676 traditional water mills spread in 52 districts of the country. The same report revealed that about 7,527 Improved Water Mills (IWM) existed at the time. This study thus confirmed the general belief that there are at least 25,000 traditional *ghattas* located mainly in the mid hill areas from east to west in the country.

A baseline study conducted in the 16 districts under IWM Programme shows that about 90 percent of the existing traditional *ghattas* can be improved. Considering this as the improvement potential factor, an estimated 20,400 *ghattas* (out of 22,676) could be potentially improved. Table 7.1 shows proportion of market satisfied by IWM in 34 districts as of mid 2012. The overall market satisfaction level in the districts was 32 percent by that time which has increased to 33 percent by mid 2013. Considering other districts as well where existence of traditional water mills (TWMs) has been reported but existence of IWMs is not reported, the overall market satisfaction level was 27 percent by mid 2012 and 30 percent by mid 2013. It is thus clearly visible that there still exists a huge market (70%) available for intervention in the country.

Table 7.1: Proportion of Improved Water Mill Market Satisfied in Various Districts (mid 2012)

District	No. of Existing TWM	No. of TWM Potential for Improvement	No. of IWM Installed by mid 2012	Total Market Size	% of Market Satisfied
Achham	328	295	30	325	9%
Baglung	243	219	37	256	14%
Baitadi	766	689	290	979	30%
Bajhang	459	413	41	454	9%
Bajura	1192	1073	8	1081	1%
Dadeldhura	540	486	228	714	32%
Dailekh	376	338	74	412	18%
Darchula	607	546	42	588	7%
Dhading	691	622	482	1104	44%
Dolakha	631	568	552	1120	49%
Doti	614	553	57	610	9%
Gorkha	128	115	12	127	9%
Ilam	72	65	58	123	47%
Jajarkot	449	404	21	425	5%
Jumla	906	815	164	979	17%
Kabhrepalanchok	813	732	788	1520	52%
Kalikot	1858	1672	334	2006	17%
Lalitpur	374	337	304	641	47%

Makawanpur	1278	1150	1067	2217	48%
Mugu	445	401	11	412	3%
Myagdi	157	141	18	159	11%
Nuwakot	1207	1086	1029	2115	49%
Okhaldhunga	142	128	59	187	32%
Panchthar	0	0	16	16	100%
Pyuthan	99	89	79	168	47%
Ramechhap	661	595	414	1009	41%
Rasuwa	85	77	57	134	43%
Rolpa	674	607	6	613	1%
Salyan	1045	941	39	980	4%
Sindhuli	275	248	337	585	58%
Sindhupalchok	599	539	472	1011	47%
Surkhet	357	321	398	719	55%
Tanahun	11	10	1	11	9%
Taplejung	10	9	2	11	18%
Total	18092	16284	7527	23811	32%

Source: RETSC and CRT/N (2012) and CRT/N (2012)

The IWM Programme has reported that new installations of IWMs have also taken place in some of the districts rather than just improvement of the existing TWMs. This indicates that there is additional market potential in some of the districts.

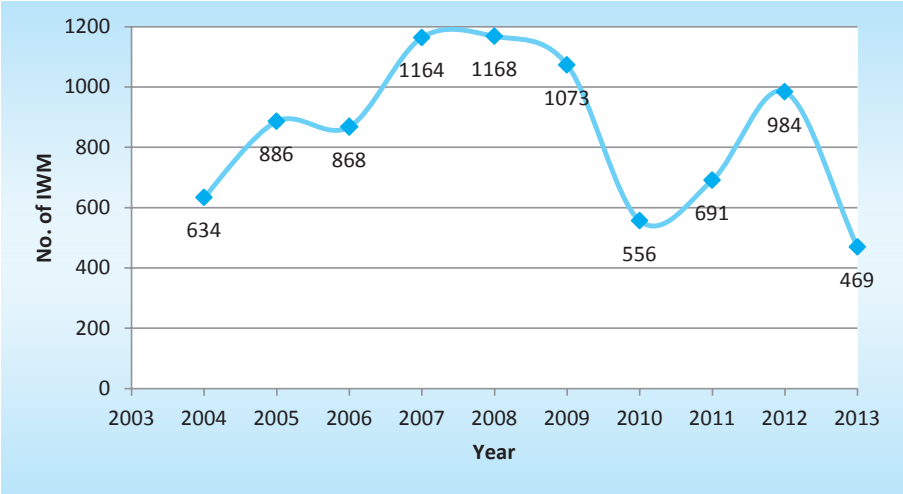


Fig. 7.1 Trend of Market Development for Improved Water Mill

Note: The data for 2013 corresponds to only first half of the year.

Source: CRT/N (2008) and IWM Programme

The year wise trend of market growth, as depicted in Fig. 7.1, shows an upward bounding trend until 2009. In 2010, the installation rate decreased when the transition of the programme support from SNV to Energy Sector Assistance Programme (ESAP) was initiated. However, there was an indication in 2010 that the growth trend would continue at even higher rate in following years (the total number of applications received during 2010 from the then 19 programme districts was more than 1,000). Accordingly, the market growth is again showing upward bounding trend in the recent years. The yearly demand of IWM across the country could be higher as the programme has been extended to more districts.

