Final Report

of

Impact Study of Community Electrification" RFP#AEPC/NRREP/CESC/2073/74-14

Submitted to:

Government of Nepal
Ministry of Population and Environment
Alternative Energy Promotion Centre (AEPC)
National Rural and Renewable Energy Programme (NRREP)
Khumaltar, Lalitpur

Submitted by:

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Abbreviation

AEPC	Alternative Energy Promotion Centre
CBO	Community Based Organization
CESC	Community Electrification Sub-Component
CO2	Carbon Dioxide
CS PRO	Census and Survey Processing System
DDC	District Development Committee
DEECCU	District Energy Environment and Climate Change Unit
DVD	Digital Versatile Disc
ERMC	Environment and Resources Management Consultant
ESAP	Energy Sector Assistance Programme
FGD	Focus Group Discussion
GoN	Government of Nepal
ICS	Improved Cooking Stove
ICT	Information Communication Technology
IGA	Income Generation Activities
KII	Key Informant Interview
MHP	Micro-Hydro Plant
N	Number
NPR	Nepalese Rupee
NRREP	National Rural and Renewal Energy Programme
PHP	Pico-Hydro Plant
RSC	Regional Service Center
TB	Tuberculosis
ToC	Theory of Change
TOR	Terms of Reference
TV	Television
VDC	Village Development Committee

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Executive Summary

Background

National Rural and Renewable Energy Programme (NRREP) is implemented by Alternative Energy Promotion Centre (AEPC) for five years from mid-July 2012 to mid-July 2017. The Community Electrification Sub-Component (CESC) of NRREP is one of the major sub-components responsible for coordination and implementation of community electrification activities throughout the country in demand driven and public-private-partnership approach. As per clause No. 14 (b) of Annex I of Renewable Energy Subsidy Delivery Mechanism 2073, an independent program evaluation team was commissioned with aiming to evaluate the impact of the project and users' satisfaction. An evaluation team comprised a team leader, renewal energy expert, and socio-economist of independent consulting organization.

Objectives:

The objective of the conduction of Impact study of Community Electrification is comprehensive assessment of the impacts of the Micro Hydropower Projects (MHPs) installed under programme activities so far, to reveal the socio economic impact in the local level, gender and social impact, environmental impact, impact on health and education in general and children in particular and impact other relevant areas.

Methodology:

The study covered 25 Micro Hydropower Projects (MHPs) for impact study. Around 10 percent beneficiaries from each sampling project were selected for field survey. Moreover 5 percent households from non-project intervention areas were selected to compare the impact of the project. The sampling units also covered 25 focus group discussions, 111 key informant interviews with concerned persons, local stakeholders, concerned government officials and service providers.

Findings:

Academic performance of children is greatly influence with having access to electricity. Around 98.4 percent of children of 6 to 15 age group from beneficiaries were school going children. Similarly average reading time at household level of school going children has increased in comparison with control groups. Due to establishment of computer institutes, computer labs at school level and internet café, student's access to education from informal sources has been increased significantly.

Around 40% of beneficiaries currently used Improve Cooking Stoves knowing its importance regarding health and environment. Usage of firewood has also decreased as compared to control group. Micro-hydro has contributed to protect forest, especially pine trees which was used to lighting before community electricity. It also indirectly support to clean the surroundings and increase usage of toilet in the evening time.

Overall health problem in different age groups has been decreased in project areas. The reason for decreasing the health problem could be access to information and communication technology

which was possible after electrification as well as lighting and changing in cooking habit of beneficiary groups. Micro-hydro directly reduced Indoor smoke free at household level. Due to availability of electricity at community level, quality of health services was increased at beneficiary's level. Incidence of disease occurrence related to respiratory disease decreases has been decreased. Personal health status has increased due to usage of clean energy and reduction of fusil fuel.

Substantial change could be seen in terms of economic and social empowerment compare with beneficiary and control groups. Around, 69.4 % of beneficiary groups family have equal control over family income where as 30.6% family have equitable control over family income. Compare to beneficiary groups and control groups of community electrification, it has been significantly different in terms of representation as well as leadership

Access to electronic media has been increased after community electrification which is either community hydro or solar energy. Multiple sources were used to reach the information by both groups. Access to information sources was noticed higher in beneficiaries groups. To access the information Beneficiary group largely used NGOs, CBOs, Television, political mechanisms. Equipment related to information technologies accumulated by beneficiaries group was recorded higher in project areas.

Average household income of beneficiary groups was NPR. 196881.8, which was higher than control groups (NPR. 167251.8). More people from beneficiary groups were engaged in off-farm IGA. Average number of assets accumulated at household level was higher in control group; however, value of these assets accrued was noticed more in beneficiaries groups. Project beneficiaries were more concentrated on acquiring productive assets where families of non-users preferred unproductive assets.

Around 22.5% respondents were found highly satisfied, while 55% and 2205% were found moderately satisfied and less satisfied with the service provider's services and performance. Beneficiaries satisfaction were observed regarding the completion of project on time, appropriate technical support received from local bodies and NGOs, contribution of project beneficiaries in the construction of plants. On the other hand, they also stated that limited monitoring of projects from donors and project stakeholders, received less financial support as per previous commitment from local bodies, limited access to maintenance and repair, delay in construction and installation were major causes to express less satisfaction regarding the project.

Average maximum capacity of micro-hydro in sampling areas was 58 kilo Watt. In the dry season, average capacity of scheme was remains nearly 52 kW. In addition energy consumption at household level was 120 watt in a day. Average amount of tariff per month per family was NPR. 91. Power generation was stopped 42 days last year due to different causes including maintenance. Moreover power load common problems observed in the project areas.

Grinder/huller mills, furniture, computer lab/institutes and poultries were major enterprises of which consume more day time electricity. Around 2.5 KW energy consumed on average by these

enterprises. End use entrepreneurs revealed that average investment of an enterprise was NPR 195,000 which earns NPR. 21,545 monthly. Average contribution of monthly income by using energy was NPR. 9,017. Majority of these entrepreneurs were received subsidy from AEPC. Limited access to credit facilities in terms of volume of loan and Financial Institutions were prevailed in the project areas. A long documentation process was required to review and approval of business plan to receive subsidy. Similarly, possible enterprises in future are grinder/huller, computer lab, grill factory, bread factory, noodle, sewing, wood mills, soap factory, herb processing, internet café, hotel and tourist restaurant. In addition, Employment generation from a micro-hydro project found around 7.6 person of which full employment was 2.4 and partial employment was 3.8 person. Engagement of men in enterprises comparatively higher than women.

Out of 10 projects utilized the maintenance fund for regular maintenance. Major sources of maintenance fund were tariff collection and grants received from AEPC. Other sources of maintenance were grants and technical support from other organizations. With the limited capacity of regular operation and low load factor caused limited productive energy use and less viable to run enterprises in sustainable manner. Hence sustainable operation and maintenance would always be an issue in micro hydro projects.

Recommendation:

- Providing financial subsidy alone is not a viable solution to make such projects economically sustainable. It is necessary to give more emphasis to expand logistics, maintenance services and facilities at district level. With provision of maintenance fund a robust guideline regarding the establishment and mobilization of maintenance fund is utmost essential.

- Capacity building to MHP management team for preparation of Operation and Maintenance manual, translation of it's into regular activities, and providing high practical trainings to operators and manager is most crucial for sustainability of MHP.

- Current subsidy mechanism is more complex: costly, requires more documentation and time taking. Hence, it would be beneficial if the subsidy will be integrated with other Business Development Services like access to finance, technologies and logistics, and insurance. Facilitation and regular follow up supports is also important to entrepreneurs for marketing and scaling up their enterprises.

- Operationalization of standard tariff determination guideline is seems essential for use in MHPs. It helps to ensure equitable pricing mechanism for household lighting purpose and productive energy use sectors.

1. Introduction and Background

1.1 Introduction

This is the **Final Report** submitted by Environment & Resource Management Consultant (ERMC) (P) Ltd/Prism Consults I.L.(P) Ltd. (here-in-after referred to as Consultant) in fulfillment of the consultancy contract for the " Impact Study of Community Electrification" to National Rural and Renewal Energy Programme, Alternative Energy Promotion Centre. The report provides a background to the study, the study objectives, methodology, findings, conclusions and recommendations.

