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

2013

endev

giz

Alternative Energy Promotion Centre

Central for Rural Technology, Nepal

SNV

COLOPHON

Concept: Monica Upadhyay

Author: Keshav C Das

Cover photo caption: SNV Improved Water Mill Programme

Cover photo: © Guy Dekelver, Saroj Rai, Monica Upadhyay and Eric Gold

Executive Summary

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 (IWM), 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 scheme is to ensure that such programs 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 prove this integration by introducing productive enduse of energy at rural enterprise level and transforming the domestic electrification aspect by introducing a 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 (HH) and rural micro-enterprise level is crucial for making a community electrification project effective and widely accpeted by communities.
- This diversifed use of electricity at HH and enterprise level needs to be commericliased by introducing a tarrif payment system. Besides, the micro-enterprises have to be properly linked to the market for a self-sustained revenue models. The crux of the matter in commercialisation process is generating multiple revenue streams.

- While rural electrification does not drive industrial development, it can provide an impetus to rural businesses and consequently a positive impact on household income. However, these effects don't come automatically, unless 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 in the case of the IWM community electrification project and this approach will also be useful for other community electrification interventions.

- Introducing training, data management, recording and repair and maintenance is very important. The proof of concept has designed such module which 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 productive use of energy (PEU) program are in place, the program will fail if the market cannot or is not willing to absorb the increase in products and services. For example, if a small business pottery manufacturer gets excited about participating in a PEU program, (s)he 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 program has designed a market-linkage mechanism, which will ensure a balance between market demand and actual supply.

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

This proof of concept is expected to help accelerate progress in the IWM sector, by enabling policy makers and development partners to better understand the complex agents of community electrification and productive use of electricity.

Key Abbreviations

AEPC	Alternative Energy Promotion Centre
ATP	Ability to pay
CRT/N	Centre for Rural Technology, Nepal
CFL	Compact fluorescent lamp
DDC	District Development Committee
DEEUs	District Energy and Envrionment Units
EnDev	Energising Development
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GSI	Gender and Social Inlcusion
HH	Households
IWM	Improved Water Mill
IWM-E	Improved Water Mill Electrification
KM	Kilo-meter
kwh	Kilo Watt hour
LS	Long Shaft
m	meter
MCB	Miniature Circuit Breaker
M&E	Monitoring and evaluation
NRREP	National Rural Renewable Energy Program
NRP	Nepali Rupee
PEU	Productive Use of Energy
RSC	Regional Service Centre
SME	Small and micro-enterpise
SNV	Stichting Nederlandse Vrijwilligers
WTP	Willingess to pay

Rural Community Electrifcation with Improved Water Mill Technology and Micro Enterprise Development in Nepal

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 towards 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 together with its partners 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 an improved source of energy, an improved Gender and Social Inclusion (GSI) setting and an increased income generation potential 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 longs shaft (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 institutional development.

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 Program (NRREP) framework. The concept is built on the key aim of using IWM Long Shaft technology to generate electricity for village electrification and productive use at rural micro-enterprises . This key aim is validated at the field, level based on 6 distinctive objectives:

i. Promoting domestic use of electricity for lighting and other needful consumptive use

ii. Promoting tariff revenue model for self-sustenance of the power unit and transformation of the IWM unit into a business enterprise

---

* *The report has identified rural micro-enterprises as the private and community based economic activities which generates income and livelihood.*

iii. i. 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

ii. Linking rural micro-enterprises (Productive End-use Unit) to the market ensuring a sustainable source of income

iii. Striving for continuous innovation in financial modalities for IWM and PEUs, starting from donor's support to government subsidy, and

iv. Strengthening coordinated sector development of IWM sub-sector in alignment with the NRREP

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, 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/profitability of IWM electrification units, possibility to introduce an appropriate metering system for tariff determination, creating a new breed of rural entrepreneurs and rural micro-enterprises, linking micro-enterprises to the market, evaluating the existing financial mechanism and enhancing its efficacy and ensuring the relevance of the program, in lne with the national development objectives of AEPC. The detailed key facts and lessons learned from the 'proof of concept' are provided in the subsequent sections.

3. Key facts related to the proof of concept

While developing the 'proof of concept', it was observed that there are a numbers of barriers, which could hinder IWM sector development with community electrification. A few major barriers are illustrated below.

Barrier Analysis:

- Existing IWM sector does not have a business model with community electrification. The flat rate tariff system for domestic users has not been designed based on thorough cost analysis. Therefore, in absence of multiple revenue streams, IWM units do not generate sufficient fund for post installation care, which eventually leads into under performance of IWM units.

- In most of the existing IWM units, productive end-use of electricity is not part of the project and at the household level, electricity is used merely for lighting. Lack of diversified use of electricity makes the IWM-E a non-sustainable proposition.

- Consumption of electricity at household level is not regulated. In some HHs, there are more than 7 CFLs and one television set, whereas, in other HH, there is only one CFL in use. The irony is that for both HHs, the monthly payment for electricity use is same. This erroneous system of monthly rental charges creates conflict.

- There is no robust system in place to provide post installation services. Neither is there a standard quality control and monitoring system in place, which could ensure appropriate operational status of the IWM-E even after the warranty period (there is a one year warranty period for IWM units from the date of installation).

- Skills development training and general business related activities in the project areas are not prevalent. In absence of such entrepreneurship development activities, it is difficult to expect that rural micro-enterprises will be established and linked to market.

- Availability of financing for establishing PEUs/micro-enterprise as well as installing the IWM-E is a major challenge.

- Most of the IWM-E sites are extremely remote. Hence, transportation of IWM turbine, other fabricated products and materials for civil works takes a long time.

Based on this indicative barrier analysis, the following Key facts have been identified (and considered) while implementing the 4 pilots.

A. Selection of sites:

Site selection is the first stepping stone in the IWM community electrification intervention. A wrong site could kill a project as well as create social conflict if the land ownership is not duly considered. Hence, a methodological approach is necessary to identify sites.

The proof of concept stage of the program has designed a site selection methodology based on a field tested guidelines, consisting of technical, social and economic parameters. A detailed list of ite selection parameters is provided below.

i. Technical guidelines:

- source of discharge must be perennial river/stream providing design discharge for 11 month. Design discharge should be more than 40 liters per second (lps) throughout the year;
- intake must be selected at safest place available (chances of landslides should be low);
- headrace canal having shortest route (15 meter) to fore-bay should be selected. Canal alignment must be safe from landslide;
- fore-bay site should be large enough (minimum 12.5 m2) to construct as per design. The site must be selected to minimize head-loss and should have passage to spill over excess water. The site must be safe from landslide;
- penstock profile must be stable and not very steep. The site must be safe from landslide. Maximum design head should be 30 meter;
- the area for powerhouse site should be big enough (minimum 20 m2) to incorporate all electromechanical equipment. Land should be stable and safe from landslide and flood;
- shortest transmission/distribution route (maximum 2 km) must be selected to ensure least power loss during transmission/distribution.

ii. Socio- economic guidelines:

- the sites must be near the road-head and identified market place (not more than 20 km);
- site should be near the settlement, which should not be very scattered (maximum 1 km radius from the IWM site);
- no water use conflict should present in the village of the selected site;
- no conflict among the community members regarding constructing and operating the IWM-E;
- community and IWM/ traditional water mill (TWM) owner must be ready to invest at least 20 % of the total project cost (in cash or in kind).

iii. Productive End-use guidelines:

- community/IWM owner must be ready to operate at least 1 productive end use and 1 micro enterprise using the electricity from IWM-E project;
- there should be market channels/mechanism present, e.g. village market, linkage with town market, presence of village cooperatives or financial institutions;
- availability of agro/forest based products in the village;
- rural micro-enterprise or individual entrepreneurs must have necessary skills for promoting their activities (vocational skills, market knowledge, accounting etc.)

The below methodology was followed while selecting the sites for the proof of concept pilot. Initially, 14 sites were selected (long list) and then further evaluated as per the site selection guidelines, bringing the number down to 10. Finally, for the pilot phase, 4 sites were selected based on the fulfilment of all the criteria of the site selection guidelines. This methodology will also be adopted for selecting sites for the full-fledged IWM community electrification project, which will be commissioned from 2014.