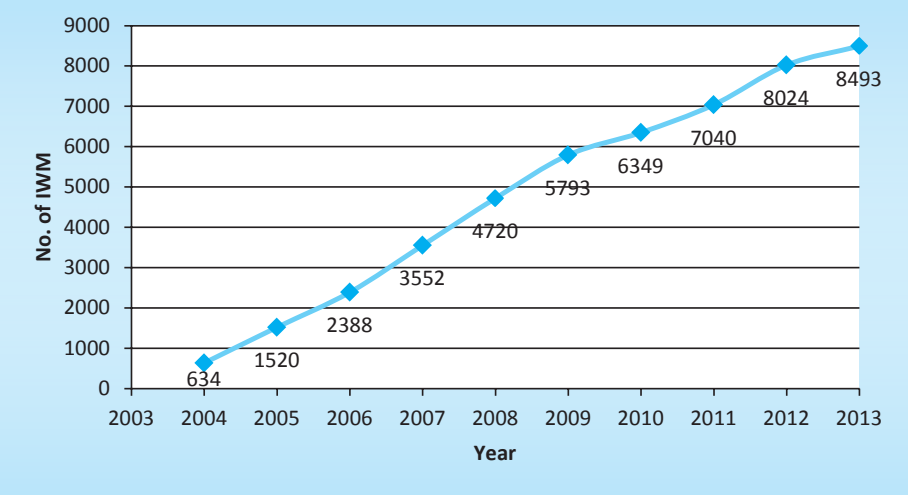


Fig. 7.2 Cumulative Trend of Market Development for Improved Water Mill

Note: The data for 2013 corresponds to only first half of the year.

Source: CRT/N (2008) and IWM Programme

The cumulative growth of IWM market over the years has depicted a linear upward bounding trend (Fig. 7.2). This is an indication that the IWM market is growing almost at the same annual rate. Considering that under NRREP, IWM technology can be promoted in all districts, the trend should show a break in the near future, and a steeper line should emerge thereafter.

7.2 Market Segments

The IWM market is segmented on the basis of technology and geographical remoteness. Two versions of IWM are being promoted in the market: IWM with short shaft and with long shaft. The total investment that an entrepreneur should make on the short shaft or long shaft IWM differs and so does the government subsidy. The long shaft IWM has covered only 12 percent of the market (Fig. 7.3) in the years which was slightly higher in December 2010 (13%).

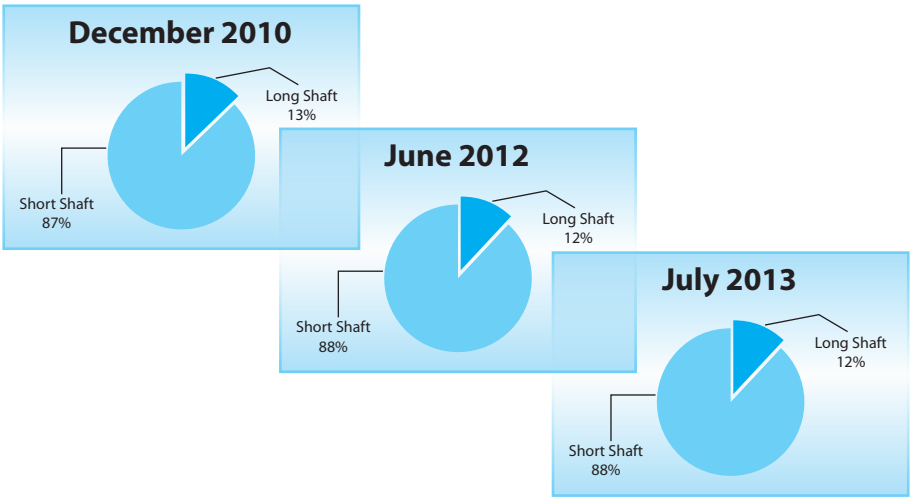


Fig. 7.3: Market Segments by Type of Improved Water Mill in Different Years

Source: IWM Programme

In line with the Subsidy Policy 2013, the geographical segmentation of the IWM market is recognised in terms of districts with very remote Village Development Committees (VDCs) (category A), districts with very remote and remote VDCs (category B) and other districts with non-remote VDCs (category C). Interestingly, the share of market for remote districts has significantly increased in 2013 (15%) compared to that in 2010 (8%). The share of market for moderately remote districts has remained the same (8%). See Fig. 7.4.

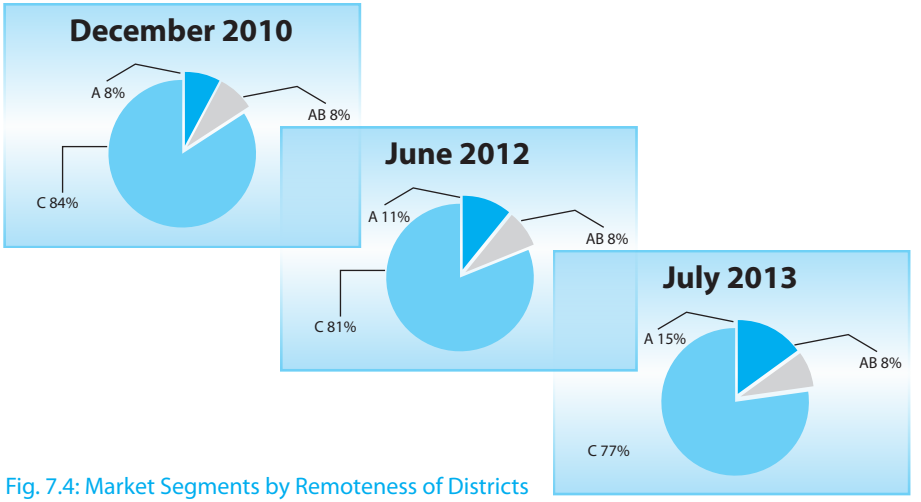


Fig. 7.4: Market Segments by Remoteness of Districts

Note: A ~ Districts with all VDCs under category A; AB ~ Districts with VDCs under category A and B; C ~ category C districts as per Subsidy Policy 2013