1.2 Background to Study

The Government of Nepal (GoN) and external development partners supporting Nepal's rural and renewable energy sector have designed National Rural and Renewable Energy Programme (NRREP) to be implemented by Alternative Energy Promotion Centre (AEPC) for five years from mid-July 2012 to mid-July 2017. The Community Electrification Sub-Component (CESC) of NRREP is one of the major sub-components responsible for coordination and implementation of community electrification activities throughout the country in demand driven and public-private-partnership approach. The sub-component aims to install 25MW of Mini/Micro Hydropower to provide electricity to 150,000 rural households during this period.

Around 6.9 MW of MHPs/PHPs has been commissioned benefitting 70,656 households with the effort of the programme considering ESAP Phase I and Phase II activities. Within the NRREP period, around 9 MW of MHPs have been commissioned benefitting 89,185 households, while around 1 MW of PHPs have been commissioned benefitting 12,601 households. These projects are scattered across the country. As per clause No. 14 (b) of Annex I of Renewable Energy Subsidy Delivery Mechanism, 2073, "the Centre shall do the evaluation of impact of the project and users' satisfaction in every two years through the independent consultant". During NRREP period, such studies have not been carried out. Hence, it is necessary to conduct a study to reveal the socio economic impact in the local level, gender and social impact, environmental impact, Impact on health and education in general and children in particular and impact other relevant areas.

In this context, National Rural and Renewable Energy Programme (NRREP) planned to conduct a study on Impact study of Community Electrification. It is anticipated that the findings will be used by the project team, AEPC, donor and the relevant stakeholders working in waste management sector for different purposes.

1.3 Objective of Study

The objective of the conduction of Impact study of Community Electrification is comprehensive assessment of the impacts of the Micro Hydropower Projects (MHPs) installed under programme activities so far, to reveal the socio economic impact at the local level, gender and social impact, environmental impact, impact on health and education in general and children in particular and impact other relevant areas. More specifically the following objectives (but not limited to) need to be addressed by the study:

- Reveal the socio-economic impact caused by community electrification and its end-use applications.
- Reveal the satisfaction level of electricity users.
- Reveal the level of end-use applications of electricity in economic sector other than for lighting.

1.4 Scope of Work

The scopes of the impact study are categorized in the following areas:

- Impact on economy--national as well as in local level.
- Impact on socio-culture/values/gender.
- Impact on environment/fuel saving/CO2 emission reduction.
- Impact on governance/information/empowerment.
- Impact on health in general and women/children in particular.
- Impact on education in general and children in particular.
- Impact on other relevant areas.

2.0 Evaluation Methodology

2.1 Consultation meeting with Project Officials

The process of conducting impact study on Community Electrification mentioned in the TOR and technical proposal has been thoroughly discussed with the client. To accomplish the assignment and be clarification on TOR, numbers of meetings were held with focal person and senior officials of NRREP. The focal person briefly introduced the status of project, methodology mentioned in the TOR, evaluation plan, and key aspects that need to be incorporated in the questionnaire and checklists. Based on the different phases of discussion, the consultant had presented modified methodology including monitoring checklists and questionnaires at the inception phase.

2.2 Evaluation Framework

The development of methodology began with a review of project documents to map out the Theory of Chang (ToC). The objective of the ToC was to establish the logic and underlying assumptions linking RE activities, with outputs and outcomes with the goals or future impact. Outcomes are the direct indicators that progress is being made towards more long-term goals. The ToC, which is based on project documents, provides the initial framework to guide the expectation of deliverable outcomes and assessment of impact.

Impact Evaluation Framework

2.3 Sampling Process

As mentioned in the TOR, the study covered 25 Micro hydropower projects for impact study. Around 10 percent beneficiaries from each sampling project were selected for field survey. Moreover 5 percent households from non-project intervention areas were selected to compare the impact of the project. Control groups were chosen from the same vicinity with have not covered by community electrification. The survey team fully considered retrieving the disaggregated data based on caste, ethnicity, gender, and economic status of respondents while selecting the sample for field survey. Detail list of sample size of each scheme is presented in Annex1.

The sampling units also covered focus group discussions, key informant interviews with concerned persons, local stakeholders, concerned government officials and service providers. The following table presents the sample size for impact study and satisfaction survey.

Table 2.3 Summary of Sample Groups

S.N.	Descriptions	Total Quantity
1	Sample districts	25
2	Sample Community Electrification Schemes(one from each district: ESAP, NRREP and PHP)	25
3	Treatment Group: In-depth Interviews with project beneficiaries	1330
	Control Group: Interview with non-project beneficiaries	657
4	Focus group discussion	25
5	Key informant interview with User Committee Chair-Person, Manager/operator, VDC Officials, DDC/DEECCU, RSCs, Installer Companies	111

6	Case stories	3

Simple random sampling method was applied in the process of sample selection in each project from population list. If the selected respondents were not at home at the survey period, the study team tried to communicate him at first. Additional sample was taken to maintain the actual sample size and minimize the non-response rate of respondents.

2.4 Method of Data Collection

Desk Study

Documents like policy to renewal energy subsidy, subsidy delivery mechanism, IGA guideline, gender equality and social inclusion, relevant reports received from NRREP, guideline for cooperative model for mini-micro hydro projects, and list of beneficiaries were collected and thoroughly reviewed during the inception phase of the assignment. The desk study was useful to generate in-depth knowledge and context about legislation and guidelines enforced to implement the project.

Structure Interview

A comprehensive set of questionnaires was developed at the inception phase and presented to the client. Feedback received from clients were incorporated before finalization the questionnaires. The final structure questionnaire was administered the randomly selected project beneficiaries to track household level data/ information. Same questionnaire was applied to collect /data information from control groups. Data/information regarding to impacts on economy, gender, environment, health education were collected from intervention and control group in the project areas. The Survey questionnaire is attached in Annex 2.

Focus Group Discussion (FGD)

Focus Group Discussion allows us to gain an understanding of the state of consensus among group members and their misunderstandings about facts through discussion among respondents. Separate checklists with guidelines were developed and oriented supervisors to conduct FGD before field mobilization. One FGD from one sample project was conducted under each component. Altogether 25 FGDs -10 from each component- were carried out during the field survey.

Key Informant Interview (KII)

The study team conducted intensive interviews with local, district level stakeholders who had engaged in community electrification activities. New ideas and perspectives of stakeholders were collected from this survey. The study team examined the information in detail to check whether it was biased or not by the views of respondents and interviewees. Altogether, 111 KIIs were conducted during the study periods. These were mainly held with 80 DDC/RSC officials, 31 operators and representatives of cooperatives.

Case studies

Interesting and successful stories were recorded during the field survey. Case analysis followed a 4C methodology (Context, Content, Critic and Conclusion). Cases regarding the broader impacts

related to capacity building, empowerments, and skill enhancement of targeted beneficiaries were collected and documented with enough evidences and presented in the report. Altogether two emblematic cases of both components were collected and reviewed during the field work.

2.5Field Composition and Training

A study team consisting of Team Leader, Renewal Energy Expert, and Socio-economist were mobilized to carry out the field study. Considering the nature of assignment the Consultant firm deputed experts additional Research and Development Expert and Statistician at centre level and 10 Supervisors at district level with aiming to maintain quality of works. Both centre level experts were intermittently engaged in works and field level supervisors were heavily engaged in back check and technical backstopping of the works of enumerators. The team leader trained the supervisors first and conducted 25 districts level orientation to enumerators and other professionals accordingly.
One enumerator and one supervisor were fully engaged in the field works in each district. At the centre level, the team of experts coordinated the field works.

2.6Adopted Quality Control Mechanism

To maintain quality in the whole survey implementation process, Supervisors, and Experts were meticulously involved in the field monitoring and supervision of data collection. At least 15 percent randomly selected survey forms were back checked and verified and scrutinized by the survey team in each district.

At the centre level, all forms were reviewed at first and then forwarded to enter into CS PRO. In the process of entry, 20 percent of entered data were randomly selected and verified to avoid error in the entry process. The Consultant also managed the household survey and completed data collection ensuring the following provisions:

- Survey forms according to sample plan received from each district
- Dates of arrival and completion of survey of each district
- Any notable difficulties or deviations from the standard field plan
- Record of each substitution of households that may have been required, including the reasons for substitution
- Any other notable occurrences
- Report on real-time validity checks done upon receipt of each form.

2.7Data processing and Analysis

Following field data collection, the questionnaires from the structured interviews with the samples of beneficiaries were first cleaned and the open - ended responses coded. Data were then entered into software designed in CS PRO program and converted into the computer using the STATA. Logical checks and frequency runs were made on all variables to further enhance the accuracy and identify any outliers before actual data analysis. Statistical tools such as; mean, standard deviation, minima and maxima, cross tab, test were performed on some variables of interest to examine the

associations based on respective values. Frequency tables and descriptive statistics were used in the presentation of the findings. On the other hand, the qualitative data mainly from the focus group discussions and key informant interviews were assembled and typed into a customized excel spreadsheets. This was done manually and analysed using content and thematic approaches and it involved classifying responses into meaningful categories so as to bring out their essential pattern. This closely followed the main themes of this impact study of NRREP. The codes were carefully developed to ensure that they were mutually exclusive, exhaustive and representative.