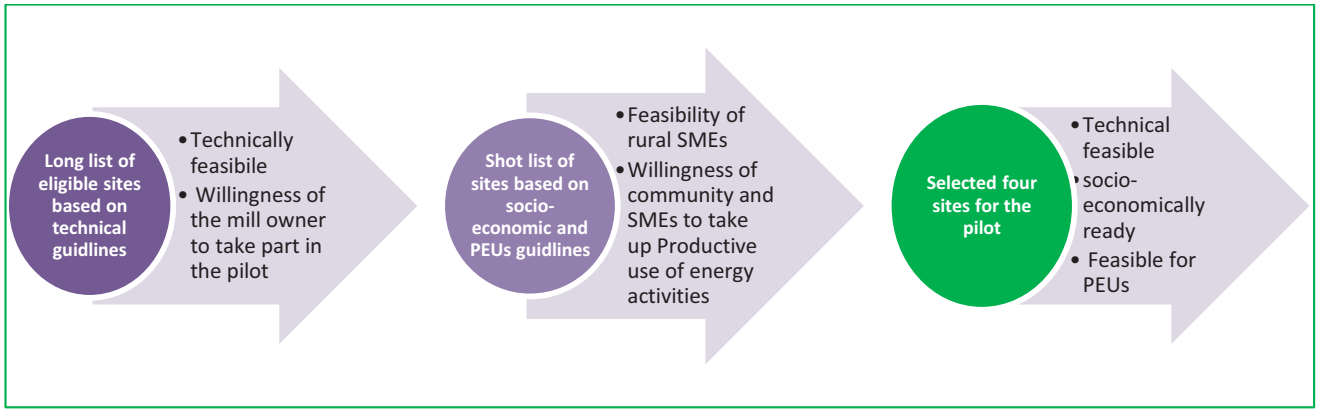


Figure2: Methodology for site selection

Results and discussions:

Based on descriptive statistical analysis, it is found that the mean design discharge is 54 lps with an error of 9 lps (54 +/- 9). Similarly, the mean of the route distance to fore-bay is 215 meter, which is below the maximum limit.

Design dischage is 50lps (lps)	
Mean	54.28571429
Standard Error	9.076251206
Median	50
Standard Deviation	33.96022237
Sample Variance	1153.296703
Kurtosis	-1.085517779
Skewness	0.229439181
Confidence Level(95.0%)	19.60804858

Route is shortest to forebay (maximum 500m) (m)	
Mean	215.2857143
Standard Error	37.39710111
Median	200
Standard Deviation	139.9271396
Sample Variance	19579.6044
Kurtosis	-0.210945937
Skewness	0.66896846
Confidence Level(95.0%)	80.79152491

While analysing the slope gradient of the surveyed sites, it is found that average slope degree is 32 degree, ranging from 23 to more than 40 degrees. From the feasibility point of view, therefore, only those sites have been selected which are having a slope off less than 25 degrees.

Stable and not very steep (degree)	
Mean	32.28571429
Standard Error	2.268824964
Median	30
Standard Deviation	8.489165687
Sample Variance	72.06593407
Kurtosis	-0.632459814
Skewness	0.656398796
Confidence Level(95.0%)	4.90149833

Max. designed head is 30m (m)	
Mean	18.64286
Standard Error	4.286264
Median	10.25
Standard Deviation	16.03773
Sample Variance	257.2088
Kurtosis	-0.47313
Skewness	1.063285
Confidence Level(95.0%)	9.25991

Distance for least power loss	
Mean	1871.428571
Standard Error	330.0730141
Median	1250
Standard Deviation	1235.020132
Sample Variance	1525274.725
Kurtosis	1.415240867
Skewness	1.627795515
Confidence Level(95.0%)	713.0793927

From the technical point of view, the desired head of the penstock should not be more than 30 m. As per the surveyed data analysis, the mean head measurement is 18.6 m. Therefore, while selecting the 4 sites for the pilot program, the mean value is considered.

It is observed there is possibility of transmission loss of electricity from the power house if the distance to and between the households is not optimum. Based on the available good practice and experiences in Nepal, it is determined that the maximum distance for transmission lines should not be more than 2 km. Based on the field data, collected from the surveyed sites, it is estimated that the mean distance of transmission lines would not be more than 1.8 km.

In case of the socio-economic data and productive use of energy related data analysis, it is found that the average walking time from the proposed site of small and micro-enterprises is 17 hours, whereas the distance from proposed IWM –electricity production sites to the settlement is 1.05 km [mean].

Walking Time (hr)		*Distance of site from settlement*		*No of HH near Project site for Electricity*	
Mean	17.42857	Mean	1053.571	Mean	28.71428571
Standard Error	2.845305	Standard Error	320.9046	Standard Error	1.984634856
Median	24	Median	750	Median	27.5
Standard Deviation	10.64616	Standard Deviation	1200.715	Standard Deviation	7.425823668
Sample Variance	113.3407	Sample Variance	1441717	Sample Variance	55.14285714
Kurtosis	-1.11446	Kurtosis	2.862259	Kurtosis	8.250860351
Skewness	-0.20211	Skewness	1.917931	Skewness	2.562637353
Confidence Level(95.0%)	6.146908	Confidence Level(95.0%)	693.2723	Confidence Level(95.0%)	4.287542928

It is estimated that approximately 28 households are present near the IWM–E site, who could avail the electricity produced for lighting. There are approximately 3 (mean) small and micro enterprises as well as individual entrepreneurs, who are also interested for taking up productive end-use activities by using electricity produced from the IWM-E sites.

A linear matrix based on the interest of community for productive use of energy and resource available in the project sites, was developed. It is found that small and micro enterprises (SMEs) as well as individual entrepreneurs are interested in a range of activities, starting from sawmilling to furniture making and hulling and agro-processing.

Community is ready to operate 1 productive end-use and 1 micro-enterprise	Agro/forest based product is available
Saw-Mill	Paddy, Maize, Millete, enough Pine tree
Huller	Paddy, Maize, Millet
Welding Machine	Paddy, Maize, Millet, Wheat
Coffee Machine	Maize, Millet
Furniture	Paddy, Maize, Millet
Huller	Paddy, Maize, Millet
Poultry Farm	Maize, Millet

A more in-depth understanding of productive end-use components has been made in the dedicated workshop on PEUs, which was held on September 4th, 2013 (cfr. report of the event). In addition, a baseline study on PEUs to assess the current capacities of SMEs and individual entrepreneurs is under development. It is believed that these two reports on PEUs will provide us more understanding on this.


SHOP COAT PRIMER
RED OXIDE

Selected sites:

Based on the above mentioned parameters and field level data and analysis, the survey team identified the below four sites.

All the selected four sites do not have considerable chances of landslides and have perennial source of water and discharge available for more than 11 months. Besides, these 4 sites have near to the average (mean) critical figures with respect to head-race, fore-bay, penstock, land availability for power house and least distance for power transmission (see table below). Hence, it qualifies as eligible for the pilot project sites from a technical point of views.

Sites		Head-race	Fore bay	Penstock		Powerhouse		Transmission and Distribution
Place	Design discha-rge is 50lps (l ps)	route is shortest to forebay (maximum 500m) (m)	Area more than 12.5m^2 (5m * 2.5m)	stable and not very steep (degree)	Max. designed head is 30m (m)	Area more than 20m^2 (5m*4m)	safe from landslide and flood	route is selected for least power loss (maximum 2 km) (m)
Gokule-6	100	150	√	25	7.5	√	√	1000
Falametar-9	50	45	√	25	8.5	√	√	1200
Foksinghtar-2	50	75	√	23	5	√	√	1000
Michhe-5	100	150	√	25	6	√	√	1100

With respect to the socio-economic and PEU eligibility criteria, it is found that these 4 sites fulfil all the required criteria: there are no water related conflicts, accessibility to the market is higher than mean value, walking distance to nearby market is again relatively lower than average/mean, community is willing to invest (20 %) in the project for electrification and SME development and resources are available for promoting PEUs.

Place	site is near from road head and market place	Walking Time (hr)	site is near from settlement not scattered (maximum 2 km) (Meter)	at least 25 HHs is covered by 1 project (1kw=10 HHs) (HHs)	water use conflict	conflict among the community members	community/ Owner can invest 20% of total project cost	community/ Owner is ready to operate 1 productive end-use and 1 micro-enterprise	Agro/ forest based product is available
Gokule-6	Taaldhunga Bazar	6	1000	32	No	No	√	Saw-Mill	Paddy, Maize, Millete, enough Pine tree
Falametar-9	Dhunkharka Bazar	16	700	30	No	No	√	Coffee Machine, Furniture	Maize, Millet
Foksinghtar-2	Budakhani	5	300	22	No	No	√	Saw-Mill, Huller	Maize, Paddy, Millet
Michhe-5	Dhulikel and Kathmandu market	8	300	22	No	No	√	Huller	Maize, Paddy, Millet

Therefore, these 4 sites are feasible both technically as well as from the socio-economic and PEUs eligibility point of view.

