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United Nations Development Programme
Country: Nepal
PROJECT DOCUMENT[1]

Project Title: Renewable Energy for Rural Livelihoods (RERL)

Program: National Rural Renewable Energy Program (NRREP)

UNDAF Outcome(s): Vulnerable groups have improved access to economic opportunities and adequate social protection. (Outcome 2)

UNDP Strategic Plan Environment and Sustainable Development Primary Outcome: Expanding access to environmental and energy services for the poor: Strengthened capacity of local institutions to manage the environment and expand environment and energy services, especially to the poor.

UNDP Strategic Plan Secondary Outcome: Catalysing environmental finance: Countries develop and use market mechanisms to support environmental management.

Expected CP Outcome(s): Same as UNDAF

Expected Country Programme Action Plan (CPAP) Output (s):

Output 2.4: Vulnerable groups have increased access to sustainable productive assets and environmental services

Output 2.4.1: Alternative Energy Promotion Centre's capacity enhanced for scaling up energy services in rural areas.

Implementing Partner: Alternative Energy Promotion Centre (AEPC), Ministry of Science, Technology and Environment (MOSTE)

Responsible Partners : UNDP

Brief Description

Nepal's primary energy mix is dominated by traditional biomass (84%), contributing to net GHG emissions. About 40% of the rural population lacks access to electricity. When access is available, low system capacity limits use to lighting and other low power applications. While progress has been made in dissemination of off-grid renewable energy systems, issues of affordability of up-front costs of systems (due both to high costs and lack of capital), financial sustainability (due partly to low utilization), and technical capacity and awareness for less disseminated but high potential technologies constrain progress. RERL project will focus on community-scale power generating off-grid renewable energy technologies to promote income generating opportunities and a low-carbon development path in rural areas. Its core strategy will consist of four interrelated concepts: (1) promotion of larger-scale, less-disseminated systems, (2) achievement of private sector financing of up-front costs, (3) achievement of financial sustainability (cash flow for repairs and maintenance), and (4) establishment of productive use enterprises to raise system revenues and generate livelihood benefits.

Programme Period:	2014-2019
Atlas Award ID:	76958
Project ID:	88046
PIMS #	4522
Start date:	July 2014
End Date	July 2019
Management Arrangements	NIM

Total resources required	US$ 59,807,030
Total allocated resources:	US$ 35,312,500
• UNDP Regular Resources	US$ 2,000,000
• GEF	US$ 3,000,000
Government contributions	
○ Government (GoN)	US$ 30,312,500
Funding to be leveraged	
○ Private Sector	US$ 19,601,710
○ Local Governments	US$ 4,647,890
○ Others (Un-Funded):	US$ 244,930

[1] For UNDP supported GEF funded projects as this includes GEF-specific requirements

Government of Nepal
Ministry of Science, Technology and Environment
Alternative Energy Promotion Center
2053

Agreed by (Implementing Partner):________________ 21 July, 2014
Date/Month/Year

Agreed by (UNDP):________________ 21 July 2014
Date/Month/Year

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List of Abbreviations and Acronyms

ADBL	Nepal's Agricultural Development Bank Limited
ADDCN	Association of District Development Committees Nepal
AEPC	Alternative Energy Promotion Centre
BFI	Banks and Financial Institutions
BSP	Biogas Support Programme
CAGR	Compounded Annual Growth Rate
CDM	Clean Development Mechanism
CEO	Chief Executive Officer
CO_2	Carbon Dioxide
CREF	Central Renewable Energy Fund
CRT/N	Centre for Rural Technology/ Nepal
CSIDB	Cottage and Small Industry Development Board
CTEVT	Council for Technical Education and Vocational Training
DANIDA	Danish International Development Agency
DCSI	Department of Cottage and Small Industries
DDC	District Development Committee
DEECCS	District Environment, Energy and Climate Change Section
DFID	Department for International Development
DPR	Detailed Project Report
EDA	Enterprise Development Advisor
EDF	Enterprise Development Facilitators
EDI	Energy Development Index
EPU	Enterprise Promotion Unit
ESAP	Energy Sector Assistance Program
EU	European Union
FAO	Food and Agriculture Organization
FI	Financial Institutions
FM	Frequency Modulation
FNCCI	Federation of Nepalese Chambers of Commerce and Industries
FY	Fiscal Year
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GESI	Gender and Social Inclusion
Gg	Giga gram
GHG	Green House Gas
GON	Government of Nepal
GTZ	Gesellschaft für Internationale Zusammenarbeit
HH	Household
IEA	International Energy Agency
IEC	Information Education and Communication
IEDI	Industrial Enterprise Development Institute

INPS	Integrated Nepal Power System
IPP	Independent Power Producers
IWM	Improved water mills
KfW	Kreditanstalt für Wiederaufbau
ktCO_2	kilo tonne of CO_2
kW	kilo Watt
kWh	kilo Watt hour
LDC	Least Developed Country
LPG	Liquefied Petroleum Gas
M	Million
MEDEP	Micro Enterprise Development Programme
MFALD	Ministry of Federal Affairs and Local Development
MFI	Micro Finance Institution
MFSC	Ministry of Forest and Soil Conservation
MH	Mini Hydro (Installed capacity between 100 kW and 1000 kW)
MHP	Micro Hydro Projects (Installed capacity between 5 kW and 100 kW)
MGP	Mini Grid Projects
MOAD	Ministry of Agriculture Development
MOE	Ministry of Energy
MOSTE	Ministry of Science, Technology and Environment
MOF	Ministry of Finance
MSME	Micro, Small, and Medium sized Enterprises
MW	Mega Watt
NA	Not applicable
na	not available
NAVIN	National Association of VDCs in Nepal
NCCSP	UK/UNDP-Nepal Climate Change Support Programme
NEA	Nepal Electricity Authority
NGO	Non-Governmental Organisation
NMDP	UK-Nepal Market Development Programme
NMHDA	Nepal Micro Hydro Developers Association
NPC	National Planning Commission
NRB	Nepal Rashtra Bank (Central bank)
NRREP	National Rural Renewable Energy Program
O&M	Operation and Maintenance
PEU	Productive Energy Use
PIF	Project Identification Form
PPA	Power Purchase Agreement
PPP	Public-private partnership
PV	Photo voltaic
RC	Regional Service Centres
RE	Rural Energy
REDP	Rural Energy Development Program
REP	Renewable Energy Project