2.8Limitation of the Study

This study attempted to provide with credible results however, it faced some constraints that are presented below:

- The data/information collected through structured and semi-structured interviews represented the perceived ideas and views on the subject matter of the respondents. The study team tried to verify and triangulate such data/information with available data in the service provider's institutions and concerned local authorities.
- The data/information presented in the report was largely based on cross-sectional. In addition, limited data were also collected from reviewing available records of concerned local authorities. In some of the cases, the study team could not track out data/information due to unavailability of respondents, absence of concern service providers and less institutional practices of documentation.
- Deployment of field research team was delayed due to local election and strikes called by some political parties.

2.9Ethical Considerations

Participation in this study was voluntary. Although, respondents/participants were encouraged to participate, they were free to turn down the invitation if they so wished. In addition, verbal consent from participants before documentation of the structured interview, key informant interview and focus group discussions was always sought and for all the sessions it was granted.

2.0 Demographic Characteristics

This chapter describes the characteristics of the respondents in terms of their sex, caste and ethnicity, education, income and so on. The study, according to TOR covers two different types of respondents i.e. beneficiaries and control groups. The background characteristics of KIIs and FGD participants of both components are also presented briefly in the subsequent sections.

Ethnically, 50.2 percent respondents were from Bramhin/Chhetri communities, 35.7 percent from Janajati, and 14.1 percent from Dalits. The distribution of ethnicity in both beneficiary and control groups was almost close.

Table 2.1Distribution of Respondents by Caste and Ethnicity

Descriptions	Beneficiary groups		Control groups		Total	
	N	%	N	%	N	%
Dalits	173	13	107	16.3	280	14.1
Janajati	485	36.5	225	34.2	710	35.7
Bramhin/Chhetri	672	50.5	325	50.5	997	50.2
Total	1330	100	657	100	1987	100

Majority of respondents represents from Hindu religion (78.3%). This followed by Buddhist (15.9 %), Christian (1.8%) and others (4.1%). According to below figure, distribution of respondent's religion in intervention and control groups was same manner.

Table 2.2 Distribution of Respondents by Religion

Descriptions	Beneficiary groups		Control groups		Total	
	N	%	N	%	N	%
Hindu	1046	78.6	509	77.5	1555	78.3
Buddhist	203	15.3	112	17.0	315	15.9
Christian	30	2.3	6	0.9	36	1.8
Others	51	3.8	30	4.6	81	4.1
Total	1330	100.0	657	100.0	1987	100.0

Mean household size of respondent families was 5.2 with 2.3 standard deviation. Average household size of beneficiary group (5.4) was higher than control group (4.9). Following tables illustrates the average household size with few statistical descriptions.

Table 2.3 Average Household size in group types

Descriptions	Beneficiary groups	Control groups	Total
Mean	5.4	4.9	5.2
Minimum	2	2	2
Maximum	20	16	20
SD	2.3	2.1	2.3

According to the population distribution of respondent's household, below 15 population was 32 percent whereas economic age group people was 57 percent (16-55 yrs). Unmarried and single person recorded 14.4 and 2.8 respectively. The following demographic table illustrates details of population of respondent families.

Table 2.4 Demographic Status of Survey Household

Age group	No of people		Gender				Marital Status based on total population in %				
	No	%	Male		Female		Married	Unmarried	Divorce	Separated	Widow
			N	%	N	%	%	%	%	%	%
0-5	982	9.4	500	50.9	482	49.1					
6 to 15	2366	22.8	1144	48.3	1222	51.6					
16-25	2387	23	1169	48.9	1218	51.0	47.0	53.0			
26-35	1534	14.8	804	52.4	730	47.6	89.0	11.0			
36-45	1169	11.2	602	51.5	567	48.5	94.8	2.7	0.5	0.4	1.6
46-55	839	8.1	437	52.1	402	47.9	91.6	2.5	0.2	0.2	5.4
56-65	627	6	331	52.7	296	47.2	84.1	0.8	0.8	0.8	13.7
66 +	495	4.8	262	52.9	233	47.1	70.5	1.0	0.6	0.6	27.9
Total	10399	50.4	5249	50.5	5150	49.5	50.4	14.4	0.1	0.1	2.8

Of the total population of household interviewed, majority were studied SLC (32.2 percent) which followed by primary education (28.2%) and lower secondary school (14.9%). Illiterate people was only 3.9 percent, this population falls under above 66 age groups. Table 2.5 represents detail status of education of respondent families.

Table 2.5 Educational Status of Family Members of Survey Household

	Education status based on age wise population in %					
Age Group	Illiterate	Literate	Up to 5 Grade	6 to 9 grade	SLC/SSC	plus 2 Level
0-5	0	0	35.1	0	0	0
6 to 15	0	0	35.1	60.6	0	0
16-25	0	0	0	0	60.5	39.6
26-35	0	7.4	0	0	92.6	0
36-45	0	17.1	60.3	0	22.6	0
46-55	0	0	89	5.5	3.4	2.1
56-65	0	68.7	31.3	0	0	0
66 to above	80.8	19.2	0	0	0	0
Total	3.9	5.1	28.2	14.9	32.2	9.1

Professionally, 39.9 percent of households interviewed worked in agriculture. The remaining was involved in wage labour (13.8%), foreign employment (10.7%), self-employment (10.6%), government job (5.9%) and private job (4.8%). Below tables portrays percentage of households engaged in different sources of income by group types.

Table 2.6 Major Sources of Income by Types

Income Sources	Beneficiary groups		Control groups		Total	
	N	%	N	%	N	%
Government Job	134	6.3	58	5.7	192	5.9
Private Job	115	5.4	40	3.9	155	4.8
Foreign Employment	240	11.2	109	10.7	349	10.7
Wage Labour	274	12.8	175	17.2	449	13.8
Self-Employment	262	11.7	83	8.2	345	10.6
Agriculture and livestock	1198	34.8	544	53.5	1742	39.1
Others	19	0.8	9	0.9	28	0.9
Total	2242		1018		3260	

Majority of household have only one (59%) income source. Households have multiple income source in beneficiary groups is higher than control groups. Following tables exhibits multiple income sources in both group types.

Table 2.7Diversity in Income sources of household

Descriptions	Beneficiary groups		Control groups		Total	
	N	%	N	%	N	%
No Income sources	11	0.8	12	1.8	23	1.2
Only one source of income	715	53.8	382	58.1	1172	59
At least two sources	343	25.8	163	24.8	451	22.7
At least three sources	220	16.5	89	13.5	300	15.1
At least four sources	35	2.6	11	1.7	35	1.8
Five and more than five	6	0.5	0	0.0	6	0.3
Total	1330		657		1987	

3.0 Analysis of Findings

This chapter presents the finding of the study related to the Impact on Community Electrification. Data/information was gathered by different sources and levels of which was entirely focused on impacts on economy, health, education, environment, empowerment at individuals, local and national level through the services/facilities offered to the beneficiaries, beneficiaries perception towards the services, and their engagement in the IGAs. For this, the study team administered structure questionnaires, FGD checklists to accumulate data/information from beneficiary's perspective. Moreover, information/data from project stakeholders were collected through key informant's survey. The findings are based on structure interviews, FGDs, KIIs, and field observation.

3.1 Socio-economic Impact caused by community electrification

3.1.1 Impact on Household Income

Poverty is multi-dimensional issue. It is directly associated with a household's income, asset holding and other economic activities that mutually generate a household's livelihood strategy and outcomes. In order to assess the impact on household income, the study focused on data/information related to income and assets accumulated at household level. In addition, IG activities operated by beneficiaries were reviewed focusing on income and, employment generation. In the livelihood framework, these assets are called livelihood assets and comprises of the following.

- Physical assets like land and house,
- Financial assets like income, savings and debt,
- Social assets like social network, pressure group, social and community help/co-operation,
- Human assets like education, knowledge and health,
- Political asset, i.e., ability to take part in policy process, decision-making and influence the decision, and
- Natural assets like land, forest, water.