The profile of ownerships and planned interventions in these 4 pilots are provided below

Selected site	Given – Identification Code	Ownership type of Water Mill	Contact details of owner	Source River	Type of Pilot intervention
Site-1	Gokule-6	Private	Mr. Dhana Bahadur Jimba Gokule-6, Tintale Phone: +977-9745062390	Chaukhola	Privately owned Long shaft-IWM with addition of community electrification and productive endues component
Site-2	Falametar-9	Private	Mr. Nabaraj Thokar Fhalametar-9, Ghaikhuriya Phone: +977- 9741272721	Mulkhola	Privately owned Long shaft-IWM with addition of community electrification and productive endues component
Site-3	Foksingtar-2	Private	Mr. Rajkumar Ghising Foksing-tar-2, Fedi Phone: +977-9621125767	Fedikhola	Privately owned traditional water mill (Greenfield) with addition of Long-shaft IWM along with community electrification and productive endues component
Site-4	Michhe-5	Private	Mr. Karna Bahadur Thapaliya Panthali-5, Michhe	Roshi khola	Existing privately owned Long shaft-IWM with electrification, which will be transformed to community electrification along with addition of productive endues component

One key aspect of site selection is land ownership. It is learned from experience that establishing a community project on private land sometimes creates conflict as in the long run the land owner fails to understand the direct and indirect benefits of the project. To avoid such conflicts, it is decided that the IWM power unit will be located on the privately owned land, with the land owner entering into an agreement with the communities to supply electricity to HHs and micro-entrepreneurs against a systemic tariff. The fund generated from the tariff system would be the revenue of the power house and the land owner will be paid from this fund for taking care of the IWM power house as well as operation and maintenance of the power house. To provide an

additional source of income to the land owner, he/she will be allowed to set up an extension unit of the IWM mechanical power use for grinding and other productive activities.

Hence, the technical, socio-economical, market-led criteria and land ownership need to be considered while selecting sites. The above-mentioned criteria will be useful to identify and select sites during the upscaling program.

B.Appropriate technology

IWM electrification technology in Nepal has been progressing satisfactorily over the last few years. Technological innovation is considered in the proof of concept only from the point of modification and efficiency enhancement of turbines. A few interventions in electromechanical equipments have been incorporated for better output efficiency, durability of electromechanical equipments and overall increment in the life of IWM-E system. Following are the interventions piloted in these four projects:

1. Turbine set: Institute of Engineering, Pulchowk with the support from RETSC/SNV has developed two different types of turbine having 350 pcd (sor discharge pressure) and 500 pcd depending upon the amount of discharge available. These turbines are different than the usual long shaft turbines commonly used in Nepal. These turbine sets comprise of a robust metallic structure which reduces vibration, an efficient nozzle with discharge control mechanism and relatively higher output efficiency.

2. Synchronous generators: in case of IWM-E projects or projects with a capacity below 5 kW, induction generators are generally used to generate electricity. Electrical motor load or productive end uses cannot be operated efficiently from the electricity generated by induction generators. Single phase Synchronous generators can operate small capacity motors which can bring diversity in PEUs. Being the pilot project, single phase synchronous generators are used in two of the four proposed pilot sites.

C. Costing:

i. Investment Cost

Investment cost on each IWM-E project is entirely dependent upon the capacity of the project, remoteness of site, transmission length and the number of beneficiary households. The figures in the table represent the average investment cost of four pilot projects.

S.N	Activities	Cost (NRS)	Remark
1	Pre-feasibility survey	10000	
2	Detailed feasibility survey	50000	
3	Civil components	150000	Excluding local material and labour
4	Mechanical Components	100000	It varies with the length and diameter of penstock pipes
5	Electrical Components	400000	It varies with the cost of transmission system
6	Installation, testing and commissioning	50000	
7	House wiring	85000	
8	Transportation	100000	
Total	945000	Excluding VAT and other taxes	

ii. Operation and maintenance cost:

S.N	Activities	Cost (NRS)	Remark
1	Annual maintenance cost	5000	
2	Operators salary	24000	1 operator and 1 manager
3	Annual Auditing fee	2000	
4	Miscellaneous	2000	CO meeting, general meeting etc.
Total		33000	

D. Diversifying use of electricity

Globally, in most of the community electrification projects, it is found that diversified uses of electricity are very limited. In general, the use of electricity is limited to lighting at the household level. One World Bank evaluation of 2008 comes to an analysis that "the general conclusion from analysis of rural electrification programs that the impact on productive activities is limited". The evaluation finds that "rural electrification does not drive industrial development, but it can provide an impetus on household level lighting, even though few households use electricity for productive purposes". The evaluation concludes that the positive effects of the evaluated programs on household income were less than expected, except in those cases where the program had been accompanied by a specific program to promote productive uses of electricity ".

The EnDev/GIZ supported IWM community electrification project has aimed to integrate a dedicated component on productive end-use of energy into the community electrification intervention, which will distinctively provide electricity to rural micro-enterprises for profit making business operations.

During the proof of concept, the possible uses of electricity were analyzed based on the available power output and availability of raw materials as well as the skills set of village entrepreneurs. The assessment focused on the below aspects:

* *The Welfare Impact of Rural Electrification: A reassessment of the Costs and Benefits; World Bank Independent Evaluation Group; 2008*

- the electricity supply to SMEs must be reliable and affordable;
- there must be abundant raw materials to provide feedstock to the SMEs;
- the village entrepreneurs must have necessary basic skills and qualification to run the business;
- there must be sufficient demand for the products or services.

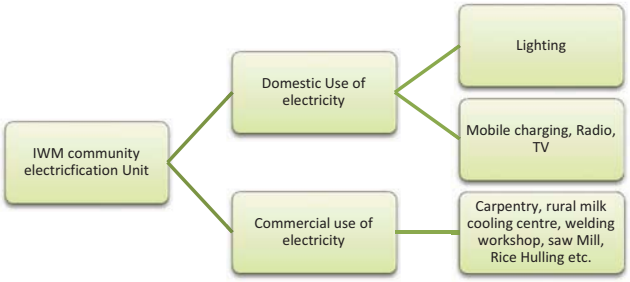


Figure: 3: Diversified use of electricity

It is found that the IWM electrification intervention can supply electricity for two categories of use, viz., productive use of energy and consumptive use of electricity. Most of the consumptive use can be at the domestic level, which will be used mainly for lighting, charging mobile phones, radio or television sets. Whereas in case of the productive use, it is understood that rural entrepreneur need to make an informed decision on the type of productive use based on the availability of power. A flow diagram on the different categories of electricity uses is provided below.

During this proof of concept stage, it was increasingly visualized that the diversified uses of electricity also raise a necessity to have a sustainable revenue flow from the consumptive and productive use of electricity. This revenue model can be established by introducing a market based tariff system for collecting revenue (income) from electricity consumers (households and rural micro-enterprises). A detailed analysis of the market based tariff system is provided in the subsequent section.

E. Determining market based tariff system

The key aspect during the determination of a market based tariff system for domestic and commercial tariff was built based on the fundamental question of 'willingness to pay'. It was assumed that properly calculating

* *The Welfare Impact of Rural Electrification: A reassessment of the Costs and Benefits; World Bank Independent Evaluation Group; 2008*

willingness to pay can demonstrate good rates of return on IWM electrification projects. Accurately quantifying the benefits and consumer willingness to pay for electricity is essential for properly assessing project rates of return.

To determine the willingness to pay, the proof of concept has practiced an approach, which measures the benefits from electricity (for instance lighting and TV, productive use of energy by business enterprises) as the willingness to pay for each facility in the form of a monthly rental. The approach also considers education, health and other co-benefits like entertainment and provision for mobile charging etc. Other benefits are harder to quantify, but many of them are internalized by the household and hence reflected in the willingness to pay. The exceptions are public good benefits, such as street lighting increasing security, and the so-called "global benefits" of reduced carbon dioxide emissions, where applicable.

Including these benefits puts the benefit for an average household consuming around 30-40 kilowatt hours a month at about NPR 500 (5 EUR) per month per household . This level of benefits is sufficient to ensure an adequate rate of return for most IWM community electrification schemes.