Source: IWM Programme

7.3 Market Structure and Competition

Currently, 14 manufacturing firms are pre-qualified to produce the IWM kits and 27 Local Partner Organisation (LPOs, earlier called Service Centres: SCs) are allowed to carry out feasibility and installation services. The LPOs are the ones who put forward demands for IWM kits to the manufacturing firms. Manufacturing firms move on to the production of the kits as specific demands are placed. Each LPO stays in contact with manufacturing firms. As such, they generally do not go around selecting a supplier for the existing demand.

The kit manufacturing firms face a free market situation wherein they can supply kits for installation in any part of the country. It demands for competitiveness in quality and price. However, their clientele is limited as there are only 27 LPOs who actually procure their products (The situation has improved since 2010 when only 16 SCs existed). On the other hand, LPOs enjoy monopolistic market situation in their respective districts. End users have no choice but to accept services of the existing local partner organisations in their district. LPOs are, however, not allowed to exercise monopolistic power in price fixing and quality of service delivery as the IWM Programme has been strictly enforcing the quality assurance system. Looking from a different angle, LPOs have limited market size geographically as they are allowed to work in allocated districts only.

7.4 Market Map of Improved Water Mill Installation and Supply Potential

The supply chain of IWM as depicted in Fig. 7.5 is very simple. IWM components are supply by kit manufacturers through LPOs to the IWM owners. LPOs extend their services for installation of the system. Existing policy and demand environment are quite conducive and there are capacity building and subsidy support available from the IWM Programme.

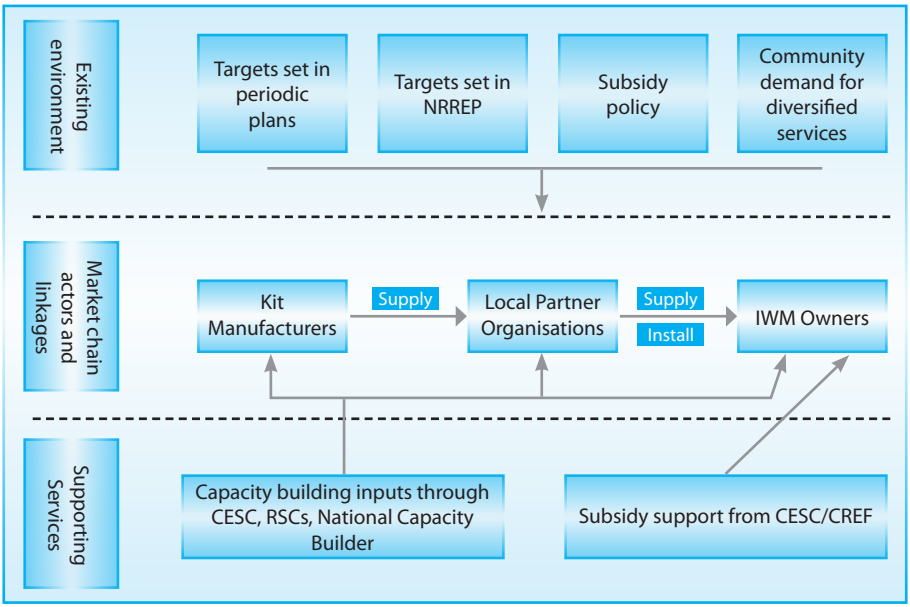


Fig. 7.5: Market Map of IWM Installation

The supply capacity of existing kit manufacturers seems to be more than the actual demand. In 2010 alone some of them have supplied kits for more than 200 IWMs (Table 7.2). Nine of the manufacturers who did not supply kits during 2010 are also potential suppliers and could probably supply in the range of 100 kits a year. This means the IWM sub-sector has enough supply capacity to satisfy the current demand for IWMs. In other words, the supply capacity of manufacturers is currently underutilized.

Table 7.2: Performance of Manufacturers during 2010

No. of IWM for which Kits have been supplied	No. of Manufacturers Supplying the Kits	% of Manufacturers
0	9	52.9
1-100	6	35.3
101-200	1	5.9
201 or more	1	5.9
	17	100.0

Source: IWM Programme, 2010

The actual installation progress depends upon the capacity of the SCs. The performance of SCs in 2010 was quite impressive. About two third of the 16 SCs installed up to 50 IWMs in 2010. Some of the SCs also demonstrated the capacity to install more than 50 IWMs per year (Table 7.3). Therefore, it seems that the supply against demand for IWM will not be constrained by service delivery capacity of the SCs in the near future.

Table 7.3: Performance of Service Centres during 2010

No. of IWM Installed	No. of SCs having installed the IWMs	% of SCs
1-50	11	68.7
51-100	5	31.3
101 or more	-	-
	16	100.0

Source: IWM Programme, 2010

7.5 Factors Affecting the Market Development

Following are some of the factors contributing/hindering the IWM market expansion.

- Factors contributing to market expansion
  - The IWM is a proven technology that has gained acceptance amongst rural owners particularly in recent years.
  - Locally established GOAs and LPOs (earlier SCs) have been good vehicle for market expansion.