Apart from this, the target group should also be able to deal with or cope with risks, disasters and other challenges, and revert back to normalcy if there is problem in deriving community electrification due to natural problems as well as human-made disasters like market failure, price increase. Considering that sustainable rural electrification is linked to socio-economic situation, some of the key indicators were used to reveal the present status and how this has changed. This could tell us the present situation of the target group.

Annual income was categorized into major two aspects: off-farm and on-farm. Off-farm income mainly covered regular jobs, remittance, self-employments, wage labor etc. Income from agricultural works and livestock was considered as on farm income. Similarly, assets accumulated by household mainly covered productive, unproductive and land acquired within a year. The study

also tried to explore to what extent the beneficiaries has engaged in IG activities by adopting promotion of end-use in the project areas.

Household Income

To assess the household income, the study covered access to diversity of income sources and gross income from these sources acquired by the individuals. These figures also compared with control groups.

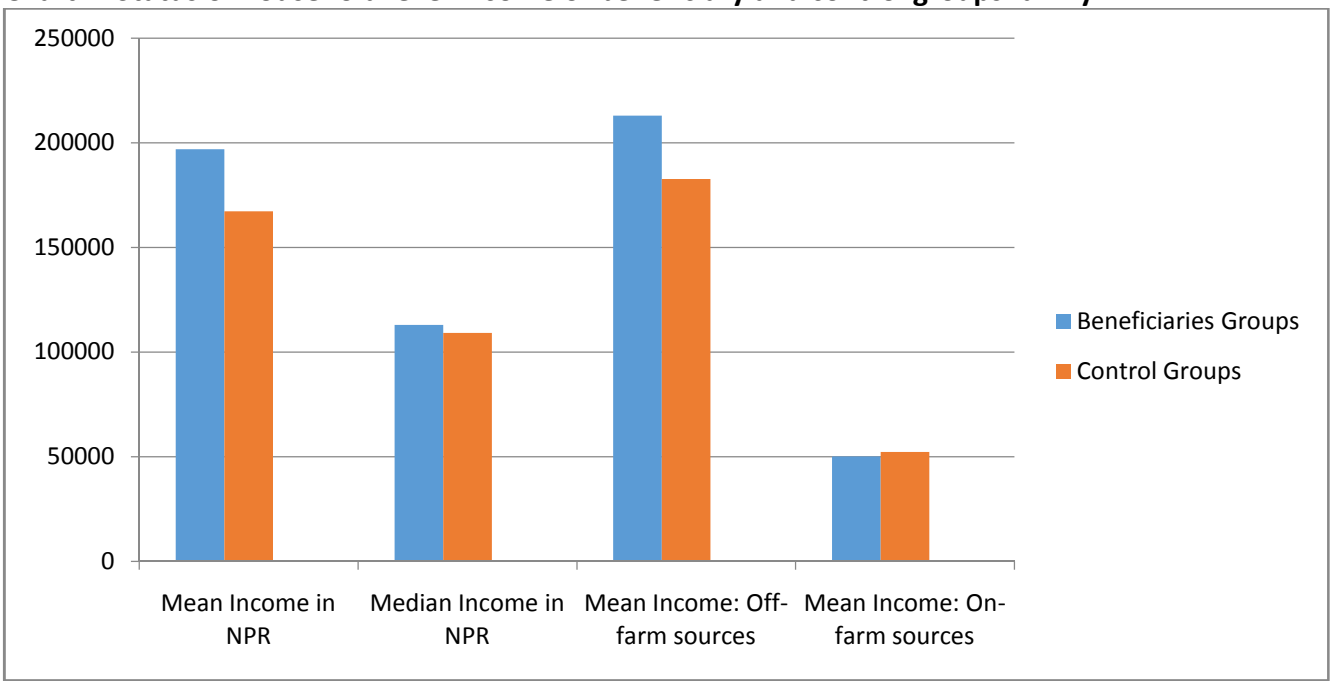
Table 3.1.1: Household level income

Descriptions	Beneficiary groups	Control group	Average
Mean Income in NPR	196881.8	167251.9	186964.3
Median Income in NPR	113000	109250	110000
Mean Income: Off-farm sources	213051	182688.2	203105.9
Mean Income: On-farm sources	50133.46	52249.32	50801.14

Average household income of beneficiary groups (NPR. 196881.8) was higher than control groups (NPR. 167251.8). With the engagement of enterprise related activities, income from off-farm sources comparatively high in beneficiaries groups.

Rural households combine a diverse set of income generating activities and construct a portfolio of livelihood activities to meet and to enhance livelihood outcomes. More diverse sources of income were observed beneficiaries groups

Chart 1: Status of household level income of beneficiary and control groups family



Accumulation of Assets

Assets can provide household stability, the capacity to weather changes such as the loss of a job or household income, triggered by business cycles, restructuring, or a family crisis. They also can help to develop other assets, for instance, building a business that generates revenues and employs others or equity in a home that can be invested in further education. Assets provide a head start for the next generation. The study collected data regarding the accumulation of assets within a year by both types of families.

Table 3.1.2: Assets accumulation with comparison between Beneficiary Groups and Control groups

Descriptions	Beneficiary groups	Control group	Average
Average number of assets (no. of assets)	2.7	2.84	2.74
Value of asset acquired/family over the year (NPR)	98596.02	94456.44	97698.39
Productive Assets: Average number of assets (no. of assets):	4.22	4.6	4.34
Productive Assets: Value of asset acquired/family over the year (NPR)	124538.4	107049.1	118878.1
Unproductive Assets: Average number of assets (no. of assets):	1.6	1.8	1.67
Unproductive Assets: Value of asset acquired/family over the year (NPR)	20012.21	29298.94	22689.98

Although average number of assets accumulated at household level was higher in control group, however, value of these assets accrued was noticed more in beneficiaries groups. Project beneficiaries were more concentrated on acquiring productive assets where families of non-users preferred unproductive assets.

3.2 Impact on Socio-culture/values/gender

3.2.1 Women with Enabling Environment

This project is explicitly focused on poor and marginal people in the project implemented VDCs by enhancing their capacity in order to meet the target and priorities of national government for providing the energy services to the poor and marginal groups in community. The survey data reveled that substantial change could be seen in terms of economic and social empowerment compare with beneficiary and control groups. For stance, 50% of beneficiary groups family have equal control over family income where as 44% family have equitable control over family income. Likewise, in beneficiary group's family, 31 % women have access to quality of health services where as in control group's family it was 27%, 25% women among the beneficiary and control groups have access to education. Similarly, 27% women und beneficiary groups have access to credit whereas only 20% have access to credit of control groups of women. It shows that beneficiary groups under rural electrification are significantly empowered in terms of social and economic empowerment.

Table 3.2.1: Status of Gender and economic empowerment of women under beneficiary and control groups family.

Descriptions	Beneficiaries groups			Control group			Total		
	Equal	Some what	nothing	Equal	Some what	nothing	Equal	Some what	nothing
equitable control over family income	663 (50%)	613 (46%)	54 (4%)	292 (44%)	336 (51%)	29 (4%)	955	949	83
equitable control over family expenditure	635 (48%)	612 (46%)	83 (6%)	273 (42%)	330 (50%)	54 (8%)	908	942	137
women have access to quality of health services	412 (31%)	787 (59%)	131 (10%)	175 (27%)	395 (60%)	87 (13%)	587	1182	218
Do women have access to education	335 (25%)	781 (59%)	214 (16%)	161 (25%)	381 (58%)	115 (18%)	496	1162	329
Do women have access to credit facilities	365 (27%)	548 (41%)	417 (31%)	129 (20%)	299 (46%)	229 (35%)	494	847	646

The community electrification in the community not only provide energy, it also support to empower women, poor and marginal groups of society. Compare to beneficiary groups and control groups of community electrification, it has been significantly different in terms of representation as well as leadership (Table 3.4)

Table 3.2.2: Status of women holding leadership positions (total household)

Descriptions	**Beneficiary groups(N:1330)**	**Control group (N:657)**	Total (N:1987)
Self-Help Group	23.6%	16.3%	21.2%
Cooperatives	15.0%	12.5%	14.2%
Community Forest User's Group	8.3%	7.2%	7.9%
Health Facilities Operation and Management Committee	3.7%	3.0%	3.5%
School Management Group	9.1%	8.1%	8.8%
Water Management Committee	19.6%	13.5%	17.6%
Farmers group	10.8%	6.7%	9.5%
Micro-finance	3.5%	1.4%	2.8%
Development Bank	3.2%	2.6%	3.0%
Local NGO/Local club	3.5%	2.4%	3.2%
Religious Group	1.1%	2.6%	1.6%
Others	10.7%	8.7%	21.2%

Survey shows that there has been changed for income and assets holding pattern by women of beneficiary groups family. It can be claimed that the community electrification support to the

women groups by empowering socially and economically. The beneficiary groups of women are little bit higher to hold income (sixty thousand Rupee) compare to control groups (fifty five thousand Rupee). Table (3.5) shows status of income and assets holding pattern at HH level by women groups.