Design of tariff:

The proof of concept considered two tariff systems, based on project specific field based analysis: a flat rate system and a tariff system based on energy meter records. The flat rate system is introduced to the domestic consumers and the metering system is institutionalized in the rural micro-enterprises.

The proof of concept has selected flat rate system for three categories of domestic consumers of electricity:

1. consumers using maximum 35 watt, paying 110 NPR per month;
2. consumers using maximum 60 watt (without TV), paying 187 NPR per month, and;
3. consumers using 140 watt (with TV and other feasible electrical appliances), paying 203 NPR per month.

Based on a matrix analysis it is found that the households can go for 5 watt compact fluorescent lamp (CFL) installation and the project has supplied 3 CFLs bulbs (15 watt in total) to each HH.

---

* *There is a caveat that the shape of the demand curve matters, and that assuming a linear demand curve, most likely results in an overestimation of project benefits. The ESMAP approach yields a willingness to pay, for lighting and TV alone, of around $0.50-0.70 per kilowatt hour. This figure is already well in excess of the average long-run supply cost.*

For the productive end-use of electricity by rural micro-enterprises, the tariff structure and monthly rental is dependent on the type of micro-enterprise and its energy demand. An attempt was made to generalize this and it is estimated that the average minimum demand for a PEUs stand at 160 units and that per KWh, the tariff should be 4.4 NPR. Alternatively, from the financial viability perspective, a fixed monthly rental of 700 NPR is proposed for 90 units and the surplus unit consumption will be metered as per actual meter reading. For metering, an energy meter is introduced into the PEUs. [More details on the tariff design and the advantages and disadvantages of each system have been made for all four projects. Reports are available in this dropbox link: https://www.dropbox.com/sh/hh5yhhfkd0t4bvk/Hpite9Nw_h].

Domestic Tariff		Commercial Tariff based on metering
Maximum 35 watt	110 NPR	4.4 NPR/KWh
Maximum 60 watt	187 NPR	Or fixed monthly rental: 700 NPR for 90 units and the surplus unit as per meter reading @ 4.4 NPR/KWh
Maximum 140 watt	203 NPR	

Light load scheme:

To optimize the electricity use, a pre-determined scheme (time slot) to provide electricity supply to end-users (HHs) and commercial rural micro-enterprises is proposed and currently implemented in the project sites. This time table was agreed during community consultations and sounds useful to replicate in the forthcoming projects too. The relevant tabulation for this light load scheme is provided below.

Options	Type of loads	Time Schedule		Remarks
1	Light load	6 PM To	5 AM (next morning)	11 hours
2	Productive End use load	12 PM To	6 PM	6 hours
3	IWM only to run	6 AM To	12 PM	6 Hours

Light load unit Calculation:

Type of load	No of households in a single village (average)	Total power in Kw per HHs	Total days in year	Time in Operation 6 PM- 5AM In hour	Total Yearly energy consumed in Unit(Kwh)	Yearly watt
Light load	25	0.140	300*	11	11550	3500
* Only 300 operational days is assumed. (1 Unit = 1 Kilowatt x 1 Hours)						

End use load unit Calculation:

Type of load	Capacity	Capacity in Watt	Capacity In Kw	Time in Operation 12 PM- 6 PM In hour	Total Yearly energy consumed in Unit
Motor single phase	2.5 HP	1865	1.865	6	3357

A comparison between micro-hydro power project and IWM –E is presented below.

SL No.	Projects Name	Rate in Nepali Rupee	Remarks
1	Pokhar Khola MHP	Nrs. 150 flat rate	Foksingtar ward no 9 (Reference Mr. Indra Bahadur Ale Magar Local resident
2	Choukhola III PHP	Nrs.100 Flat rate	Reference Mr. Dil Dash Shrestha Local resident, Foksingtar, Cahukhola
3	Choukhola IV MHP	Nrs.150 Flat rate	Reference Mr. Dilip Rana Local resident, Foksingtar
4	Roshi Khola IWME (Existing project)	Nrs.120 Flat rate	Reference form Mr. Krishna Bahadur Thapaliya
5	Khani Khola PHp (1Kw)	Nrs. 50 Flat rate*	Private PHP of Mr. Nawaraj Thokar
	Nrs. 50 Flat rate*	Private PHP of Mr. Nawaraj Thokar	200 for 20 Unit
6	Nepal Electricity Authority for Min. 20 unit	Nrs.200 Metering	200 for 20 Unit

Check on power theft:

To check power theft at domestic and enterprise level Miniature Circuit Breaker (MCB) power control system will be introduced along with strong community led inspection and project management. The MCBs are installed before wiring. 1 Ampere MCB for 140 watt is selected and similarly, 0.5 ampere MCB for 40 watt and 60 watt have been selected and installed. In case of productive endse unit a single phase energy meter with current capacity of 12 Ampere to 16 Ampere is used.

Conclusion:

- A strong community driven tariff system is highly helpful and in case of the IWM community electrification project, this approach will be useful for other community electrification interventions.
- The tariff structure needs to be revisited and revised at least every 3 to 4 years. This will ensure effective pricing.
- The distance between powerhouse and SMEs should not exceed 300 meter one-way. This will reduce power loss because we are generating very little power.
- It is found that placing two separate distribution boxes for End-Use and HHs is useful, this will segregate the power use at the level of power distribution itself.
- Introducing a robust training, data management and repair and maintenance system is very important. The proof of concept has designed such module and can be used for the full-fledged IWM community electrification program.

F. Establishing SMEs:

Productive end-use of energy at the micro and rural enterprise is crucial to generate a sustainable source of revenue in the community electrification program. In case of selecting rural micro-enterprises and rural individual entrepreneurs for this proof of concept phase, a methodological approach was designed and tested at the field level, then used as the standard procedure for selection. (Figure 4).

As illustrated in this figure, the SMEs were selected through a consultative process. A village resource mapping was carried out to assess the availability of raw materials and feedstock in the project area, followed by mapping the potential entrepreneurs and micro-enterprises based on their current skills, capacity, funding available (own fund) etc. A sample of village mapping is provided below.

Based on this resource mapping a long list of potential productive end-use interventions were identified. The list has been provided as table.1. .

The resource mapping exercise was followed by a feasibility assessment of the enterprises and this assessment includes (i). economic and commercial feasibility of the indentified enterprise and entrepreneur; (ii). technical capacity need assessment of enterprise/ entrepreneur; (iii). technical (skill) and business development training to SMEs and (iv). development of individual business plan for all four SMEs.

As part of this assessment, a sub-national level (project area based) market feasibility, pricing and sales plan has also been produced. It was understood that without a sound production and investment plan, the micro-enterprise can't operate. Hence, the proof of concept stage has produced production, market, and investment plan for each micro-enterprise. Eventually a strategy has been developed for linking these micro-enterprises to the market (an illustrative representation of this flow is provided as figure 4).

Figure:4 (a). PEU selection process

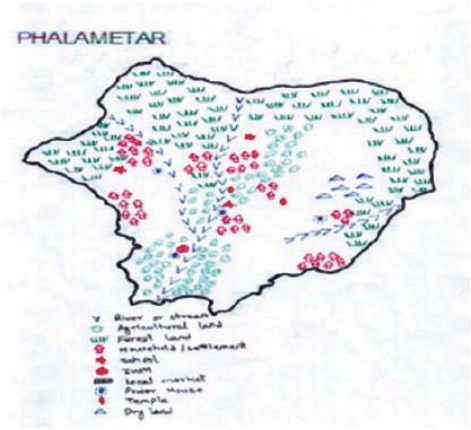


Figure:4

Selected site	Given-Identification code	PEUs
Site-1	Micche-5	Carpentry, Milk Cooling Centre
Site-2	Foksingtar-2	Carpentry
Site-3	Falametar-9	Saw Mill and Carpentry
Site-4	Gokule-6	Metal workshop and Carpentry