- End uses diversification is attracting additional investment as it contributes to further income generation.
- Enhanced competitiveness of kit manufacturers and LPOs (earlier SCs) due to capacity building opportunities is also a plus point.
- Users' preference for *ghatta* ground flour, which has better taste and can be stored over a longer period, has provided inducement for investment in IWM.

- Factors hindering market expansion
  - Water use conflict sometimes discourages installation of new IWMs.
  - Rise in total investment cost in recent years has discouraged investors.
  - High initial investment cost of long shaft end-use application
  - In remote areas the installation rate has been slow because of high cost and difficulties in transportation of components.
  - Electrification through IWM needs high investment and a high level of technical knowledge, so is difficult to promote.
  - Inaccessibility to credit is one of the major barriers for promotion of IWM end-uses. The investment cost for end-uses installation is still high and varies as per the type of end-uses.

8. Socio-Economic Development

The growth of Improved Water Mill (IWM) sub-sector has made contributions at national as well as community level. Nationally, the Service Centres (SCs) have emerged as a small scale industry providing investment opportunity for middle class entrepreneurs and employment opportunity for the rural youths. Moreover, it has contributed to the diversification of the business of kit manufacturing firms resulting in sustainability of these firms and additional job creation.

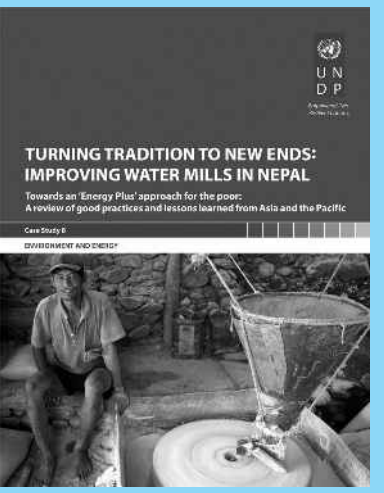
At the local level, IWM is a capital investment which provides for commodities in the form of services like grinding, hulling, and so on. The installation of IWM, along with improvement in efficiency and increased potentiality of end uses, has brought about some dramatic changes in socio-economic life of the mill owners. More importantly it has provided opportunity for investment, and generated employment thus contributed to poverty reduction. Furthermore, it has been instrumental in bringing about gender balance and has also contributed to social inclusion. Following sub-sections briefly describe the contribution of IWM in the socio-economic aspects of rural communities.

8.1 Impact of Improved Water Mill on Millennium Development Goals (MDGs)

Operation of IWMs has resulted into following impacts on Millennium Development Goals (MDGs) (CRT/N, 2008):

Millennium Development Goals	IWM Contribution
MDG 1: Eradicate extreme poverty and hunger	Employment generation through end-use diversification, increased food supply and nutrition
MDG 2: Achieve universal primary education	Reduced work load of women and girls resulting in increasing enrolment of girls in schools, provision of lighting facilities in rural household
MDG 3: Promote gender equality and empower women	Reduced drudgery of women, capacity building of women creating employment opportunity
MDG 4: Reduce child mortality	Improvement in maternal health by reducing workload of walking long distances carrying heavy load for agro-processing, improved nutrition and affordability to get better child birth services
MDG 5: Improve maternal health	Reduced drudgery by reducing workload and contribute in good maternal health
MDG 7: Ensure environmental sustainability	Environmental friendly technology as water, a renewable source, is used thus reducing carbon emissions from fossil fuel use
MDG 8: Develop a global partnership for development	Future prospect of carbon trade between and among national and international organisations/agencies with dissemination of technology to neighbouring countries

A report published by UNDP Asia-Pacific Regional Centre entitled *Turning Tradition to New Ends: Improving Water Mills in Nepal* has highlighted impacts of IWM on following Millennium Development Goals (MDGs) (UNDP, 2011):



Impacts on income and livelihood (MDG 1)

Employment and income-generating opportunities. IWMs provide communities with more efficient milling systems, employment and income-generating opportunities.

1. Increased labour productivity. Increased efficiency of IWMs improves labour productivity. This improved performance has increased the availability of food in communities.

Achieving universal primary education (MDG 2)

Better lighting and more time for studies. IWMs reduce children's time spent on labour-intensive agro-processing activities, allowing for more time to be spent on education. In addition, the children in the households that have received electricity from IWM electrification projects benefit from electric lighting which increases the number of hours available for study.

Impacts on women's empowerment (MDG 3)

Less drudgery. With TWMs, women use inefficient traditional technologies such as the dhiki and janto (stone tools for beating and grinding grains). IWMs reduce processing time by more than half and, more importantly, women are freed from the back-breaking chores of grinding and hulling.

More time to devote to other ends. Labour and time saved by IWMs can be devoted to productive purposes such as farming, weaving, caring for children and participation in community affairs. The IWM programme also encourages women to participate in various project activities.

Changing perceptions of the roles and status of women. IWMs bring about changes in gender relations in rural Nepal. IWM technology is changing the social belief that agro-processing and kitchen-based activities are mainly the responsibility of women. The percentage of men using IWMs has been on the rise:

Ensuring environmental sustainability (MDG 7)

Reduced greenhouse gas (GHG) emissions. Programme contributions to reducing GHG emissions can be calculated on the basis of fuel savings in existing diesel mills that provide agro-processing services and the replacement of kerosene in lighting appliances after IWM electrification.

Possibility of obtaining carbon credits. Greenhouse gas (GHG) emission reductions enabled by the programme may qualify for registration to receive carbon credits under the Clean Development Mechanism (CDM).