Table 3.2.3 Income and Assets holding at HHs level by women

Descriptions	Beneficiary groups		Control group	
	Male	Female	Male	Female
Mean Income in NPR	169462.1	60562.08	144160.3	55375.7
Median Income in NPR	96000	31000	93500	31000
Average number of assets (no. of assets)	1.89	1.93	2.7	2.8
Value of asset acquired/family over the year (NPR)	106138.7	83611.84	67655.92	51282.6

3.2.2 Opinion of FGD participants:

During the impact study of community electrification survey, 25 FGD have been done and 274 were participated on FGD. The summary of participant's perception, opinion and insight as well as feelings on community electrification is accumulated as follow.

- **Reduce workload of women:** Basically women hold all types of household in addition to outside agriculture harvesting. Before community electrification the responsibility goes to women to do grinding cereals as well as cooking. But now, for grinding cereals, male engagement has been increase because male bring the cereals up to the local rice mills located close to the house. About 50% of women work load has been reduced after electrification. It also support to women for maintaining good health.
- **Women's access to information:** Electricity is the basic things to use all types of electronic devices and equipment. After community electrification, women have access to listen the radio, television as well as using cell phone and internet. Through this devices women can listen different types of messages, notice and can acquired information related to women empowerment, health and education. The information system significantly transfer to the knowledge as well as they can adopt various things.
- **Enabling environment to women:** After community electrification not only women are empowered but male people equally empowered by getting various types of information from electronic media and devices. In every social gathering and meetings, gradually women participation has been increased and ask by male people for women participation. This is the significant impact of the community electrification project implemented in our community.
- **Education:** Compare to before educational status of women have been increased. After finishing the household work, women watch the television, listen the radio as well as use cell phone and internet. This compels to learn women about the electronic devises which is possible only through basic education. After few months later they can read and write as well as able to sign. This is the impact of electricity.

- **Women engagements in off farm Income Generating Activities increased:** Energy creat environment to do micro enterprise related business and activities e.g. weaving, sewing, noodles Udhyog, soap, incense production (agar batti) etc. which does possible from community electrification. This micro business and skill works can do in the evening and night time because they have light.
- Increase Safety and Safeguard: The lighting support them to do household work even at night. It is safety and safeguard to do household works at evening and night. Especially, women fells safety and safeguard while working at evening and night time.
- Women health is improved: Overall women health increased because of reducing human power use work load e.g. grinding, cooking in traditional stove etc.

3.3 Impact on Environment/fuel saving/ CO2 Emission reduction

Compare to before community electrification support to save environment, fuel saving and reduction of co2 emission. Table (3.6, 3.7) below shows energy sources of household in beneficiary groups and control groups.

3.3.1 Sources of lighting and day to day works

Around 22 percent of beneficiaries were used solar system including micro-hydropower. Apart this, only 40 percent beneficiaries used solar system for lighting purpose. In control group around 40 percent installed solar system for lighting purpose.

Table 3.3.1: Energy sources types for lighting at household level

Descriptions	Beneficiary groups		Control group	
	N	%	N	%
No	0		393	60
Micro-Hydropower	1330	100	0	0
Solar including MHP	288	22	264	40

Firewood was noticed major sources of energy for day to day works in both study groups. This was followed by LPG gas and kerosene. Usage of kerosene for daily household works was less in beneficiaries groups.

Table 3.3.2: Major Sources of household level energy for day to day works

Descriptions	Beneficiary groups		Control group	
	N	%	N	%
LPG gas	115	7.8%	62	8.0%
Kerosene	53	3.6%	60	7.7%
Firewood	1289	87.7%	640	82.6%
Others	13	0.9%	13	1.7%
	1470	100.0%	775	100.0%

Consumption of firewood as daily energy sources was higher in control groups (11.69 bhari). Basically, the study team was informed that particularly pine trees which was used to lighting before community electrification was reduced in beneficiary groups.

Table 3.3.3: Status of firewood consumption

Descriptions	Beneficiary groups (Bhari)	Control group (Bhari)
Fire wood bundle used in a month	10.9 (40 Kg./ Bhari)	11.69 (40 Kg/Bhari)

CO2 molecule is made of one carbon atom and 2 oxygen atoms. The atomic weight of carbon is 12 and that of oxygen is 16. The molecular weight of CO2 will be 44. This means 12 Kg of carbon on complete combustion will produce 44 Kg. of CO2 or 1 Kg of carbon on complete combustion will produce 3.67 Kg. of CO2.

Wood is heterogeneous and exact amount of carbon in 1 Kg of dry wood will vary depending on the species of wood, age of wood etc. It is reported that 1 Kg of wood contain about 450 to 500 gm of Carbon. This means 1 Kg of wood is holding about 1.65 to 1.80 Kg of CO2. This is how wood or forest act as carbon sink.

Similarly burning of 1 kg of wood will generate 1.65 to 1.80 Kg of CO2. (Source: http://www.paperonweb.com/A1110.htm)

From table 3.2.4.3, it shows, due to availability of electricity in the project areas, the wood consumption is reduced by 31.6 kg per month per house in average. Thus the wood consumption from total households (12822) is reduced by 4,05,175.2 kg per month in average. This makes annual reduction of 4,862,102.40 kg. This has reduced the annual carbon dioxide emission by 8,022,468.96 kg to 8,751,784.32 kg.

From table 3.2.4.3, it shows, due to availability of electricity in the project areas, the wood consumption is reduced by 31.6 kg per month per house in average. This have reduced the average carbon dioxide emission by 52.14 kg to 56.88 kg per month.

ICS is a device that is designed to consume less fuel and save cooking time, convenient in cooking process and creates smokeless environment in the kitchen or reduction in the volume of smoke produced during cooking against the traditional stove. Around 40% of beneficiaries currently used Improve Cooking Stoves knowing its importance regarding health and environment.

Table 3.3.4 Status of ICS used

Descriptions	Beneficiary groups		Control group	
	N	%	N	%
HHs currently using ICS	537	40%	99	15

According to FGD participants, micro-hydro has contributed to protect forest, especially pine trees which was used to lighting before community electricity. It also indirectly supports to clean the surroundings and increase usage of toilet in the evening time.

3.4 Impact on Governance, information, and empowerment

Radio and Television are easy sources of information in rural areas of Nepal. The electronic media plays pivotal role to inform and educate people in various aspects of life. Access to electronic media has been increased after community electrification which is either community hydro or solar energy. Table (3.11) shows sources and information and utilization, Table (3.12) shows the access to information sources and Table (3.13) Assets accumulation related to information technology.

Multiple sources were used to reach the information by both groups. Around 69.4 percent of beneficiaries had answered regarding the information sources which was followed by 30.6 percent from control groups.
To access the information Beneficiary group largely used NGOs, CBOs, Television, political mechanisms.

Table 3.4.1: Major Sources of Information and its utilization

Descriptions	Beneficiary groups		Control group		Total
	N	%	N	%	N
Business groups	305	58.7	215	41.3	520
Government employees	179	64.9	97	35.1	276
Groups CBOs	996	77.3	292	22.7	1288
Local news paper	263	69.4	116	30.6	379
National news paper	99	57.9	72	42.1	171
NGOs	157	78.5	43	21.5	200
Political mechanisms	238	69.8	103	30.2	341
Radio	907	67.0	446	33.0	1353
Social leaders	403	65.1	216	34.9	619
Television	599	72.7	225	27.3	824
Total	4146	69.4	1825	30.6	5971

The following table reveals the satisfaction level of beneficiaries regarding the access to information sources. Respondents from beneficiaries groups were stated more satisfy (70.2 %). This was followed by control groups (63%). More respondents from beneficiaries groups were perceived regarding the significant changes in access to information sources.

Table 3.4.2 Access to Information sources

Descriptions	Beneficiary groups		Control group		Total	
	N	%	N	%	N	%
Significantly changed	317	23.8	76.0	11.6	393	19.8
Satisfactory	934	70.2	414.0	63.0	1348	67.8
Not changed	42	3.2	59.0	9.0	101	5.1

Poor	37	2.8	108.0	16.4	145	7.3
Total	1330	100.0	657.0	100.0	1987	100.0

Following table reveals assets related to information technologies accumulated by beneficiaries group and control groups. Beneficiaries groups largely preferred on telephone and mobile (56.4%) and radio and DVD player (28.7%). On the other hand, respondents from control groups were reported regarding the telephone (52.5%), radio (23.7%) and TV (23.2%).