RERL	Renewable Energy for Rural Livelihoods
RETS	Renewable Energy Testing Station
Rs	Nepalese Rupees
SEMAN	Solar Equipment Manufacturers' Association of Nepal
SHS	Solar Home System
SNV	Netherlands Development Organization
SPV	Special Purpose Vehicle
SREP	Scaling-up Renewable Energy Programme
ToE	Tonne of Oil Equivalent
ToR	Terms of Reference
TR/EC	Technical Review/Evaluation Committee
UN	the United Nations
UNCDF	UN Capital Development Fund
UNDP	the United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	The United States of America
USD	US Dollar
VAT	Value Added Tax
VDC	Village Development Committee
W	Watt

Renewable Energy for Rural Livelihoods (RERL)

Background

Nepal has a predominantly rural population, with an overwhelming dependence on biomass for fuel. Almost 90% of the energy is used for household purpose. Despite huge hydropower potential, Nepal has one of the world's lowest per capita electricity consumption. Two out of every five households still do not have access to electricity.

About 15% of the rural households get electricity through off-grid renewable energy sources. Off-grid renewable energy systems will be essential for reaching the rural population still lacking electricity. In this regard, donor supports have played a very significant role in up-scaling of decentralized electricity supply. However, most of the decentralized electricity supply is limited to smaller systems like micro hydro power (MHP) and solar home systems.Electricity from micro-hydro and solar home systems are primarily used for lighting and powering some low capacity household gadgets. These systems have not facilitated extensive productive end-uses of electricity leading to enhanced livelihoods and increased income generation. Even though Electricity-based enterprises have come up close to micro-hydro plants, contributing to enhanced livelihoods, they suffer from low load factor, one of the reasons being low installed capacities leading to inadequate productive end use applications.

Moving towards bigger sized systems (mini-hydro and large scale solar PV systems) will bring economies of scale, faster progress, wider coverage, and/or more income generating opportunities for local people. Bigger systems offer greater opportunity for enterprise development and better financial and commercial viability.

Barriers

The key barriers to sustainable expansion of the large-scale systems are high upfront capital cost, lack of sufficient commercial financing to cover these costs, lack of favourable investment environment in the country, lack of financial sustainability of operational systems, insufficient technical capacity and lack of awareness.

Baseline project

The UNDP-GEF RERL project will integrate into the Government's single umbrella programme, the National Rural Renewable Energy Programme (NRREP). It will address some of the gaps and needs in the Programme relevant to identified interventions for promoting Mini-hydro and Large-scale solar PV projects. All activities of NRREP that are relevant to the GEF project will together comprise the baseline project. Out of the total NRREP budget of about USD 184 million, USD 46.6 million will fund baseline activities relevant to the UNDP-GEF RERL project.

Baseline scenario and UNDP-GEF RERL project interventions

Given AEPC's vast experience in smaller micro-hydro systems, it is likely that most of the off-grid hydro installations by NRREP will be micro-hydro of less than 60 kW capacities. Consequently, it may be difficult for NRREP to meet its five-year target of 25 MW. Furthermore, financial sustainability of these systems will continue to be an issue because of insufficient productive end-use applications due to limited power availability. Given the high initial cost of these systems, there is a huge requirement of commercial financing. However, the private sector as well as banks will continue to be hesitant to invest because commercial viability of these systems will likely remain unattained. Issues regarding domestic manufacturing of components for the mini-hydro sector may not be able to improve its ability to offer a cost advantage, lowering total system costs. Support for manufacturers, while provided, may lack strategic focus to ensure manufacturers that may offer potential cost-savings to mini-hydro installations are targeted.

In the baseline scenario, in the absence of the UNDP-GEF RERL project, under the NRREP, a total of 10 MW of micro-hydro capacity is planned to be installed. These collectively are expected to operate on the average at22% load factor. Moreover, The majority of solar PV efforts are likely to remain focused on solar home systems (SHS), and larger scale applications of PV will continue to remain virtually absent from Nepal. Thus, remote areas without water resources may lack the opportunity of productive applications that such larger systems offer.

Funds disbursed under the NRREP will likely be limited to basic loan and subsidy models. While productive applications of renewable energy will be pursued under NRREP, micro-finance may continue to be unavailable to entrepreneurs due to lack of coverage by micro-finance institutions in their areas.

In the NRREP, policies specifically promoting mini-hydro and large-scale solar PV systems will remain absent. The proposed project will support establishment and operationalization of a policy that enables PPP model for Mini-hydro and large scale solar PV systems development. Furthermore, under the NRREP, capacity building specific to mini-hydro and large scale solar PV manufacturing/installation, operation and other technical areas may not occur. The proposed project will build up these capacities.

As an improvement to the current baseline initiatives on renewable energy development and utilization in Nepal, the proposed UNDP-GEF RERL project will address the identified gaps and barriers to further enhance the sustainability of the planned efforts, increase the socio-economic impacts to the rural areas of the country that can benefit from the available renewable energy resources, and to realize global environmental benefits mainly in terms of GHG emission reductions. The barrier removal and gap filling interventions that will be carried out as incremental activities to the baseline activities of the country are meant to facilitate and enable the design, engineering, installation and operation of the following:

- Mini-hydropower generation projects as demonstrations to showcase the effective application of Private-Public Partnership (PPP) schemes;
- Mini-power grid system that integrate several existing micro-hydro stations, as demonstrations showcasing the design and implementation of financially sustainable and reliable power distribution systems;
- Off-grid large micro-hydro and mini-hydro power generation projects as demonstrations to showcase increased load factors through cost-effective and feasible application of the electricity generated for productive end-uses; and,
- Large scale solar PV power generation projects as demonstrations showcasing cost advantages over smaller PV systems, financial feasibility, and potential for productive end-uses.