Promoting global partnerships (MDG 8)

The IWM Programme has been visited by teams from the Islamic Republic of Afghanistan, the Republic of India and the Islamic Republic of Pakistan. The Nepal team has also participated in a study visit to the Indian Institute of Technology (Roorkee) and the Himalayan Environment Studies and Conservation Organization to learn about the Indian programme.

8.2 User Services

As per the baseline survey conducted in 2012 (RETSC and CRT/N, 2012), one IWM is serving 52 households. Thus, altogether 441,636 households (8.1 percent out of 5,427,302 household in the country, 2011 Census) are being served by 8,493 IWMs installed so far. The user services include grinding, rice hulling, husking and polishing, saw milling, *chiura* beating and others e.g. *theki* cutter, juice extractor, *choya* separator and tea squeezer (RETSC and CRT/N, 2012). Likewise, around 871 household have got lighting facility from 23 IWM electrification schemes with total installed capacity of 62.6 kW. Fig. 8.1 shows various services being provided by long shaft IWMs, the dominant service being rice hulling, husking and polishing followed by saw milling.

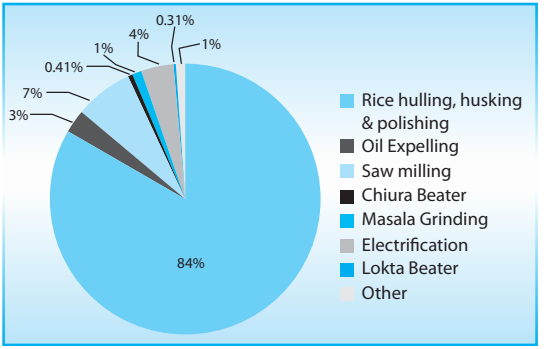


Fig. 8.1: Composition of long shaft IWM Services

Source: RETSC and CRT/N (2012).

8.3 Employment

Promotion of IWM has become good means for creation of economic, environment and employment activities in rural areas. IWM installations have created additional employment opportunities in rural areas. According to the baseline survey conducted in 2012, around 7,572 persons have been employed in IWM operation. Comparatively the short shaft IWM, which provides grinding service only, has a limited impact on employment generation as it does not require additional involvement of an operator. However, it has shortened the time for users to grind their grains. On the other hand, the long shaft IWM provides additional services such as hulling, oil expelling, rice beating (*chiura*), *lokta* beating, saw milling, husking and polishing, electricity generation and other end uses. Each additional end use provides additional services for users, provides income, generates employment opportunity for others and demands extra time from the owner.

8.4 Income Level

The livelihood of the mill owners is based upon the income they make from the IWM they operate. Income level of mill owners can substantially increase with diversification of end uses such as rice husking, oil expelling, saw milling, generating electricity power etc. Reportedly, income level has risen even by 100 percent in the case of end use diversification. It is also reflected in the improved living standard of the millers as indicated by various documented success cases. When the income from IWM operation segregated it is revealed that average annual income from mill only to be around NPR 39,000 from short shaft and NPR 85,000 from long shaft which is approximately 34 percent and 74 percent of total family annual income respectively.

8.5 Thrust to Local Economy

The IWM has become an important hub in the value chain of various products in rural economy such as production of rice, flour, oil, furniture, etc. Moreover, the establishment of IWM has induced institution of small cottage industries in rural areas. This has been possible due to the higher and more efficient output from the long shaft IWMs. The time saved from using IWMs is also salient. With the time that is saved the owners are able to devote their time in other income generating activities like agriculture, cattle farming, households, business, etc.

The improved implements have also made it possible for the water mills to operate with lower flow rates replacing the convention of closing the water mill during the winter seasons.

8.6 Gender Mainstreaming and Social Inclusion

Women involvement in water mill operation has been another distinctive feature of IWM. There are instances of women as mill owners and quite a few who help their husbands in the day to day activities of the water mill. According to the baseline survey conducted 2012, 4.68 percent IWMs are owned by women. This involvement has assisted in the development of the female gender and has given them meek control over income.

Fig. 8.2: A Female IWM Operator

According to the impact study conducted in 2012, the IWMs have, directly or indirectly brought some changes in gender roles and relations. More and more women are being brought to public places as members of workforce, service recipients etc. The weakening of gender stereotype division of labour is noticeable within the workforce as well as on the assignment of the jobs of the service recipients such as carrying and milling. Moreover, women do not face gender-specific problem in the mill.

The IWMs have minimized drudgery of women and children involved in agro-processing. Participation and leadership skills of women and socially excluded groups have improved. The IWM programme has played a role to reduce inequality between male and female by imparting technical skills and providing economic and employment opportunities to rural people.

No More Dark Nights in Jhatetar

Dal Bahadur Chepang with a family of 8, is a permanent resident of Jhatetar Gaun, at Kalikatar Village Development Committee of Makwanpur district. Agriculture is the main occupation of Dal Bahadur and has inherited traditional water mill from his father which was used by all the villagers for grinding wheat, maize and millet. Rice grows abundantly in the village but lack of rice processing mill forces them to sell it in the market at cheaper rate. When he heard about Improved Water Mill (IWM) and its benefits during his visit to district head quarter, he decided to improve his traditional water mill (TWM). Technician from service centre surveyed his TWM and informed him about government subsidy to improve the TWM. Then after, a long shaft IWM was installed with grinding, rice husking and rice polishing facility.