Table 3.4.3 Assets accumulation related to information technology

SN	Descriptions	Beneficiary groups		Control group		Total
		N	%	N	%	N
	Radio, cassette recorder, or DVD player	98	28.7	42	23.7	140
	TV	37	10.8	41	23.2	78
	Telephone, mobile	193	56.4	93	52.5	286
	Computer	14	4.1	1	0.6	15
	Total	342	100.0	177	100.0	519

FGD Participants of beneficiary groups stated that availability of electricity directly contributes to increase usage of communication and information related devices like cell phone, telephone, radio and televisions. Families have easy access to information, easy to communicate with other people to know information timely. Marketing of information communication and technologies related equipment has been increased in the respective areas.

3.5 Impact on Health in General and Children in particular

Overall health problem in different age groups has been decreased in beneficiary groups compare to control groups. The reason for decreasing the health problem could be access to information and communication technology which was possible after electrification as well as lighting and changing in cooking habit of beneficiary groups. Table (3.14) shows the status of general health of beneficiary groups and Table (3.15) shows the status of general health of control groups. Similarly, Table (3.16) presents the status of children and mother health comparison with beneficiary groups and control groups.

Table 3.5.1: Status of General health (Beneficiary groups)

	0-5	6-15	16-25	26-35	36-45	46-55	56-65	66 above	Total
viral/common Cold	25 (7.9%)	62 (19.6%)	71 (22.5%)	53 (16.8%)	36 (11.4%)	32 (10.1%)	21 (6.6%)	16 (5.1%)	316
Sinusitis		1 (3.4%)	3 (10.3%)	4 (13.8%)	4 (13.8%)	9 (31.0%)	6 (20.7%)	2 (6.9%)	29

Migraine		1 (10.0%)	1 (10.0%)		4 (40.0%)	2 (20.0%)	2 (20.0%)		10
Fever with Common clod	19 (15.8%)	16 (13.3%)	21 (17.5%)	17 (14.2%)	13 (10.8%)	14 (11.7%)	8 (6.7%)	12 (10.0%)	120
Ear Itching	1 (7.7%)	2 (15.4%)	1 (7.7%)	1 (7.7%)	6 (46.2%)	1 (7.7%)	1 (7.7%)		13
Day Cough	2 (3.9%)	7 (3.7%)	13 (25.5%)	9 (17.6%)	3 (5.9%)	7 (13.7%)	8 (15.7%)	2 (3.9%)	51
Asthma			4 (10.3%)	3 (7.7%)	3 (7.7%)	2 (5.1%)	14 (35.9%)	13 (33.3%)	39
Pneumonia	63 (70.0%)	10 (11.1%)		1 (1.1%)	7 (7.8%)	5 (5.6%)	2 (2.2%)	2 (2.2%)	90
TB			2 (11.8%)	1 (5.9%)	2 (11.8%)	6 (35.3%)	5 (29.4%)	1 (5.9%)	17
Eye Infection	1 (4.0%)	7 (28.0%)	5 (20.0%)	1 (4.0%)	4 (16.0%)	1 (4.0%)	5 (20.0%)	1 (4.0%)	25
Cataract							1 (25.0%)	3 (75.0%)	4
Bronchitis	1 (20.0%)		1 (20.0%)			2 (40.0%)	1 (20.0%)		5
Lung Infection	1 (2.9%)	2 (5.7%)	6 (17.1%)	4 (11.4%)	4 (11.4%)	4 (11.4%)	7 (20.0%)	7 (20.0%)	35
Others				1 (25.0%)		3 (75.0%)			4

Table 3.5.2: Status of General health (control group)

	0-5	6-15	16-25	26-35	36-45	46-55	56-65	66 above	Total
viral/common Cold	9 (4.9%)	48 (26.2%)	45 (24.6%)	24 (13.1%)	26 (14.2%)	17 (9.3%)	9 (4.9%)	5 (2.7%)	183
Sinusitis			2 (28.6%)	3 (42.9%)	2 (28.6%)				7
Migraine			1 (25.0%)		3 (75.0%)				4
Fever with Common clod	6 (7.1%)	14 (16.5%)	17 (20.0%)	15 (17.6%)	10 (11.8%)	12 (14.1%)	7 (8.2%)	4 (4.7%)	85
Ear Itching	1 (9.1%)	3 (27.3%)	2 (18.2%)	3 (27.3%)		1 (9.1%)	1 (9.1%)		11
Day Cough		13 (26.0%)	15 (30.0%)	3 (6.0%)	6 (12.0%)	8 (16.0%)	2 (4.0%)	3 (6.0%)	50
Asthma	1 (3.6%)			3 (10.7%)	3 (10.7%)	1 (3.6%)	9 (32.1%)	11 (39.3%)	28
Pneumonia	31 (60.8%)	14 (27.5%)	2 (3.9%)		2 (3.9%)	1 (2.0%)	1 (2.0%)		51
TB	1 (20.0%)		1 (20.0%)	1 (20.0%)	2 (40.0%)				5
Eye Infection	1 (10.0%)	4 (40.0%)	1 (10.0%)	1 (10.0%)	1 (10.0%)	1 (10.0%)	1 (10.0%)		10
Cataract							1 (33.3%)	2 (66.7%)	3
Bronchitis						1 (20.0%)	3 (60.0%)	1 (20.0%)	5
Lung Infection	1 (5.9%)	2 (11.8%)	3 (17.6%)		3 (17.6%)	2 (11.8%)	2 (11.8%)	4 (23.5%)	17
Others						2 (66.7%)	1 (33.3%)		3

Table 3.5.3 Status of children and mother's health at birth

Problem types	Beneficiaries groups	Control groups	Total
No. of child birth (N)	109	44	153
Child problems: during the child birth	6 (5.5%)	5 (11.3%)	11 (7.1%)
Women problems: during the child birth	20 (18.3%)	8 (18.8%)	28 (18.3%)
Average weight of children in kg	3.2	2.9	3.05
Premature birth of children	5 (4.5%)	6 (13.6%)	11 (7.2%)

Respondents of beneficiaries groups stated that problems regarding to congenital wounds, bleeding and obstacle to pass urine and stool of children, excessive bleeding, high fever and infection and problem to breast feeding were noticed children and women. On the other hand, according to respondents of control groups, complication of birth like long labour pain and abnormal position of children, birth of premature baby, excessive bleeding and fever were recorded in neonatal child and mother.

FGD participants of beneficiaries groups stated that Micro-hydro directly reduced Indoor smoke free at household level. Due to availability of electricity at community level, quality of health service has been increased. Health services like laboratory facilities, cold chain maintenance of essential vaccine and drugs were available at local community. It also made easy to warm room and houses to prevent excessive cold in high hill and mountain areas. Incidence of disease occurrence related to respiratory disease decreases has been decreased. Personal health status has increased due to usage of clean energy and reduction of fusil fuel. ICS and other biomass related technologies promoted by AEPC have been increased.

3.6 Impact on Education in general and children in particular

Study shows that there is significant different in school going children between beneficiary groups and control groups. The reason could be the empowerment women and reducing the workload of women and children after community electrification among the beneficiary groups. Whereas reason for less school going children among the control groups could be less access to information, high workload of women including cereals grinding, agriculture harvesting which resulted less given the time to the children from household family particularly women.

Table 3.6.1 Status of Children education Compare with Beneficiary groups and Control Groups

SN	Descriptions	School going status		Average time of reading at home (minute)
		No. of children of 6 to 15 years	No. of school going children of 6-15 years	
	Beneficiary groups	1595	1569 (98.4%)	114
	Control group	771	695 (90.1%)	95
	Total	2366	2264 (95.7%)	104.5

According to FGD participants, student's study times at evening has increased. Quality of education increased: at school level number of computer labs established, number of institutional school opening increased, online education and trainings increased. Students' access to informal education through internet services increased. Students' access to information increased due to availability of computer institutes, internet café has established.

3.7: Satisfaction level of electricity users

This subsection deals regarding satisfaction level of beneficiaries: general users and end-use entrepreneurs. This covers heading related to services received from service providers, micro-hydro schemes and other institutions and relation with project performance and follow up activities and suggestions.

Participants especially beneficiaries, chairperson of cooperatives, operators, entrepreneurs and concerned persons of local bodies were asked about their satisfaction level of services provided by Install companies and NGOs.