In addition, and to address the project financing-related barriers, the UNDP-GEF RERL project will facilitate the establishment of credit facilities for domestic manufacturers; as well as financing instruments for promoting commercial financing for mini-hydro and large-scale solar PV projects and related electricity-based enterprises.

Project Strategy and Design

The GEF Project is highly aligned with the Government of Nepal's off-grid renewable energy program. Technology selection and project design has been done to most effectively address root barriers to energy access and low carbon development in Nepal, provide both integration and value-addition to NRREP, leverage UNDP experience and comparative advantages, and emphasize technologies that have had only limited application in Nepal. The project will focus on micro-hydro of over 60 kW, mini-hydro, mini-grid and large-solar PV systems as technological interventions. The proposed project will provide both investment support and technical assistance.

The root barriers addressed by the project are (a) lack of capital for up-front investment; (b) high cost of systems; (c) lack of financial sustainability of systems and (d) lack of technical capacity and awareness.

Policy, regulatory, and institutional barriers are cross-cutting/overarching across financial support, capacity building, financing and efficient-use of energy. Enhancing productive uses is especially important because investors will be attracted to commercially viable systems which have demonstrated financial sustainability through productive use applications.

The project's core strategy will consist of (1) promotion of larger-scale, less-disseminated systems, (2) achievement of commercial viability and private sector financing of up-front costs, (3) achievement of financial sustainability (cash flow for repairs and maintenance), and (4) establishment of productive use enterprises to raise system revenues and generate livelihood benefits.

Project Objective, Outcomes and Outputs

The project objective is the removal of barriers for increased utilization of renewable energy resources in rural Nepal. The project will meet its objective by ensuring 12.5 MW of large-scale off-grid renewable energy projects implementation.

The project will meet its objective as follows:

Firstly, it will strengthen the legal, institutional and policy environment. It will do this by ensuring a private sector investment friendly policy for PPP model, supporting district development process by integrating larger systems in their planning process, and providing orientation and training to government officials, and other relevant stakeholders about the sub-sectors and the relevant policies.

Secondly, it will support increased investments in RE through financing and technical assistance to demonstrate attractiveness of larger systems. It will do so by implementing 1 MW of mini-hydro[2](MH) demonstration projects and 500 kW of large-scale solar PV systems preferably through PPP model by establishing a legal entity, Special Purpose Vehicle (SPV), as well as for mini-grids (local-grid connecting micro-hydro projects totalling 300 kW) to demonstrate more extensive productive use and thus greater system revenues. It will also provide technical assistance for installation of 2 MW of micro-hydro projects above 60 kW, 7 MW of mini-hydro projects based on the above model and 2 MW of large-scale solar PV systems.

Thirdly, it will enhance the availability of RE financing through establishing financing instruments for manufacturers and developers as well as ensuring financial sustainability. It will also partially finance the establishment of the financing tools (funds) to enhance the availability of RE financing. Furthermore, the project recognizes the importance of promoting productive use of electricity to enhance financial sustainability of RE investment which will increase utilization of electricity and thereby revenue. The project will ensure that a number of micro, small and medium enterprises (MSME) are functional in the RE project areas and consume substantial amount of electricity which contributes to financial sustainability of RE projects with affirmative intervention to promote women's organizations and women-led business to have access to finance for operating MSME.

Finally, the project will focus on enhancing technical capacities and skills for the selected technologies. It will support capacity building in the design and manufacture of mini-hydro systems and capacity building in the installation and after-sales service of both mini-hydro and larger scale PV systems. Capacity building for manufacturers will focus on those that manufacture components identified by the project to have the potential for lowering costs through domestic manufacturing. Skill trainings will follow guidelines specified by the project to ensure women's and marginalised and vulnerable communities' participation (33%).

[2] Mini Hydro is defined as hydropower projects of installed capacity between, 100 kW and 1MW

The project will implement various activities to achieve the project outcomes and outputs.

Risks and assumptions

Even though project implementation presents substantial challenge, the proposed project is feasible. The overall project risk is moderate. Major areas of risk include the external investment and political environment, the response of the private sector and banks to the opportunity to invest in off-grid renewable energy electrification projects, effectiveness of project management and stakeholder coordination under the NRREP umbrella, and the ability to maintain project targets in spite of possible changes in NRREP targets.

Key assumptions include banks and private sector being interested in financing commercially viable off-grid renewable energy power projects., the investment environment and the local and national political environments remain conducive to project implementation, the project is driven by strong leadership from the National Project Manager and strong support of the National Project Director, local people are interested in productive applications and possess the capacity to benefit from project efforts to support them in enterprise development and achievement of market linkages and CREF funds are available to support capacity targets.

Global environmental benefitsand Cost effectiveness

The contribution to sustainable development and environmental benefits of renewable energy systems are well established. Off-grid power generated by mini-hydro and solar PV systems provides rural households with electric power for lighting, milling, and other productive use. The environmental benefits accrue as a result of reduction in kerosene, diesel, un-sustainable fuel wood and dry cell consumption for various applications. Both mini-hydro and large solar PV systems have the potential to attract carbon financing as they qualify as proven technologies. Along with environment benefits, they also contribute to other areas of the Sustainable Development Agenda.

It is estimated that when all the systems (demo and post-demo) come into operation, a total of about 22,040 tCO_2 will be abated annually over the period of 15 years attributable to productive applications of the energy. Considering lifetime of the systems to be 15 years for both the mini-hydro and the large scale solar systems, the RERL supported projects will contribute to the reduction of 330,604 tCO_2. The RERL demonstration projects alone will be responsible for abating 37,585 tCO_2 whereas the remaining 293,019 tCO_2 reduction will be from the post-demo projects supported.

However, "GHG Benefits of GEF Projects: Carbon Dioxide Calculator" methodology, which is used for providing inputs to the GHG tracking tool yields slightly different emission avoided estimation. Based upon this, the lifetime direct post-project emissions avoided, totaled over the respective lifetime of the investments (15 years) is 131,545 tCO_2. Likewise, the lifetime indirect emissions reduction is estimated to be 338,265 tCO_2 and 293,058 tCO_2 using bottom-up and top-down approach respectively. Taking all projects into account (demonstration

projects and post demonstration projects including indirect impacts) and as per the indirect bottom-up approach, the GHG emissions avoided is 507,397 tCO_2. The CO_2abatement cost per tonne comes to about USD 9.85 when the contributions of GEF and UNDP alone are considered.