He was happy about his increased income and service he provided to the villagers. After two years, during the visit to the service centre, he came to know about electricity production from IWM. He says, *"I looked back to my village, all the trouble we are having due to lack of electricity, the cost of kerosene used for lighting the house during night time, and compared it with city life where there is access to electricity. It encouraged me to develop IWM as electrification project."* He consulted with the technician of service centre and learnt about the provision of additional subsidy for electrification by Government of Nepal. But subsidy from government and his equity was not enough to complete the project. So, he shared his idea with the villagers. They were ready to support him and were excited to know about electricity generation from IWM. But, the available investment was not still enough to complete it. Upon request, Poverty Alleviation Fund (PAF) also provided NPR 200,000 as financial support. Then the project was completed electrifying 50 households of Jhatetar.

Today, Dal Bahadur earns NPR 112,500 annually from agro processing and NPR 72,000 from tariff for electrification. Livelihood of his family is enhanced drastically and he gives all the credit to IWM. Villagers of Jhatetar are also very happy as they do not have to live in darkness anymore.

Source: CRT/N Annual Report 2012

A Successful Female Entrepreneur in the Male Dominated Water Mill Business

Parvati Paudel, a 44 years old mill owner from Ghyang Sukathor Village Development Committee, Dolakha district, is an example of a female mill owner who has improved her Ghatta and is running successfully. Her husband has left the house in search of a job to improve their economic condition. However, she did not stay idle and started a water mill to run a grinding and hulling business from the water of the nearby Ladke Khola in 2006.

After having encouraging economic benefit from the IWM, she diversified the services after adding on Chiura beater in the IWM in 2007 which intensified their family income further.

Parvati Paudel invested a total amount of NPR 218,215 on feasibility survey and transportation of equipment, civil and mechanical works, a rice huller and chiura beater machine. She received a subsidy amount of NPR 20,000 from the Government, NPR 31,000 from a local cooperative at a 12 percent interest rate, NPR 100,000 from local money lenders at 33 percent interest rate, and rest from her own savings.

Parvati earns NPR 128,000 annually from grinding of maize, millet, and wheat, rice hulling and chiura beating .Her annual expense is around 88,000 which covers salary of a chiura operator and a rice hulling operator, repair and maintenance cost, as well as interest of the loan.

IWM has brought visible economic benefit to Parvati's family. She has managed to buy 23 ropanies of land in Dolakha district, and 2 hectares land in the Terai. Parvati is engaged in other economic and income generating activities as well by utilising the saved time from IWM operation. She earns additional income from various agro-based activities, banana and pineapple farming and goat rearing.

Parvati is now planning to install an oil expeller, husker and polisher to be powered by the existing IWM.

Source: Adopted from *Success Story of Water Millers, CRT/N 2008*

From social and economic point of view, different studies have revealed that about 73 percent of the IWM users are from the poorest strata of the society and socially excluded groups. While 14 percent of the mills are owned by marginalized group of people, *Janajatis* own 27 percent of total IWMs operated in IWM Programme districts (RETSC and CRT/N, 2012). Thus IWM has contributed to improve the livelihoods of the rural poor and socially excluded population through provision of energy services.

The IWM is serving as a public place for interaction and intimacy for the residents of the communities and villages. Not only that caste and ethnicity discrimination is not practiced in the mill, but that mills have become those places where people of different caste and ethnicity get mixed-up and develop social ties based on cooperation and solidarity. They have also become places for the people to share and exchange the news and views on various social, political, national, international affairs (PLFRC, 2011).

9. Environment and Emission Reductions

The Improved Water Mill (IWM) operates from water, a renewable source of energy, which is essentially non-polluting. It can also be thought as a water-driven, non-exhaust producing machine. It is environmentally sound and acceptable. It does not create any air pollution. It also makes maximum use of local resources. The operating costs are low as no fuel is required and heating is also not involved. The water used in operating the mill can be reused and is not polluted by the mill. Hence the same water can be used by people downstream as well as by those living upstream. There is no noise pollution as the mill does not make a loud noise when operating

IWM has decreased dependency upon traditional and conventional fuel. In some places IWM has displaced existing diesel mills. A field survey shows that 8 diesel mills were replaced in Dolakha district alone. IWM has also helped in checking the entry of diesel mills thereby controlling the emission of carbon dioxide into the atmosphere. In many places mill sites are now considered as an attraction of energy centre.

Estimations show that each IWM could replace about half the capacity of a diesel mill and therefore offset about 900 litres of diesel per year, which is equivalent to 2.4 tonnes of carbon dioxide emissions. The IWMs installed under the support of IWM Programme from 2004 to 2010 have saved more than 40 thousand tonnes of carbon dioxide emission.

As IWM displaces diesel fuel, there is possibility of developing IWM Programme as a CDM (Clean Development Mechanism) project. In fact, the Designated National Authority (DNA) has already approved a Project Idea Note (PIN) submitted by Alternative Energy Promotion Centre (AEPC) for development of a CDM project on IWM and Project Design Document (PDD) is under the process of validation.

Studies show that operation of one IWM can reduce emission of 4.454 tons of carbon dioxide per year approximately (Source: cdm.unfccc.int).

Not only mitigation, IWM has adaptation potential as well. Since IWMs save milling time of the users, both men and women, they have more time to engage in other livelihood activities. Community people do not opt for moving too far away locations where electricity or diesel powered agro-processing facility is available when they have IWM services in their own locality. Availability of IWM services in the locality helps to increase in resilience of the community (CRT/N, 2011).