3.7.1 Beneficiaries Satisfaction: Service provided by Service providers

Around 55% respondents were found moderately satisfied, while 22.5 % were found poor with the service provider's services.

Table 3.7.1: Satisfaction on Services Provided by Service Providers

	Below average (%)	Moderated (%)	Good (%)	Total (N)
Operators/Cooperatives	5 (18.5%)	17 (63%)	5 (18.5%)	27
Key Informants/local bodies	8 (28.6%)	15 (53.6%)	5 (17.9%)	28
FGD Participants	5 (20%)	12 (48%)	8 (32%)	25
Total	18 (22.5%)	44 (55%)	18 (22.5%)	80

The respondents who expressed their satisfaction in term of services provided by service providers were completion of project on time, appropriate technical support received from local bodies and NGOs, contribution of project beneficiaries in the project construction. On the other hand, they also stated that limited monitoring of projects from donors and project stakeholders, received less financial support as per previous commitment from local bodies, limited access to maintenance and repair, delay in construction and installation were major causes to express less satisfaction regarding the project.

FGD participants were also asked to assess to what extent has the expectation of beneficiaries were fulfilled by the project. FGD participants from 12 groups were expressed their moderate satisfaction with the works. It also provides broad opportunity for income generation activities, reduced workload of women and significant changes in the usage of ICT.

To increase the efficiency of project, concerned stakeholders should pay attention to the establishment and operationalization of maintenance fund, capacity building of operators, and support to establish maintenance workshops/garage, tariff collection and management, coordinate soft loan or subsidies for end-use entrepreneurs.

3.8Productive Energy Use

Micro-hydro has established an appropriate model for extending rural electrification across Nepal and for providing tools for poverty alleviation. Two major uses of micro-hydro are rural electrification and agro-processing. To complete the micro-hydro project, Different stakeholders have been engaging with distinct roles like government, donors, private sectors, and users.

In consultation with different stakeholders of sampling districts, the survey team inferred following key roles of user committees/groups regarding the successful implementation of micro-hydro projects.

- Appropriate tariff setting
- Promotion of productive energy use
- Ownership of micro-hydro project
- Ensure regular operation, repair and maintenance
- Users committee formation, carryout regular meetings, and institutional strengthening
- Coordinate for maintenance fund and technical capacity building of technicians

The micro-hydro schemes selected for the impact study were owned by community with maximum average capacity of 58 kilo watt in average. In the dry season, average capacity of scheme was 52 kW. Around 460 households consume 120 watt energy in a day. The micro-hydro connected houses generally pay NPR. 91 as monthly average tariff. With the causes of flood, landslide, technical problems, earthquake power generation was hindered in 42 days in a day. Moreover power load a common problem observed in the project areas.

Tariff setting and management plays an important role in the improvement of the plant's technical and financial performance. For most domestic users, electricity tariff was based on the amount of peak-power purchased. Although this system is easy to handle for administrative process, but does not reflect equity toward the investment cost of the infrastructure and discourages use of off-peak power for further revenue generation.

3.8.1 Productive Energy Use and Local Economic Activities

It is obvious that having access to a reliable and affordable supply of electricity, small enterprises can be developed as the local community level that ultimately contributes the rural economy. However, in rural communities electricity is mainly used for lighting rather than commencing commercial enterprises. In the sample project areas, micro-hydro based electricity is mainly used for meeting lighting demand. During the day time, the electricity is used to running some enterprises. The following tables portrays different types of businesses run in project areas, power consumption status and employment generation running through using day time electricity.

Table: 3.8.1: Status of Productive Energy Use at Sampling Areas.

types	Number	Average energy consumption/plant in kw daily	Employment/enterprises
Grinder/huller Mills	24	4.9	3.5
Rural Carpentry	15	2.9	3.2
Computer Institute	6	2.1	1.6
Library	1	1.5	3
Poultry farm	7	4.5	2.4
Cable	1	3.8	1
Cheese factory	1	1	4
Bread factory	1	2	3
Computer lab in school	7	2.4	1.7
Communication center	2	0.5	1
Others	6	2.1	1

The survey team observed 10 major types of enterprises were operated in the sample project areas. Grinder/huller mills, furniture, computer lab/institutes and poultries were major enterprises of which consume more day time electricity. On the other hand, employment generation and day time energy consumption of these enterprises was also found high.

According to the interviewed respondents, the community electrification has brought series of positive changes in the daily livelihoods. Having access to electricity, engagement of rural people in income generating activities has been increasing stages. End use entrepreneurs reveal that average investment of an enterprise was NPR 195,000 which earns NPR. 21,545 monthly. Average contribution of monthly income by using energy is NPR. 9,017.

Government of Nepal has been providing 30% subsidies amount for total investment cost for energy conversion and processing equipment and/or hardware part of the enterprise/business but not exceeding
Rs.100,000 will be provided for private enterprises, whereas that of 50% or Rs. 300,000, whichever is less, will be provided for community based enterprises. Especially additional 10% but not exceeding NPR. 10000 has been provided to single women, backward, disaster victim, poor and endangered ethnic groups.

With the facilitation of service provider NGOs, number individual enterprises has been received subsidy from AEPC. According to the individual entrepreneurs, the process to receive subsidy was very complex. It required 3 to 4 months after submission of application. The major criteria were to register the business entity at district level authorities which requires at least NPR. 20000 in total. However, individuals who received subsidies from AEPC were found more active enterprises activities.

Considering the importance of credit facilities, the study team reviewed access, availability and usage of the formal financial system for promoting productive energy use. Out of 25 entrepreneurs only 8 have utilized credit from cooperatives. The portion of loan in total investment is only 15 %. Participants also stated that very limited access to credit facilities in terms of volume of loan and Financial Institutions were prevailed in the project areas.

User/community groups of MHP mostly represent rural farmer. This group can be capacitated for commercial agriculture development. Only respondents from Khotang and Darchula stated about the usage of water after generation of electricity.

Key informants from local bodies and service providers mentioned that around 34 end-use enterprises are operating with utilizing 235 kW at district level. Average employment generation was found 92 in the sample districts. Similarly, possible enterprises in future are grinder/huller, computer lab, grill factory, bread factory, noodle, sewing, wood mills, soap factory, herb processing, internet café, hotel and tourist restaurant.

3.8.2 Status of Employment Generation

NRREP has been promoting productive energy use in order to generate employment and income of the rural women and men by engaging households in income generating activities. In sampling projects, employment generation from a micro-hydro project found around 7.6 person of which full employment was 4.6 and partial employment was 13.71 person. Engagement of men in enterprises comparatively higher than women.

Table 3.8.2 Average Employment Generation by Types.

Employment types	Women	Men	Total
Full employment	.69	4.9	4.6
Partial employment	10.25	13.75	13.71

To minimize the migration of youth for employment and generation of employment within communities, Government of Nepal has been launching subsidies policies for entrepreneurs. The FGD participants including beneficiaries and entrepreneurs reveals that it required long process of documentation, review and approval, and inadequate knowledge of potential entrepreneurs regarding the business proposal development to receive the subsidy amount. Moreover, due to high migration very limited skill man power available in the communities. The participants and key informants also demanded the skill based trainings with focusing on potential enterprises.

3.8.3 Sustainability of Projects

Two major aspects reviewed by study team regarding the sustainability of community electrification are initiatives taken for continuation of project and behavior change for productive energy uses. This chapter mainly deals with considerable initiatives taken for continuation of project in the sample areas. The study team discussed with micro-hydro management team

regarding the annual maintenance practices, access to service providers for maintenance and feeling ownership of projects.

Maintenance fund and mobilization

Out of 25 sample projects, the study team found operationalization of maintenance funds only in 10 projects.

Major sources of maintenance fund were tariff collection and grants received from AEPC. Annual expenditures for maintenance was NPR. 245563 which is range from NPR. 44000 to 1000000 in a year. Other source of maintenance was grants and technical support from other organizations.

Table 3.8.3.1 Involvement of Different Institutions for Maintenance

Types	**No. of projects**
Maintenance fund	10
Grant	7
Tech support from different organizations	4
Others	4
Total	25

It has been recognized that the MHP plant operating staffs lack sufficient capacity building activities, thus resulting in longer downtime which in turn reduces the potential revenue. The technical skills and knowledge required to maintain the plants was observed lacked cooperatives and technicians. Despite the guidance and instruction by the installer companies and NGOs working in this field, the community people could hardly carry out proper maintenance.

Operators and cooperatives reveal that frequency of following was widespread in the project areas.