Sustainability and Replicability

Focusing on sustainability of the UNDP-GEF RERL project and ensuring that it can be replicated has been a major focus while designing the project. This has been done in a number of ways. The project will be sustainable and replicable because firstly, the Project is completely aligned with the objectives and priorities of the Government of Nepal. Secondly, the project emphasizes the enactment of policies and regulations, establishment of suitable financing mechanisms, capacity building and places particularly strong focus on productive end use promotion. Thirdly, the project has taken special care not to top up any subsidy or facilities being provided by the government. Finally, the progression in the phases of the project from demonstration, to post demonstration projects has been consciously adopted to ensure sustainability and replicability.

Stakeholders

Potential stakeholders for the UNDP-GEF RERL project from the government, non-governmental organizations, private sector groups who will have a role in the successful implementation of the project have been identified. A detailed capacity assessment of AEPC, the lead executing agency of the project, has been carried by NRREP and roles of various institutions have been identified.

Cross cutting issues

The objective of the UNDP-GEF RERL project with regard to GESI is to build an equitable and gender inclusive society by ensuring equal rights of women and men of all castes, creed and geographical regions in the social, political and economic aspects of national development.

The Project will contribute to poverty reduction and livelihood enhancement through savings on women's time, increasing employment opportunities, and access to better health facilities. Consequently, villagers will have less days of sickness thereby enhancing their productivity.

Mainstreaming GESI is crucial throughout the programme cycle, including efforts to analyze systematically and with the flexibility to address the specific needs of both women and men during the project implementation phase. The UNDP-GEF RERL project will provide socio-economic benefits to communities through extensive promotion of productive end-uses of energy in rural areas where at least 33% participation of women will be ensured. As an outcome of the project, the cash incomes from productive uses will increase substantially thereby empowering both women and men financially contributing towards overall social and economic empowerment. People's time mainly that of women and children spent on many of household chores will be saved. Women can use that time for other productive uses.

Management Arrangement

The full-sized project (FSP)UNDP-GEF RERL will be implemented by the Alternative Energy Promotion Centre (AEPC) of Nepal under Ministry of Science, Technology and Environment (MoSTE) guided by the Compact Principles agreed with the government to provide technical assistance to AEPC in implementation of National Rural and Renewable Energy Programme (NRREP). UNDP will serve as the GEF Agency for the Project and be responsible for the provision of project cycle management services. Government Cooperating Agency: The Ministry of Science, Technology and Environment (MoSTE), as a cooperating agency shall do high-level monitoring of the project. *Alternative Energy Promotion Centre (AEPC)* as a national implementing partner under the guidance of the MOSTE will implement the project under National Implementation Guidelines. APEC shall be overall responsible and accountable for the delivery of the project objectives and results aligned with NRREP objectives.

To facilitate smooth and effective implementation of project activities, a Project Executive Board (PEB) will be established. The Executive Director of the AEPC will serve as the NPD of RERL Project. AEPC will depute a full time National Project Manager as per the NIM guidelines to oversee the day-to-day operation and management of the project. Aligning with NRREP structure, a full time Senior National Advisor (SNA) with a reporting line to NPD/NPM will be recruited for RERL. To achieve the broader objectives of NRREP programme; it plans to recruit *Mini-Hydro Expert (1), Solar PV Expert (1), Livelihood Expert and Energy Finance Expert (1) and Planning and Monitoring Officer (1)* as professional staff to provide the needed technical assistance to AEPC/NRREP for the successful implementation of RERL.

Renewable Energy for Rural Livelihoods (RERL)

1 Situation Analysis

1.1 Energy and Electricity Situation in Nepal

Geographic and Economic Background: A land-locked country in South Asia, Nepal has an energy situation that reflects challenging terrain (over 75% mountainous) and very low income levels. The nation is among the poorest countries in the world, with per capita annual income of USD 742 in Fiscal Year 2011/2012.[3]It has a population of 26.5 million people of which about 83% live in rural areas.[4]About 25%ofNepal's people live below the poverty line, which varies by region but averaged 19,261 NPR per year in FY 2010/2011, or aboutUSD0.75 per day.[5]Poverty rates of the nation's different geographic areas present significant variation. Unemployment has been increasing in recent years, creating a "brawn and brain drain" for employment.

Nepal contains some of the most rugged mountain terrain in the world. In many areas, difficulty in transportation can result in substantial and sometimes extreme increases in the ex-factory cost of goods by the time they reach the final destination. This situation is a major contributor to the high cost and slow pace of energy infrastructure development. It also inhibits market linkages needed to develop income-generating opportunities in remote rural areas.

Both per capita income and per capita energy use in Nepal, while growing, lag far behind regional averages for Asia; and per capita commercial energy consumption is among the lowest in the world. Per capita income (USD 742 in2011/12[2]) grew at a compound annual growth rate of 3.3% between FY 2002/2003 and 2011/2012. Per capita energy consumption grew with an estimated Compounded Annual Growth Rate (CAGR) of 1.8% between 2006/2007 and 2010/2011.[6]

Overall Energy Use and Sources of Primary Energy: Nepal's per capita annual energy consumption, at 341 kg oil equivalent per capita in 2010, is one of the lowest in the world. Further, the primary energy consumption in Nepal is mostly derived from traditional biomass,

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[3]*Economic Survey: Fiscal Year 2011/2012*, Ministry of Finance, Government of Nepal, 2012. Preliminary estimate based on 8 months of data

[4] Population figures from *Nepal Population and Housing Census 2011*, Central Bureau of Statistics, National Planning Commission Secretariat, Government of Nepal.

[5]Poverty figures from *Nepal Living Standards Survey III* and *Poverty in Nepal* (both Fiscal Year 2010/2011), Central Bureau of Statistics, National Planning Commission Secretariat, Government of Nepal.