Table-1. List of PEUs

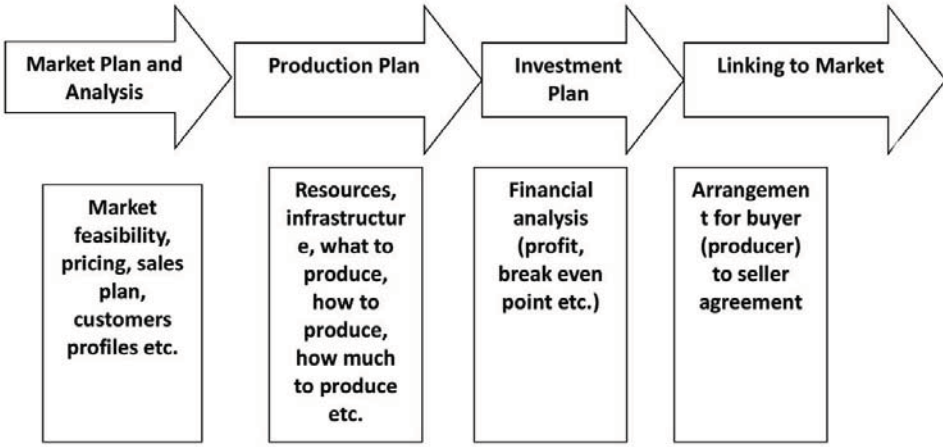


Figure: 5. PEU selection process

With respect to linking the productive end-user (micro-enterprises) to the market, the proof of concept has created an enabling environment for having a MoU signed between SMEs and wholesale marketers or retailers. However, in case of the current micro-enterprises of the 4 sites, such MoU could not be signed as the type of business operations does not provide an opportunity to have wholesaler or retailers (for instance, in case of carpentry, the owner of the SMEs itself is producer and retailer).

It is planned that there will be match-making arrangement for financial supports to micro-enterprises from financial institutions. The type of financing can be in the form of micro-finance and or the general credit system. This part of SME development will be incorporated to the full-fledged program implementation.

The current investment plan of the SMEs includes 40 % own contribution from micro-enterprises, with 60 % being paid from the EnDev/GIZ funding. The average investment for a single PEU is 100,000 NPR. The detailed business plan is available in the dropbox.

[https://www.dropbox.com/sh/hh5yhhfkd0t4bvk/W4YLHygOdY/PEU]

Under this proof of concept phase, six micro-enterprises have been established and are currently operating in the project sites (see table:1). The general break even points for these PEUs are expected to be met in the next 1.5 years.

It was evident from the lessons learned during the proof of concept that IWM electrification programs should target direct impact on livelihoods and revenue generation beyond the provision of connections and kilowatt-hours by implementing electricity projects that affect livelihoods and generate new revenues. Hence, the program has generally adopted a systematic approach, which operates based on five key steps:

I) identification of the productive activities taking place in a project area;

II) analysis of the production processes involved, identification of possible improvements and limitations;

III) review of the contribution of electricity to these expected improvements and what other additional intervention is required;

IV) analysis of the technical and economic feasibility and the social viability of the electricity based solution proposed, and;

V) a targeted promotion campaign to potential users about the gains from the use of electricity for a new production process, involving Ghatta Owners Association (GOA), relevant service providers, microfinance institutions and any other relevant stakeholders, such as local governments, cooperatives and/or NGOs.

Conclusion:

- Generating improved business competitiveness through productive uses of electricity will translate to higher incomes, better community services, and in general, a better opportunity for integrated development.
- SMEs require reliable energy to produce goods or to provide services. A classic example to illustrate the importance of reliable electric service is a rural milk-cooling shop, which was interviewed during the proof of concept stage. No power, no more chilled Milk.
- Even if all of the other components of a PEU program are in place, if the market cannot or is not willing to absorb the increase in products and services, the program will fail. Hence, the IWM community electrification program has designed the market-linkage mechanism, which will ensure a balance between market demand and actual supply.
- Once the program beneficiaries are aware of the program possibilities, the market offerings, and the investment in equipment and working capital required, the program should turn its attention to financing options. In some cases, rural micro-enterprises may have capital ready to expend. However, the majority will require some form of credit or grant to obtain the necessary equipment. To maximize program success, the PEU sub-component should therefore provide information regarding available financial resources. This is also necessary to mobilize funding from micro-enterprises as their own contribution/investment to the program.
- It is found during the proof of concept stage that to finance the purchase of electrical equipment (like induction motors), it is necessary to involve financial institutions that are willing to participate in the program. However, prior to defining alliances with a particular financial entity, it must be analyzed. The proof of concept stage could not include this component, the full-fledged program will.

G. Training and capacity development: community and PEUs

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

Consumer education and promotion of productive uses would enhance the benefits of electrification. In most of the cases, it is visualized that the full potential benefits of providing electricity to the poor are not being realized—first by not enabling the poorer households to connect to the grid, and second, by not providing information to consumers for them to obtain maximum benefit . The proof of concept has developed a community mobilization and education toolkit, which has been introducing a transformational change in consumer's willingness to take part in the program activities. **There are three levels of consumer education and training provisions within the IWM community electrification program:**

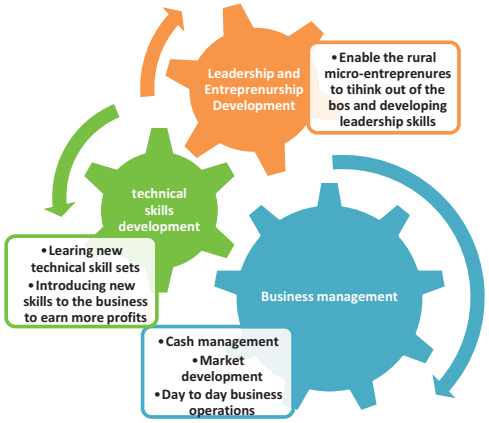


Figure: 6: PEU training components

(i). general rural entrepreneurship training for communities to be entrepreneurial in their activities and consumer education on effective use of electricity at household and at enterprise level;

(ii). skill based training to interested rural entrepreneurs who want to establish micro-enterprises , and;

(iii). Tailor-made skills, business operation training (accounts keeping, cash management, business plan management, credit management, demand development, market development, etc.) to the currently prevailing entrepreneurs/micro-enterprise owners.

Each productive use activity needs to have people with the skills necessary to make the business survive and thrive. There may be reliable electricity, electric equipment and financing, as well as a favourable market, but if the business does not have the human resources required with the necessary business and technical skills to operate it sustainably, it is doomed to fail.

Here again, the program aims to decide how much training the program itself will have to provide versus using existing institutions such as vocational schools, technical institutes, universities, and NGOs. Besides, for the IWM community electrification and micro-enterprise development program itself to succeed in designing a productive energy use program, those involved must understand the entire program, how and why it was conceived. Hence, a level of orientation is necessary to the program management unit. Personnel involved in

* *The dominant use of electricity in rural households is lighting. All households use it for this purpose, and many use it for little else. Consumer education may enable a greater range of benefits to be realized by newly electrified households. For example, electricity is rarely used for cooking in rural areas. The potential benefits to be gained from displacing firewood or kerosene stoves are not realized in the vast majority of cases.*

the program should not only have a clear understanding of the project, but also be sensitive to the circumstances that prevail in the target population.

H. Sustainable revenue model development

Both the tariff revenue and PEUs revenue potential in the proof of concept stage depicts that, in general, an improved water mill community electrification unit along with rural micro-enterprises can reach at the breakeven point in the 3rd or 4th year of the project cycle. An indicative financial analysis is presented below

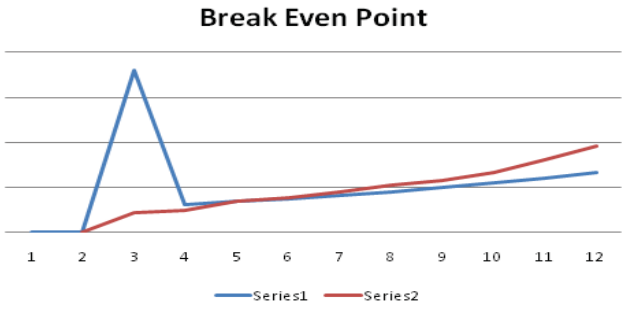


Figure: 7: Financial Analysis of business model

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Project invest-ment	1700000	302131	332344	365578.4	402136.2	442349.9	486584.8	535243.3	588767.7	647644.4
PEU invest-ment	100000	5000	5500	6050	6655	7320.5	8052.55	8857.805	9743.586	10717.94
Total project Investment	1800000	307130.9	337844	371628.4	408791.2	449670.4	494637.4	544101.1	598511.2	658362.4
Tariff Revenue HHS	60900	60900	60900	66990	73689	81057.9	89163.69	98080.06	107888.1	118676.9
Tariff Revenue PEU	14770	14770	14770	16247	17871.7	19658.87	21624.76	23787.23	26165.96	28782.55
Total Tariff	75670	75670	75670	83237	91560.7	100716.8	110788.4	121867.3	134054	147459.4
Revenue for PEU	134500	162050	262050	302050	352050	427050	467050	537050	667050	807050
Total Revenue	210170	237720	337720	385287	443610.7	527766.8	577838.4	658917.3	801104	954509.4
Cost benefit	-1,589,830.00	-69410.9	-123.99	13658.61	34819.47	78096.42	83201.06	114816.2	202592.8	296147.1
IRR	9%									

9 % IRR exhibits the financial additionallity of the program, justifying donors funding to the program.