10. Future Prospects

Improved Water Mills (IWMs) are owned and operated by the families who have been involved in water milling since generations. Both men and women take part in the operation of the mills. Therefore, there is high chance that they will continuously be involved in the business. Moreover, new district level institutional structures such as *Ghatta* Owners Association and Service Centres are actively involved in the promotion and providing technical assistance to the IWM owners. These are contributing factors for sustained use of already established IWM and enabling factors for dissemination of new IWMs (CRT/N, 2011).

In fact, as discussed earlier, there is huge potential market for IWM in rural Nepal. The demand for IWM is growing steadily if not rapidly. Because of the diversification of application of its power, the potential thrust an IWM can provide to a local economy has been demonstrated. Private, civil society and public sector institutions have grown to support the development of the IWM sub-sector. More favourable policy environment is gradually being created. With the completion of its pioneering, take off and market expansion phases, IWM sub-sector seems heading towards a commercialisation phase.

Although one cannot expect a situation of perfect competition, a phase of commercialisation is characterised by free entry and exist of market players, no price leader, competition based upon quality and price, informed buyers/sellers, and a levelled playground created by policy environment for the market players.

Keeping in mind the commercialisation perspective, some of the possible directions of IWM development in coming years could be:

- Expansion of market covering all potential areas.
- Promotion of Service Centres lifting the restriction of geographical coverage.
- Quality control regulation.
- Promotional activities for optimum use of IWM power.
- Encouragement for installation of IWM at new sites rather than just improvement of traditional water mills.
- Innovation of end use technologies.
- Integration with other renewable energy technologies.
- Rural electrification from IWM.

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Appendix

Rural Community Electrification with Improved Water Mill Technology and Micro Enterprise Development in Nepal (Proof of Concept)

1. Context

A proposal for developing a program on Rural Community Electrifcation with Improved Water Mill Technology and Micro Enterprise Development in Nepal was submitted to the Dutch-German-Norwegian-Australian-British-Swiss Partnership 'Energising Development' (EnDev), which is managed through German Development Corporation (GIZ). The proposal was to introduce a new business model for promoting IWM community electrification technology and using the electricity for electrifying households for lighting as well as using it at rural micro enterprises for productive uses.

With three revenue lines from the project, viz., (i) tariff revenue from households for lighting, (ii) tariff revenue from micro-enterprises for processing or powering machines, and (iii) revenue from business activities from micro enterprises; it was planned that the IWM community Electrification would make a paradigm shift from its existing status into a commercial and market led project. This transformational change in the IWM electrification sub-sector was expected to bring a market sustainability of the intervention with limited supports from donors and government of Nepal (AEPC), which could produce significant direct benefits to the project areas and strong socio-economic co-benefits to the country.

EnDev/GIZ advised SNV to first validate this concept in 2013. As a result, SNV commissioned a 'proof of concept' in collaboration with the Alternative Energy Promotion Centre (AEPC) in July 2013 and 4 pilots sites were selected to validate the concept. The Centre for Rural Technology, Nepal (CRT/N) is the implementing agency for these pilots and with the partnership of AEPC, GIZ and CRT/N; SNV has successfully completed the proof of concept.

2. The Concept

In spite of huge potential on improving the livelihood of the rural and remote population through access to improved source of energy, Gender and Social Inclusion (GSI) and income generation potentials from IWM, the performance of the sector has remained below its potential. Of the total potential of around 30,000 watermills, only 6,500 traditional watermills have been improved with short shaft IWM technology. The proliferation of LS IWM technology with electrification is still in a rudimentary stage with less than hundred IWMs in place. Therefore, there is a need to upscale achievements of the IWM electrification sector with innovation, appropriate enabling environment and institution development of the sub sector.

With the funding support from EnDev/GIZ, SNV has commissioned four pilot IWM community electrification projects in the district of Kavre (based on accessibility, number of IWM installed and the percentage with electrification potential). In doing so, SNV worked in close

collaboration with relevant IWM sector actors: CRT-N (project execution); IWM kit manufacturers (produce quality kits); IWM installation companies (install and maintain units); IWM owners (and their associations), financial institutions (long term commercial and financial sustainability); and District Development Committees (DDC) and potential micro-enterprises. This pilot phase strictly followed the policies and development objectives of the Alternative Energy Promotion Centre (AEPC), Government of Nepal under the National Rural and Renewable Energy Programme (NRREP) framework. The concept is built on the key aim of using IWM Long Shaft (LS) technology to generate electricity for village electrification and productive use at rural micro-enterprises. This key aim is validated in the field level based on 6 distinctive objectives, viz.,

i. Promoting domestic use of electricity for lighting and other needful consumptive use
ii. Promoting tariff revenue model for self sustenance of power unit and transform the IWM unit into a business enterprise
iii. Introducing commercial use of electricity in rural micro-enterprises and generating revenue for the IWM unit from the commercial tariff payment, which will eventually transform the IWM power production unit into a business enterprise
iv. Linking rural micro-enterprises (Productive Enduse Unit) into market for sustainable source of income
v. Striving for continuous innovative in financial disbursement in IWM and PEUs, starting from donor's support to government subsidy, and
vi. Strengthening coordinated sector development of IWM sub-sector in alignment with the NRREP of AEPC

A pictorial presentation of the concept is illustrated below.