[6]Calculated based on data from *Economic Survey: Fiscal Year 2011/2012* (op. cit.)

contributing to deforestation and Green House Gas (GHG) emissions.[7] Further, excessive dependence on traditional biomass leads to serious indoor air pollution linked health hazards as well as overall inefficiencies in energy use. According to *Nepal's First National Communications to the UNFCCC* (July 2004), the majority of the nation's GHG emissions in 1994/1995 came from land conversion, by a substantial margin over fuel use (1,465Gg net CO_2 emissions due to fuel use versus 8,117 Gg net CO_2 emissions due to land use change).

According to the Government of Nepal, the share of traditional biomass in primary energy consumption is about 84percent (FY 2010/11), of which firewood accounts for a major share (Table1).Petroleum products account for 10.4% of primary energy use, coal 2.9%, and grid-connected power generation (mostly large hydropower) 2.6percent. The share of off-grid renewable energy resources is only 0.7%. Nepal has no proven source of petroleum products and depends completely on imports. Petroleum imports, predominantly from India, account for a large share of total foreign currency expenditures. They have increased sharply over the years, with increases in demand for petrol in the transport sector and for Liquefied Petroleum Gas (LPG) for cooking in the residential sector. Price hikes in petroleum products have been a major contributor to domestic inflation. The four-year compound average annual growth rate of Nepal's total primary energy consumption between FY2006/7 and FY2010/2011 was 3.2%.

Table1: Nepal's Sources of Primary Energy

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Source of Energy	FY 2006/07	FY 2007/08	FY 2008/09	FY 2009/10	FY 2010/11	4 year CAGR 2006/07 – 2010/11	Share of Total Energy 2010/11
Traditional Biomass	**7,854**	**8,015**	**8,185**	**8,342**	**8,500**	**2.00%**	**83.7%**
Firewood	6,999	7,149	7,301	7,467	7,606	2.10%	74.9%
Agricultural residue	337	337	344	324	331	-0.45%	3.3%
Livestock residue	518	529	540	551	563	2.10%	5.5%
Commercial	**1,031**	**1,038**	**1,139**	**1,464**	**1,580**	**11.26%**	**15.6%**
Coal	144	193	182	286	293	19.43%	2.9%
Petroleum products	709	655	775	965	1,058	10.52%	10.4%
Electricity	178	190	182	213	229	6.50%	2.2%
Off-grid Renewable	**59**	**59**	**64**	**70**	**75**	**6.18%**	**0.7%**
Total	**8,944**	**9,112**	**9,388**	**9,876**	**10,156**	**3.23%**	**100.0%**

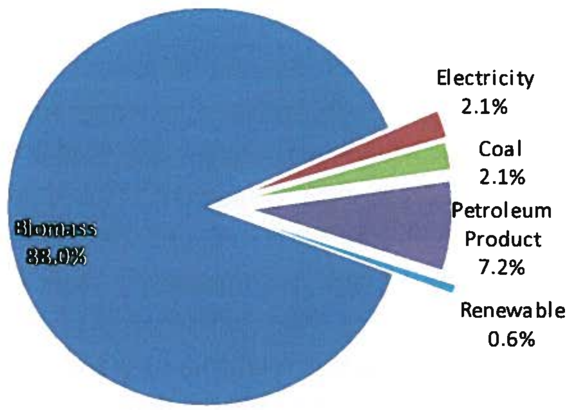
Source: Ministry of Energy, Government of Nepal quoted in *Economic Survey: Fiscal Year 2011/2012* (op. cit.); computations by RERL Formulation Team.

Figure 1and Figure 2below show the breakdown of primary energy consumption by energy sources and by consuming sectors as reported by the Government of Nepal's Water and Energy Commission Secretariat in Energy Balance 2010. According to these estimates, biomass accounts for about 88% of the total supply and 90% of it are used by residential

[7] Other major contributors to deforestation in Nepal are cutting of trees for timber, clearing land for agriculture, and livestock impacts.

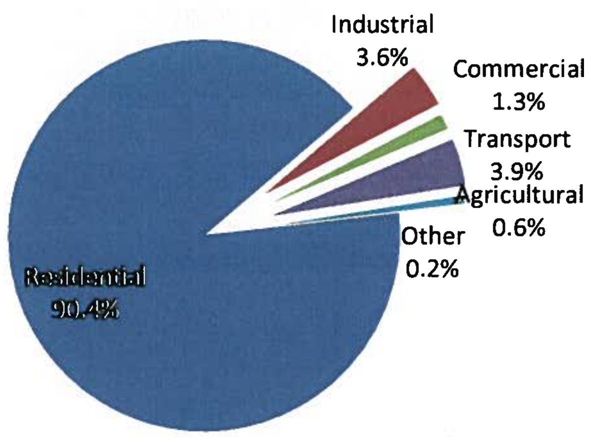
sector. Sector-wise primary energy consumption data shows that the residential sector accounted for 89.1%of the total in FY 2008/09

Figure 1: Primary Energy Consumption, 2008
Total Consumption 388,382 TJ



Source: Energy Sector Synopsis Report, Water and Energy Commission Secretariat, July 2010

Figure 2: Sector-wise Primary Energy Consumption, 2008
Total Consumption 388,382 TJ



Cooking and heating are the main household uses of energy and thus, given the predominant role of the residential sector in overall energy use, the top energy applications in Nepal. Other significant residential energy uses are for animal feed preparation and lighting. Rural and household enterprises use of energy fall into the household end-use category, though it is believed that these at present make up a very small, but growing proportion of the household energy use as compared to daily use applications. Breakdown of consumption by end-use is given in Table2.