I. Introducing effective monitoring and QC system and Post Installation Care:

A detailed and robust monitoring & evaluation (M&E) system will be worked out for comprehensive monitoring of results for the IWM program interventions. This will start with commissioning of different studies, including the baseline for general information, including existing capacities. In addition, SNV will commission mid-term and final evaluations for the program. Regular M&E of the program will be the responsibility of the implementing organisation with backstopping support from SNV (see table below).

Case: IWM electrified community of Samundra Devi in the Nuwakot district [Developed by: Eric Gold]

Technical Issues and Processes: While the capacity is 3.5 kW and is operational throughout the year, there are "many" failures. The failures are reported from the operator to the electricity committee for approval and fund allocation. Smaller failures occur approximately 3-4 times/yr and last for approximately 1-2 days. However, there are also larger failures that result in longer outage periods. Three months ago heavy rains caused a rise in the stream level, which reached the backside of the powerhouse and caused a shutdown of 15 days. The reason could be from dismantling the penstock pipe that leads into the powerhouse? Also, a defect in the ballast resulted in a failure of the control system. The controller was brought to the service center for repair 1 year ago. However, there weren't and aren't enough funds to pay for the repair and they are currently operating the unit without controller! It was mentioned that technical support from Battar could cost 5000 NRps/day for site visit.

Community recommendations:
The IWM program should focus more attention on the durability of the sites. Cement and steel should be used in place of wooden poles. These result in many smaller failures that cause outages. (Secondary example of proper flow control systems.) It is desired for a better permanent fund to eliminate larger problems the community cannot afford to fix, such as the ballast/control problem mentioned. Greater community contributions for this relief account could be made along with additional funding, but are also hard to manage.

Activity	Purpose	Responsibility	Frequency
Fabrication and installation activities	Monitor production of IWM kits as per standard guidelines	DDC/DEEUs, SNV and local partners	During the production period, year-round
Financial activity	Reporting achievements and expenditure	SNV and local partners	Semi-annually
Programme outputs	Report achievements of targets and outputs of the activities planned for the period	SNV and local partners	Annually
User surveys (to include gender, environment and economic and technical aspects of the programme)	Assess the impacts and performance of technology and service of suppliers and installers	SNV and its partners with support from independent consultant	Annually
Programme evaluation (mid-term and final)	Assess and review the programme's effectiveness, outputs and impacts	Independent consultant	At the middle and end of programme

Table-2: Quality Control Plan

For quality control, the program will follow the micro/pico-hydro standards, which have been developed by AEPC/NRREP. In addition to this, producer/manufacturers are the private sector organizations pre-qualified by AEPC, involved in production and delivery of quality appliances (e.g. IWM kits and equipments). GOAs play a key role in IWM installation, community facilitation for demand creation, information dissemination, marketing of products, etc. Therefore, the program will introduce periodic capacity development and training activities on quality control and post installation care at the level of DDC/DEEUs, GOA, kit manufactures, mill owners and PEU owners as well as at community level.

J. Developing capacity of DDCs, installation companies and GoA

It was distinctively visible during the proof of concept stage that there are significant needs for support on capacity development at the district development committee (DDC) level and its district energy and environment unit (DEEUs). This is particularly important since IWM community electrification schemes are expected to be managed by DDCs/DEEUs in the near future.

Similarly, there is need to strengthen the capacity of national capacity builder (RETSC) as well as another good organization for up scaling IWM program implementation to cover all potential sites of Nepal. Current district level IWM actors (GOA, service centres and manufacturers) have limited capacity and the overall sub-sector performance is arguably below par. Membership organisations of IWM owners (GOA) exist in the selected district, but are poorly functioning as an association whereas there is huge potential for them to provide business and financial services, act as an intermediary and advocate on behalf of its members for more support.

Developing capacity of IWM sector actors (AEPC, Ghatta Owners Association, IWM kit manufacturers, microfinance institutions, service centres and local capacity builders) for improved effectiveness and efficiency of the current program implementation modality as well as institutional development of the sector is crucial.

The capacity of RETSC (national capacity builder) a subsidiary of CRT/N is primarily on the technology front. As a result, the focus of CRT/N has largely been on the technical skills and know-how of the IWM actors. Strengthening the capacity of CRT/N in IWM enterprise development, association development and management of GOAs, social mobilisation and community engagement, multi-actor facilitation for knowledge sharing, lobbying and advocacy, is a key requirement to achieve the intended results of this project.

The full-fledged IWM community electrification and micro-enterprise development program will include these capacity development activities. The major suggested activities are:

- Strengthen capacity of DDCs/DEEUs in pico-hydro [mainly IWM] sub-sector development: site selection, implementation and quality control of programs;
- Strengthen GOAs for revenue generation, resource mobilization, networking and managerial/organization development aa well as providing enterprise development services to its members;
- Strengthened service delivery capacity of IWM actors : service centres, manufacturers;
- Strengthen capacity of RETSC and CRT for facilitating IWM program implementation;
- Partnering with AEPC/NRREP for IWM program execution.

A conceptual framework for this capacity development support and the expected outcome, output and level of impacts are provide in the figure 7 below.

Impact *Improved access*	***Impact target*** • Improved use of IWM community electricity schemes by the remote and rural population • Increased income of community, rural entrepreneurs		
Outcome *Improved Performance of Clients*	**Improved client performance** • Increased coverage/ proportion of LS IWM-E • Emergence of viable and sustainable Ghatta Owners association in all districts • Increased clients and revenue of the IWM owners		
Outcome *Improved Capacity of Clients and Enabling Environment*	**Improved Capacity** • Strengthened DDC/DEEUs, GOAs for promoting, protecting and supporting development of their member water mill owners sustainably. • Strengthened capacity of national capacity builders for facilitating IWM programme implementation • Strengthened IWM Service centres and manufacturers • IWM enterprises strengthened	**Enabling environment** • Conducive govt policy for IWM electrification • Government policy favourable for IWM technology • Financing through micro finance available for IWM [working closely with Clean Energy Development Bank and NRREP] .	
Output *Capacity Development Services Delivered*	Targeting IWM: • LS IWM –electrification technology improved with R&D. • Financing through micro finance facilitated. • Pro-LS IWM subsidy policies lobbied • IWM enterprises developed through training and value chain development of IWM products. • GOA formation and strengthen supported • Promotion of productive enduse Targeting community: • Local micro enterprise development that access the energy from LS IWM supported		
Input *Strategy, Human Resources, Finance*	**Human Resources** • SNV Advisory supports	**Strategy** • AEPC's strategy and policy supports	**Finance** • Funding from EnDev/GIZ

Figure: 8: Intervention areas for Capacity Development

K. Managing expectation of community

The huge community expectations from the program are a challenge. Most of the project sites are very remote and require walking down to the project sites for more than 3-4 hours (average). Communities are far from mainstream of so called development and therefore, there are huge expectations for roads, bridges, schools etc.

A diligent and systemic approach has been adopted to clearly present the objectives of the IWM community electrification and micro-enterprises development activities. To have a single message for the communities, the program implementation team is also trained on the key aspects of the program and the major direct and co-benefits, which would be derived from the program.

4. Impact of the pilots IWMs electrification projects

The pilot project provides clean, renewable energy for lighting purposes at the household level and strengthens small scale enterprise development in rural and remote areas of Nepal. Four key benefits and positive impacts are expected from this intervention, viz., (i). clean energy access for lighting to HH, (ii). enhance productive use of energy at rural micro-enterprise level, (iii). Income generation from the Productive end-use at rural micro-enterprise level, and (iv). rural street light system for enhancing security.