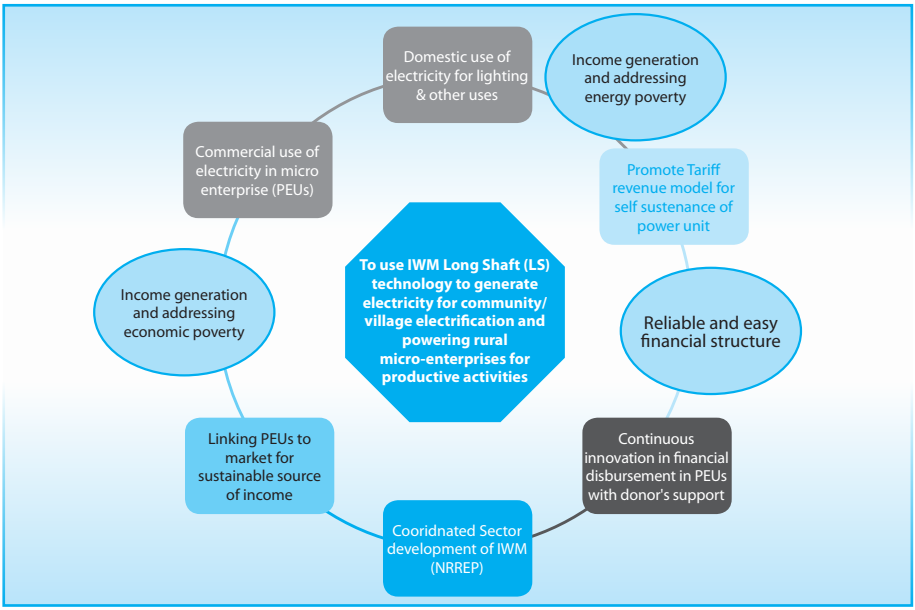

Figure: 1: Framework of the Proof of Concept

The key development objectives of the program are-

I. Providing access to clean and efficient lighting energy to the socially and economically marginalized people of the project sites (energy poverty),

II. Ensuring effective income generating activities by using electricity at rural micro-enterprises and thereby reducing economic poverty of the people; and

III. Introducing a reliable, easy to use and bankable financial structure, which could stimulate the development and further proliferation of the IWM sub-sector in Nepal

During the 'proof of concept' stage of the program, diligent attempts are made to establish factual findings on site selection, viability of IWM electrification units with profits, possibility to introduce appropriate metering system for tariff and innovation in tariff determination, creating a new breed of rural entrepreneurs and rural micro-enterprises, linking micro-enterprises to market, evaluating the existing financial mechanism and enhancing its efficacy and ensuring the relevance of the program to the national development objectives of AEPC. The key facts and lessons learned from the 'proof of concept' are provided in the box below:

Executive Summary of Working Draft Report

Waiting for spontaneous positive effects of electrification projects to trickle-down in rural areas is not a satisfactory option. In case of community electrification intervention with Improved Water Mills technology, we need to break down this notion and therefore, it is necessary to integrate community electrification intervention with productive use of electricity at rural micro-enterprise level.

The most efficient way to deliver effective and lasting impacts when designing a rural electrification (IWM) scheme is to ensure that such programmes provide a direct impact on livelihoods and revenue generation, in addition to the more conventional impacts on standards of living. Increasing revenue generation can be accomplished by transforming the IWM community electrification intervention into a profit making business enterprise as well as by improving productivity of an existing production process and by creating new lines of activities that will generate employment and local demand.

Indeed, the current IWM community electrification pilot (proof of concept) has made an attempt to proof this integration by introducing productive enduse of energy at rural enterprise level and transforming the domestic electrification aspect by introducing commercially sensitive tariff structure, which has further examined whether it could transform the generally conceived community electrification component into a profit making enterprise.The outcome of this brief pilot (proof of concept) was positive. This report presents the detailed outcomes and lessons learned from the pilot, which can be summaried as below.

- Diversifed use of electricity at households and rural micro-enterprise level is crucial for making a commnuity electrification project effective and widely accpeted by communities.

- This diversifed use of electricity at HH and enterprise level needs to be commericliased by introducing tarrif payment system. Besdies, the micro-enterprises is necessary to link to the market for a self-sustained revenue models. The crux of the matter in commercialisation process is generating multiple lines of revenue streams.

- While rural electrification does not drive industrial development, it can provide an impetus to rural businesses. There is therefore a positive impact on household income. However, these effects to be less than expected, except when there has been a specific program to promote productive uses of electricity. Project components to promote productive uses could, therefore, greatly increase electrification's benefits.

- A strong community driven tariff system is highly helpful and in case of the IWM community electrification project, this approach will useful for other community electrification interventions.

- Introducing a robust, training, data management, recording and repair and maintenance is very important. The proof of concept has designed such module and can be used for the full-fledged IWM community electrification program.

- Generating improved business competitiveness through productive uses of electricity will translate into better income, better community services, and in general, a better opportunity for integrated development.

- Even if all of the other components of a PUE program are in place, if the market cannot or is not willing to absorb the increase in products and services, the program will fail. For example, if a small business pottery manufacturer gets excited about participating in a PUE program, it might well be able to increase production tenfold. Yet if a mere threefold increase in supply exceeds maximum market demand, the newly expanded business is not likely to survive. Hence, the IWM community electrification programme has designed the market-linkage mechanism, which will ensure a balance between and market demand and actual supply.

- Sustainable market development of IWM community electrification and micro-enterprises can be promoted by providing access to finance to this micro-enterprises as well as introducing timely and appropriate skill development training to the entrepreneurs.

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