Results show that overall, of the nation's over five million households, the majority (64%) use firewood for cooking, with LPG (21%) and dung (10%) the second and third most common fuels. Use of electricity for cooking is less than 1%. Yet, given the predominance of cooking in end use energy applications, one strong emissions reduction benefit of certain distributed renewable energy systems could be cooking fuel replacement. Rural households, as expected, show an even greater share of fuel wood use as their main cooking source (73%) than the national average, with dung (13%) and LPG (10%) is being their second and third most common cooking fuels. In contrast, only 26% of urban households use fuel wood as their primary cooking fuel. LPG instead is the main cooking fuel accounting for 68% of households in the urban category. Looking at the data by Ecological Belt, Mountain households, depend more than any other group on fuel wood for cooking (95% of households) and Terai, the least (57%).[8]

Table2: Main Energy Source used in Cooking in Nepal in %

Household Type	Firewood	LPG	Dung	Biogas	Kerosene	Electricity	Other
All Households	64.0%	21.0%	10.4%	2.4%	1.0%	0.08%	0.42%
Rural versus Urban							
Rural Households	73.1%	9.9%	12.5%	2.6%	0.8%	0.04%	0.42%
Urban Households	25.7%	67.7%	1.5%	1.8%	2.0%	0.12%	0.39%
Ecological Belt (including both Rural and Urban)							
Mountains	94.8%	3.1%	0.42%	0.22%	0.54%	0.32%	0.09%
Hills	67.0%	29.4%	0.11%	1.6%	1.1%	0.09%	0.17%
Terai	56.5%	15.2%	22.1%	3.5%	1.0%	0.05%	0.71%

Nepal Population and Housing Census 2011(op. cit.); computations by the RERL Formulation Team

The above discussion highlights a number of key motivations for promoting renewable energy development in rural Nepal, both from a global environmental and national socio-economic development perspective. Further, the general lack of access to modern forms of energy in rural areas, along with the greater need for rural development in this predominantly rural nation, implies that there is a need for renewable energy options. Particularly for rural communities lacking access or lacking dependable access to power from the grid, off-grid renewable energy technologies can facilitate income generating opportunities that would otherwise be absent.

Electrification and use of Electricity: Despite the availability of extensive hydropower potential of the order of 42,000 MW, Nepal has one of the world's lowest per capita electricity consumption, averaging 146 kWh/person annually for FY2010/2011. For comparison, averages in 2009 were 517 kWh/person in South Asia, 571 kWh/person in India, 2,631 kWh/person in China and 2,807 kWh/person in the world.[9] Electricity accounts for only 2.2% of Nepal's total energy use.

[8] Note: Mountain and Hill areas make up the 75% of Nepal that is considered mountainous, while the Terai are rural lowland areas along the country's southern border making up the other 25%.
[9] Nepal data from *Economic Survey: Fiscal Year 2011/2012*(op. cit.) and calculation of RERL Formulation Team. Other data from "UN Data," accessed at http://data.un.org

Government statistics on sector-wise usage of Nepal's electrical power are given in Table3. The reported number of grid-connected electricity consumers (points of service) has been growing rapidly, rising from 1.85 million at the end of FY2010/2011to 2.05 million by January 2012 (an increase of 10.7%).[10]

Table3: Share in Electricity Consumption in Nepal

Residential	Industrial	Commercial	Other
42.5%	37.7%	7.6%	12.1%

Source: *Economic Survey: Fiscal Year 2011/2012* (op. cit.). Note: Data likely refers to grid-connected power only.

The status of access to electricity may be inferred from census data on main source of households' lighting, as displayed in Table4. In 2011, about 67% of households used electricity as their main source of lighting. The proportion was 60% for rural households and 94% for urban households. Thus, we may infer that 40% of rural households lack electricity. The issues of load shedding (for grid-connected users) and limited capacity (off-grid users) may limit both the times of day at which they have access as well as the type of electricity consuming activities in which they may take part. The second largest source of household lighting is kerosene (named as main source of lighting by 18% of households), which must be imported.

Table4: Main Source of Lighting in Nepal by Household (2011)

Group	Electricity	Kerosene	Solar	Biogas	Other
Rural	60.1%	21.7%	9.2%	0.5%	7.4%
Urban	94.1%	4.0%	0.2%	0.4%	0.5%
All	67.3%	18.2%	7.4%	0.28%	6.1%

Nepal Population and Housing Census 2011 (op. cit.); computations by the RERL Formulation Team

Of the 60% of the rural population that does have access to electricity, roughly a quarter get that power from off-grid sources, while the other three-quarters obtain access from the grid.[11]The breakdown in terms of ecological zones of the other 40% of the rural population that still do not have access to electricity is given in the right column of Table5. The left column shows the proportions of households in each type of zone without electricity. While mountain areas have a higher proportion of homes without access to electricity, given the lower total population in such zones, hill and Terai areas still account for a higher proportion of total Nepali households without electricity. On a regional basis (see Table6), the Mid-Western and Far-Western regions have the greatest proportion of households without electricity. Yet, given their larger population, the Eastern and Central regions, lead among

[10]*Economic Survey: Fiscal Year 2011/2012*(op. cit.).

[11]AEPC as referenced in "Off-grid Prosperity," Shoko Noda, UNDP Country Director, in *Kathmandu Post*, January 24, 2013, has indicated around 12% of the Nepali population has access to electricity through renewable energy sources, mainly micro-hydro and solar home systems. Assuming these are mostly rural households, the RERL Formulation Team has estimated based on census data that 650,796 rural households in Nepal use off-grid renewable energy.

regions in total number of households without electricity. In general, these two tables show that lack of access to electricity is an issue spread across the rural areas of each of Nepal's three types of ecological zones and across all of its development zones. That is, a significant proportion of households in each type of ecological zone and in every regional development zone lack access to electricity.

Table5: Households in Nepal without Access to Electricity, by Ecological Zone (2011)

Ecological Zone	Proportion of Households in Ecological Zone without Electricity	Share of Total Households in Nepal without Electricity
Mountains	50.8%	10.4%
Hills	32.7%	46.7%
Terai	30.2%	42.9%

Nepal Population and Housing Census 2011 (op. cit.); computations by the RERL Formulation Team with an assumption that the households that do not indicate electricity as their main source of lighting are the ones that do not have access to electricity. Total households without access estimated at 1,775,551.