- Natural disasters like lightening, swap away cannel and dam, earthquake
- Technical problems: Generator belt, motor damage, transformer, wire and pole broken, low power loading in pick hour
- Capacity of technical staffs: limited maintenance and overhauling knowledge and skills, absenteeism of technical staffs,
- Insufficient maintenance and repair services: skill manpower and institutions.

With the limited capacity of regular operation and low load factor caused limited productive energy use and less viable to run enterprises in sustainable manner. Hence sustainable operation and maintenance would always be an issue in micro hydro projects. The FGD participants reveals the following key aspect for continuation of the projects.

- Establishment and operationalization of maintenance fund with clear guideline
- Regular monitoring and supervision from project stakeholders will be more beneficial for appropriate utilization of royalty,
- More priority given to promote end-use based enterprises and capacity building for entrepreneurs,

- Improve tariff collection practices: regularly, effectively,
- Monitoring of utilization of tariff,
- Establishment of electrical workshop at rural area for routine repair and maintenance services,
- Effective monthly meeting of user committees,
- Capacity building of operators and user's organization,

Power Synchronization

The study team observed that few MHPs were working on power synchronization to national grid. Sobuwa Khola II MHP, Taplejung has already communicated with AEPC through RSC. Similarly other few MHPs discussed on user's committee level as well as conversed external agencies regarding the power synchronization with other micro-hydro and national grid.

The FGD participants revealed that in due to low load capacity and smaller size of schemes, and rapid expansion of central grid line in the MHP areas, productive energy end-use has not been increased as expect previously. Most of entrepreneurs preferred to national grid for business promotion. During the discussion they also emphasized to upgrade the capacity of MHP to Mini-hydro plants.

4.0 Conclusion and Recommendations

4.1 Conclusion

The following conclusion can be drawn from the impact study conducted on sampling areas of NRREP project.

Impact on education:

Academic performance of children is greatly influence with having access to electricity. Around 98.4 percent of children of 6 to 15 age group were school going children. Similarly average reading time at household level of school going children has increased in comparison with control groups. The micro-hydro based electricity has many other positive impact on school children. In the project areas, the study team observed increasing trend to establish computer labs, education through internet sources. Moreover, due to establishment of computer institutes and internet café, student's access to education from informal sources has been increased significantly.

Change in Firewood consumption:

ICS is a device that is designed to consume less fuel and save cooking time, convenient in cooking process and creates smokeless environment in the kitchen or reduction in the volume of smoke produced during cooking against the traditional stove. Around 40% of beneficiaries currently used Improve Cooking Stoves knowing its importance regarding health and environment. Usage of firewood has also decreased as compared to control group. Micro-hydro has contributed to protect forest, especially pine trees which was used to lighting before community electricity. It also indirectly supports to clean the surroundings and increase usage of toilet in the evening time.

Impact on Health:

Overall health problem in different age groups has been decreased in project areas. The reason for decreasing the health problem could be access to information and communication technology which was possible after electrification as well as lighting and changing in cooking habit of beneficiary groups. Micro-hydro directly reduced Indoor smoke free at household level. Due to availability of electricity at community level, quality of health services was increased at beneficiary's level. Incidence of disease occurrence related to respiratory disease decreases has been decreased. Personal health status has increased due to usage of clean energy and reduction of fusil fuel.

Impact on socio-culture and gender:

Substantial change could be seen in terms of economic and social empowerment compare with beneficiary and control groups family. Around, 69.4 % of beneficiary groups family have equal control over family income where as 30.6% family have equitable control over family income. The community electrification in the community not only provide energy, it also support to empower women, poor and marginal groups of society. Compare to beneficiary groups and control groups of community electrification, it has been significantly different in terms of representation as well as leadership

Access to information:

The increasing role of electronic media cannot be minimizing to inform and educate people in various aspects of life. Access to electronic media has been increased after community electrification which is either community hydro or solar energy. Multiple sources were used to reach the information by both groups. Access to information sources was noticed higher in beneficiaries groups. To access the information Beneficiary group largely used NGOs, CBOs, Television, political mechanisms. Equipment related to information technologies accumulated by beneficiaries group was recorded higher in project areas.

Impact on household income:

In order to assess the impact on household income, the study focused on data/information related to income and assets accumulated at household level. Average household income of beneficiary groups was NPR. 196881.8 which was higher than control groups (NPR. 167251.8). More people from beneficiary groups were engaged in off-farm IGA. Average number of assets accumulated at household level was higher in control group; however, value of these assets accrued was noticed more in beneficiaries groups. Project beneficiaries were more concentrated on acquiring productive assets where families of non-users preferred unproductive assets.

Beneficiary's satisfaction:

Around 55% respondents were found moderately satisfied, while 22.5% were found not satisfied with the service provider's services and performance. The respondents expressed their satisfaction regarding the completion of project on time, appropriate technical support received from local bodies and NGOs, contribution of project beneficiaries in the project construction. On the other hand, they also stated that limited monitoring of projects from donors and project stakeholders, received less financial support as per previous commitment from local bodies, limited access to maintenance and repair, delay in construction and installation were major causes to express less satisfaction regarding the project.

Productive Energy Use:

Average maximum capacity of micro-hydro in sampling areas was 58 kilo Watt. In the dry season, average capacity of scheme was remains nearly 52 kW. In addition energy consumption at household level was 120 watt in a day. Households generally pay NPR. 91 as tariff. Power generation was stopped 42 days last year due to different causes including maintenance. Moreover power load common problems observed in the project areas.

Grinder/huller mills, furniture, computer lab/institutes and poultries were major enterprises of which consume more day time electricity. Around 2.5 kW energy consumed on average by these enterprises. End use entrepreneurs revealed that average investment of an enterprise was NPR 195,000 which earns NPR. 21,545 monthly. Average contribution of monthly income by using energy was NPR. 9,017. Majority of these entrepreneurs were received subsidy from AEPC. Limited access to credit facilities in terms of volume of loan and Financial Institutions were prevailed in the project areas. A long documentation process was required to review and approval of business plan to receive subsidy.

District level project stakeholders stated that around 34 end-use enterprises were operated with utilizing 235 kW at district level. Average employment generation was found 92 in the sample districts. Similarly, possible enterprises in future are grinder/huller, computer lab, grill factory, bread factory, noodle, sewing, wood mills, soap factory, herb processing, internet café, hotel and tourist restaurant. In addition, Employment generation from a micro-hydro project found around 7.6 person of which full employment was 2.4 and partial employment was 3.8 person. Engagement of men in enterprises comparatively higher than women.

Sustainability:

The study team found that only in 10 projects utilized the maintenance fund for regular maintenance. Major sources of maintenance fund were tariff collection and grants received from AEPC. Other sources of maintenance were grants and technical support from other organizations. With the limited capacity of regular operation and low load factor caused limited productive energy use and less viable to run enterprises in sustainable manner. Hence sustainable operation and maintenance would always be an issue in micro hydro projects.

Due to low load capacity and smaller size of schemes, and rapid expansion of central grid line in the MHP areas, productive energy end-use has not been increased as expect previously. Most of entrepreneurs preferred to national grid for business promotion which was available in the MHP areas. In addition, timely upgrade the capacity of MHP to Mini-hydro is also essential in future.

4.2 Recommendations

The study team would like to make the following recommendations to National Rural and Renewable Energy Programme, local authorities and service providers so that they can tie up the initiatives of the project with other programs in future to ensure their effectiveness on the one hand. On the other, these recommendations can act as the references for launching similar initiatives in the other parts of the country

Providing financial subsidy alone is not a viable solution to make such projects economically sustainable. It is necessary to give more emphasis to expand logistics, maintenance services and facilities at district level. With provision of maintenance fund a robust guideline regarding the establishment and mobilization of maintenance fund is utmost essential.

Capacity building to MHP management team for preparation of Operation and Maintenance manual and providing high practical trainings to operators and manager is most crucial for sustainability of MHP.

Current subsidy mechanism is more complex: costly, requires more documentation and time taking. Hence, it would be beneficial if the subsidy will be integrated with other Business Development Services like access to finance, technologies and logistics, and insurance. Facilitation and regular follow up supports is also important to entrepreneurs for marketing and scaling up their enterprises.

Operationalization of standard tariff determination guideline is seems essential for use in MHPs. It helps to ensure equitable pricing mechanism for household lighting purpose and productive energy use sectors.

Although connecting community-based micro-hydro schemes to the national grid was a new initiative. More efforts need to be done to establish technical standard for this. In addition, robust policies with budget are essential to address technical, social and financial issues regarding the power-synchronization and interconnection with national grid.