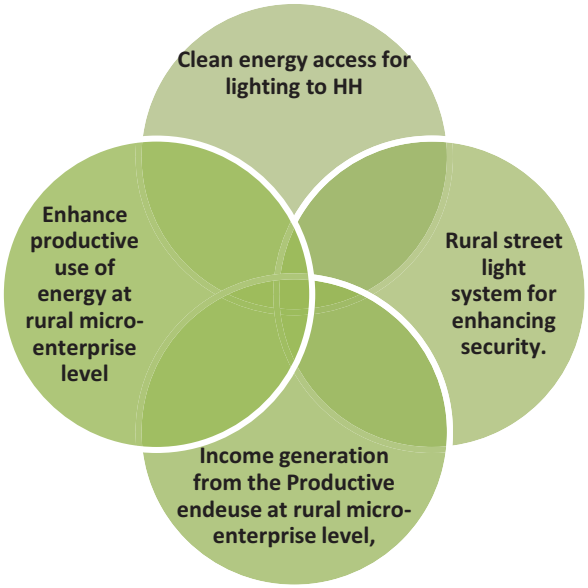


Figure:9-benefits of IWM projects

At household level, the project is reducing drudgery on average by two hours per milling which frees up time for schooling, education or productive activities. With the implementation of the proof of concept project it is expected that up to 720 men and women (6 persons X 30 HHs/Electrification X 4 Projects) will benefit from the project.

It is also estimated that by establishing 6 micro-enterprises, there will be (average 5 direct employment opportunities per enterprise) 30 direct and 100 indirect employment opportunities.

In case of the full-fledged program (to be commissioned from 2014), the program aims to install 20 IWM units, aiming to provide clean lighting to 3600 men and women and it is also estimated that by establishing 35 micro-enterprises, there will be 200 direct and 1000 indirect employment opportunities.

Electricity power generated by the IWM project provides a large number of rural households with electricity and power for lighting, milling and other needs. Such off-grid IWM systems not only help in poverty alleviation but also have direct local environmental benefits, such as:

- reduction in diesel consumption by replacing use of diesel power with electric agro processing mills and household lighting;
- reduction in use of dry cells used to operate radios and torchlights, leading to reduced pollution of the local environment and also reducing the health hazard resulting from the exposure and contact with related chemicals;
- reduction in pollution from Lead Acid Cell Battery. With proper electric supply households will no longer need to purchase a battery to supply electricity for lighting. Therefore, charging practices will be eliminated, hence eliminating the need for continuous transport of wet lead acid batteries from houses to charging stations.

Aside from the environmental benefits, the project will benefit other areas of the Sustainable Development Agenda, such as::

- plants constructed under the project will be managed and operated by the community, institutions or private entrepreneurs leading to local empowerment;

- skills development and training for operation, repair and maintenance will be provided to the people for smooth operation of the plant, which will enhance the skill set of local people;
- electrical end-use enterprises will lead to different opportunities for self-employment at local level.

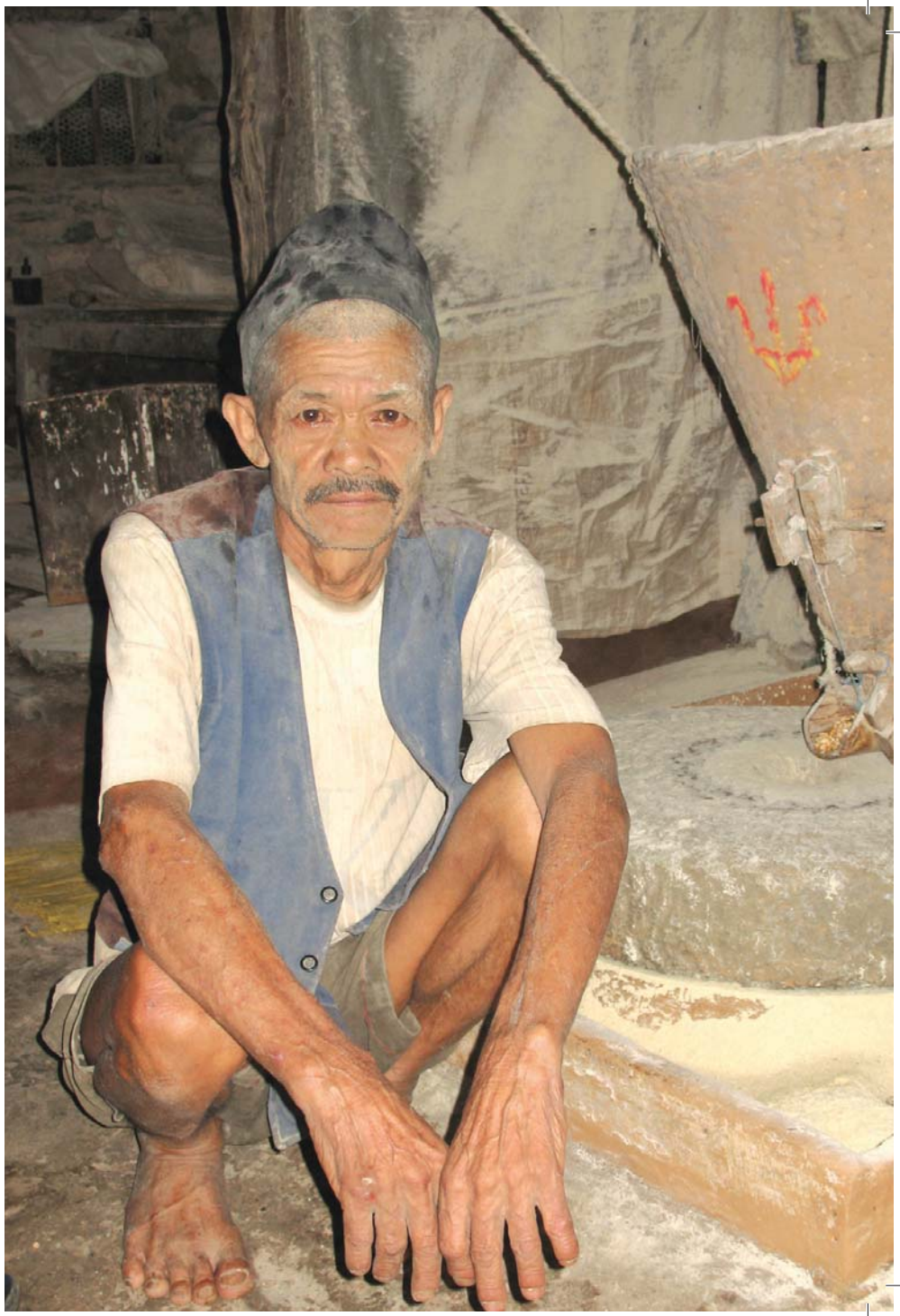
Besides, all the 4 villages of the proof of concept stage are now having street light connections and it is also planned for the future 20 project villages. The street light system will enhance the security in the villages.

5. The Proven Concept:

Based on the aforesaid analysis and field testing, *iit is now evident that community electrification with IWM technology and establishing micro-enterprise with the use of electricity produced from IWM units is technically, commercially and socially feasible in the rural set up of Nepal.*

It was found that the previous installation process of IWM units was slow in comparison to IWM proof of concept of EnDev/ GIZ where the time required for installation of 4 units was only 5 months. This speedy installation and commissioning was possible owing to effective program management of SNV, timely guidance and support of AEPC/NNREP and efficient field level implementation by CRT/N, GoA and other key stakeholders.