Table6: Households in Nepal without Access to Electricity by Development Region (2011)

Development Region	Proportion of Households in Development Region without Electricity	Share of Total Households in Nepal without Electricity
Eastern	36.4%	25.2%
Central	22.9%	25.3%
Western	22.0%	13.2%
Mid-Western	57.7%	22.6%
Far-Western	50.0%	13.7%

Nepal Population and Housing Census 2011 (op. cit.); computations by the RERL Formulation Team with assumption that households that do not indicate electricity as their main source of lighting are the ones that do not have access to electricity.

The Government of Nepal has cited "energy crisis" or power shortage as one of the greatest obstacles faced in the nation's economic development.[12] It is widely accepted that the shortage of power and frequent power outages have severely constrained economic growth in the nation. Grid-connected power generation capacity of 706 MW (reported for FY2011/2012), predominantly hydropower, is insufficient to meet demand. Even with the addition of imported power from India which allowed a peak demand of 1,027 MW to be met during the period, daily load shedding is required. The duration of load shedding can reach over 14 hours per day in Kathmandu in the winter, when river flow volume is low and demand is high.

[12]*Economic Survey: Fiscal Year 2011/2012*(op. cit.).

Of domestically produced grid connected electricity (as represented by the Nepal Power System (INPS), 92% is hydropower.[13]The electricity supplied by the domestic grid system in 2009-2010 was about 3,690 GWh. Of this, about 57% was generated by power plants owned by the Nepal Electricity Authority (NEA), 26% by Independent Power Producers (IPPs), and the remaining 17% was imported from the Indian grid. Peak demand met by NEA has been growing steadily from 603 MW in 2006 to 946 MW in 2011 (with excess over installed capacity achieved by purchases from India). Various issues inhibit more rapid growth of the domestic grid-connected sector, including low tariffs.

Huge differences in elevation, abundant snowmelt, and the monsoon rainfall have given Nepal vast hydropower potential. Estimated technically feasible hydropower potential in Nepal at 42,000 MW exceeds capacity installed till now by far, but progress in exploiting this potential has not kept up with demand. The first hydropower plant (of 500 kW) was built in Nepal in 1911, but development since has been slow. Progress has been seen since the opening up of the market to independent power producers in the 1990s.

Although the nation's armed conflict ended in 2006, the political situation is still a barrier to development of the large-scale power sector. Political instability stalls progress in large energy infrastructure projects. Some project developers have decided to continue activities, but the construction and commissioning of large plants is still very uncertain and subject to various delays due to the political situation. Many projects are either in their study phase or the developers are in a wait-and-see mode. In contrast, small-scale off-grid hydropower stations (totalling about 37 MW) and other renewable energy power producing technologies currently provide much more potential for progress as they are not stymied by larger political and institutional issues.[14]

As with the previous sub-section's general overview of energy use in Nepal, this sub-section's discussion of electricity in Nepal highlights a number of motivations for promoting renewable energy development in the country's rural areas and development of renewable power generation, in particular: The large proportion of rural households lacking electricity (40%) highlights the need for alternatives, as does the significant proportion of rural households lacking electricity across all types of ecological zones and in each and every regional development zone. Further, this very substantial population without electricity, when considered along with the nation's very low per capita incomes, raises the idea of potential income-generating opportunities that may be facilitated by electrification. Indeed, the serious capacity constraints associated with the grid-connected systems suggest off-grid systems may have more potential to benefit rural livelihoods and reduce drudgery than the grid itself. In addition, off-grid renewable power sources do not face the same political and institutional

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[13]*Nepal Electricity Authority Annual Report* 2011 as quoted in *Scaling up Renewable Energy Program (Srs P) Investment Plan*, 2011, Government of Nepal.

[14]*Renewable Energy Data Book, 2011*, Alternative Energy Promotion Centre (AEPC), Ministry of Environment, Science, and Technology, Government of Nepal, 2012: Provides statistics on types (mini, micro, and pico) of installed hydro capacity less than or equal to 1 MW and the total of these categories as of July 2011 is 37 MW.

barriers that are currently stalling large grid-connected projects, suggesting off-grid efforts can move forward more quickly.

1.2 Off-grid Renewable Energy in Nepal

As indicated in Table1, off-grid renewable energy accounts for 0.7% of total primary energy in Nepal (as of FY2010/2011). While this share seems low, it reflects the predominance of traditional biomass in Nepal's primary energy mix. Comparison to the 2.2% share of grid-connected electricity in overall primary energy during the same time period offers better perspective on the role of off-grid renewable energy. Further, estimates of the proportion of the rural population with access to electricity that gets that access through off-grid renewable power also highlights the importance of off-grid renewable energy in Nepal. According to our estimates, of the 60% of the rural population that does have access to electricity, roughly a quarter gets that power from off-grid sources. Overall, around 15% of the rural population and 12% of the Nepali population has access to electricity through off-grid renewable energy sources, mainly village micro-hydropower stations and solar home systems.[15]

In this section, we offer data on Nepal's current installed capacity of various off-grid renewable energy technologies, perspectives on recent growth, and a brief history of donor programs that have played a critical role in the growth of renewable energy technologies in the nation. We then offer information on the current status of the key renewable energy technologies that will be addressed in this project. All of these technologies are power generation technologies. They include: micro-hydropower, mini-hydropower, village-scale PV systems, institutional-scale (e.g. hospitals, schools) PV systems, and PV-based agricultural pumping technologies. The strategic reasons that these technologies were selected as the key areas of focus for this project are explained in Section 2 (Project Strategy and Design).

Current Installed Capacity of Rural Off-Grid Renewable Energy Technologies in Nepal: Table7shows the number of installations and installed capacity for various sub-sectors of the key renewable energy segments of hydropower, solar, and wind. In terms of power generation, the data shows the dominance of the sub-sectors of micro-hydro, mini-hydro and solar home systems (SHSs). In terms of geographical spread, the table shows that most technologies have achieved substantial spread, with installations in a significant portion of Nepal's 75 districts.

In general, a predominant theme conveyed by the Table7is that smaller-scale systems have been disseminated much more widely than larger scale systems. In looking at installed capacity, mini-hydro may appear to be the one exception of a larger scale technology that has achieved substantial capacity. Yet, as will be discussed later, most of the mini-hydro capacity installed to date was installed in 70s and 80s, so that mini-hydro is not really part of the current growth trend of off-grid renewable energy technologies in rural Nepal.