In the full-fledged IWM program SNV should be responsible for technical assistance and overall project management under



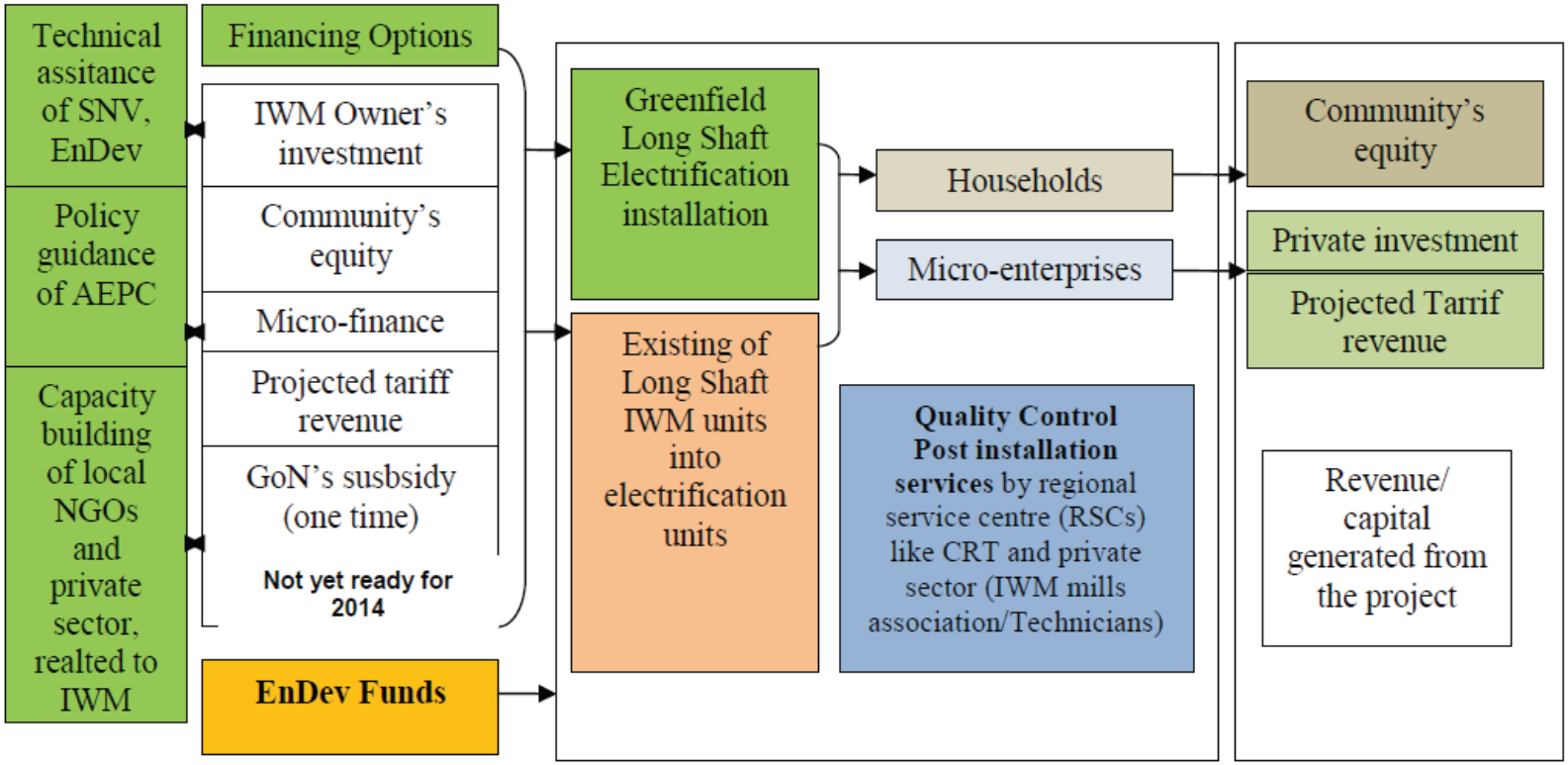
the National Rural and Renewable Energy Program (NRREP) of the AEPC. AEPC will provide policy guidance and will be responsible for overall quality control. CRT/N will work with the national capacity builder (RETSC) to support SNV for ground level implementation and will provide training to construction teams, as well as creating demand and raising awareness about supply side management and IWM-electrification benefits. In addition to CRT/N, other eligible and competent Regional Service Centres (RSCs) will also play a critical support role in demand creation.

It is anticipated that after the 18 months implementation period of the full-fledged program (2014-2015), sufficient software and hardware will be available to provide critical inputs towards the design of a national replication strategy. Such a strategy will integrate specific off-grid electrification policies and programs within an overall plan that would cover line extensions, independent mini-grids and individual systems as solutions to providing access to suitable remaining unserved areas. The replication strategy will include a clear plan for financing IWM electrification and will define a set of policies for determining tariffs and for allocating subsidies.

It is important to mention here that to strengthen local ownership and to build towards long term financial sustainability, supplementary financing was made available via IWM owners' contributions and community investments in labour costs. The micro-finance lending system was not addressed as a separate project on IWM micro-lending was carried out by AEPC/ADB. The lessons learned from this project demonstrate that micro-finance is a possible financial option for the IWM sector. The full-fledged program will include this component.

Government subsidy was not part of this pilot. As per the recent subsidy mechanism and policy, all requests for pico-hydro subsidy disbursement shall be controlled by DDCs/DEEUs, whom on top of being new to the pico-hydro sector, have to deal with a sub-national level set up that is not yet ready. As a result of this and based on previous experiences, subsidy disbursement takes an extremely long time causing significant delay in project installation. Hence, subsidy finance would not be ideal to finance program upscaling. The full-fledged IWM program also needs to further develop the capacity of DDCs/DEEUs. It is also apparent from the experiences of the proof of concept that introducing a robust post-installation care and regular maintenance system are key. Hence, the program established a post installation unit for each IWM scheme, to be paid with the project revenue [HH tariff and PEU tariff].

To summarize, the IWM community electrification with productive end-use of energy is a viable business option, which is capable to meet the breakeven point in year 3 or 4 from the date of installation. Eventually it can run as a self-propelled and commercially viable rural power house and rural business enterprise. Detailed outcomes and pitfalls of the program will surface during the first annual monitoring of the program.



6. Critical Success factors:

The program needs to consider the below critical success factors while implementing the next phase of the program:

Timely planning and installation	Most of the IWM project sites are remote and do not have motorable roads in the summer season. Hence, it is obligatory to have fast track project planning, DPR development, site selection, baseline development and installation activities. Even a month delay in planning could result in a year long delay in actual installation and commissioning of the project.
Timely subsidy	Disbursement of subsidy payment is time consuming. DDC/DEEUs are new to the subsidy mechanism and to the IWM sector in general. Strong capacity development support to DDCs/DEEUs is crucial, along with facilitating the subsidy disbursement mechanism with technical assistance.
Selecting right rural entrepreneur and training on PEUs skills	Selecting appropriate rural entrepreneurs is critical. After installation of PEUs, initial hand holding supports on business operations, cash management, demand creation etc. are necessary. Besides, regular training on skills and entrepreneurship development are also useful.
Continuous support and strong post installation care	Any project intervention without a sound and systemic post installation care mechanism cannot sustain. This is also true for IWM community electrification. Hence, the program has introduced a system for this aspect.
Having IWM fund to cover investment risks	Financing is a key aspect. Community and IWM owners do not have cash and subsidy disbursement takes a long time. Hence, an investment fund [as revolving fund] is very important to accelerate IWM sector development. This can be clubbed with the micro-finance facility.
Working closely with DDCs/DEEUs, timely DPR development and simplification of process	SNV and its implementation partners are working very closely with DDCs/DEEUs. This will help to timely develop DPRs, baseline studies and site selection activities.

The larger share of benefits from rural electrification is captured by the non-poor	It is widely recognized that the larger share of benefits from rural electrification are captured by the non-poor. The analysis shows that this continues to be the case, though the gap closes as coverage expands. Two factors underpin this pattern: which communities get connected and which households can afford the connection once the grid is available. Hence, the IWM programme will avoid this scenario and ensure to provide maximum benefits only to needy beneficiaries. This can be ascertained with strong community participations.
Knowledge product development on IWM community electrification	There is a huge gap on knowledge products [like manual, books, implementation handbooks etc.] in IWM sector.
Timely supports and policy guidance from AEPC	Swift and timely policy guidance from AEPC is also necessary and could drive the project towards success.

7. Plan for a full-fledged programs:

With the successes and critical lessons learned from the proof of concept, SNV is confident for developing a full-fledged IWM community electrification project with the promotion of productive end-use of energy at rural micro-enterprise, in a partnership with EnDev/GIZ and AEPC. The full-fledged IWM program will be implemented as an integrated rural community electrification and micro-enterprise development initiative using IWM technology, to provide electricity for lighting purposes at household level and for productive end-usage such as rice hulling, oil expelling, etc, to support small business development and income generation at the household level. The program aims to install 20 IWM electrification units and 50 rural micro-enterprises in 18 months time.

The implementation modality of the program will be aligned to the AEPC/NRREP framework and follow a fast track implementation strategy to ensure that the program can be implemented timelywhile producing the necessary software and hardware to provide critical inputs towards the design of the national replication strategy. Such a strategy will integrate specific off-grid electrification policies and programs within an overall plan that would cover line extensions, independent mini-grids and individual systems, as solutions to providing access to remaining un-served areas/HHs.The success of this program and vision for a national replication strategy will depend on the level of effective commitments of all key stakeholders in the IWM community electrification sub-sector.