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[15] Shoko Noda, 2013, op. cit.

Table7: Nepal's Cumulative Installation of Off-Grid Renewable Energy Technologies as of July 2011

Renewable Energy Technology	Total Installations		Districts Covered*
	Number	Capacity	
Hydropower: *36.8 MW (not including IWM)*			
Mini hydro (100 kW < x ≤ 1MW)	40	14.95 MW	31
Micro hydro (5 kW < x ≥ 100 kW)	999	18.65 MW	59
Pico hydro (x ≤ 5 kW)	1,480	3.18 MW	53
IWM (improved water mill)	7,959	*NA*	46
Solar:*(7.49 MW SHSs only)*			
Solar home system	284,097	7.44 MW	74
Institutional solar PV**	299	Unknown	42
Solar pumping	81	Unknown	22
Small solar home system (<10 Wp)	11,687	0.05 MW	49
Wind			
Wind	21	Unknown	12

Source: *Renewable Energy Data Book, 2011*, AEPC (op. cit.)

*Note: Nepal has a total of 75 districts.

**Institutional solar PV consists of solar systems serving institutions such as schools and hospitals or clinics. Applications of power generated include computers, FM radios, and refrigeration of vaccines.

Recent Growth and Potential of Off-Grid Renewable Energy Technologies in Nepal:

Table8below contains the aggregate data provided by AEPC on recent installations (between July 2009 and July 2011) of various renewable energy technologies. The table shows the substantial progress made in certain sub-sectors. From the perspective of power generation, in the two years covered, installed capacity has been about 8.5 MW or about 19per cent of Nepal's cumulative off-grid renewable power installed to date. These numbers reflect the increased pace of installation of certain off-grid renewable energy technologies in recent years. Further, annual data over a recent period of ten years (see Table9) shows that progress over the past decade has been steady, rather than sporadic for the smaller renewable energy systems, which have been the focus over this period.

Even more clearly than Table7,
Table8 shows the dominance of smaller (e.g. micro versus mini-hydro) and household-scale (e.g. SHS versus institutional solar or solar pumping) technologies in the recent growth of off-grid renewable energy technology installations in Nepal. In terms of MWs, micro-hydro over the two recent years had the highest capacity installed (5.56 MW), while large solar home systems had the second highest capacity (2.08 MW) additions.

This data reflects the trend in recent years that installation of micro-hydro capacity is much greater than that for mini-hydro. One of the most important points supported by the figures in Table8 is that, while mini-hydro has fairly significant cumulative capacity (as indicated in Table7); there has not been any activity in recent years. That is, the strong growth in off-grid renewable energy technologies in Nepal in recent years has excluded mini-hydro, with existing mini-hydro plants mainly being those installed many years ago.

Table8: Nepal's Recent Installation of Off-Grid Renewable Energy Technologies

Renewable Energy Technology	Recent Installations July 2009 – July 2011		No. of Beneficiary Households
	Number	Capacity	
Hydropower: *6.32 MW (not including IWM)*			
Mini hydro (100 kW < x ≤ 1MW)	None	None	None
Micro hydro (5 kW < x ≥ 100 kW)	202	5.56 MW	50,332
Pico hydro (x ≤ 5 kW)	218	0.76 MW	10,567
IWM (improved water mill)	1,350	*NA*	69,985
Solar:*2.18 MW*			
Household solar PV (large SHS)	91,277	2.08 MW	91,277
Institutional solar PV**	38	0.04 MW	Unknown
Solar pumping	2	0.003 MW	Unknown
Small solar home system (small SHS)	11,687	0.06 MW	11,687
Wind			
Wind	2	Unknown	Unknown

Source: *Renewable Energy Data Book, 2011*, AEPC (op. cit.); * for FY 2009/2010 only.

It can be seen from Table9that Nepal's off-grid renewable power development to date has focused on the small end, raising the question of whether moving towards the next step up in size could bring economies of scale, faster progress, wider coverage, and more income-generating activities for local people.

Table9: Annual Capacity Additions of Smaller-Scale Renewable Energy Systems, FY2000/01 to FY 2009/10

Year of Installation	Number of Systems Installed				
	Micro Hydro	Pico Hydro	Improved Water Mills	Solar Home Systems	Household Biogas
2000/01	40	112	107	6,211	17,857
2001/02	50	36	58	13,775	15,527
2002/03	34	61	65	18,482	16,340
2003/04	53	80	538	15,106	11,259
2004/05	35	66	599	17,887	17,803
2005/06	38	48	934	6,688	16,118
2006/07	42	46	851	10,806	17,663
2007/08	98	70	1,168	38,375	14,884
2008/09	86	32	1,073	53,662	19,479
2009/10	60	36	986	34,219	21,158

Source: *Scaling Up Renewable Energy Program: Investment Plan for Nepal*, 2011, based on data gathered from *Renewable Energy Data Book 2009* (AEPC), *Biogas Year Book 2009* and *AEPC Annual Progress Report 2009-10.*

Table10 below summarizes estimated potential capacity of off-grid renewable energy technologies, comparing them to current capacity. The Table shows that for almost all key renewable energy segments, current capacity reflects only a very small proportion of potentially exploitable capacity.

Table10: Estimates of Potential Exploitable Renewable Energy Capacities

Technology	Potentially Exploitable	Current Capacity
Hydropower* (total commercially exploitable)	42,000 MW	707.6MW
Mini-hydro (practically exploitable)	>100 MW	15.0 MW
Micro-hydro (practically exploitable)	>80 MW	18.7 MW
Solar PV power	2,100 MW	7.5 MW
Wind	3,000 MW	NA**

*May include smaller scale sites if deemed commercially exploitable.

**Only 12 installations of wind.

Sources: *Economic Survey 2011/2012*, op. cit., *Renewable Energy Data Book 2011* (op. cit.).Estimate for mini-hydro is based on district-level demand assumptions.

Note: Current capacities for mini-hydro, micro-hydro and PV are as of July 2011.

Given limited progress in recent years in extending the grid to un-electrified, yet accessible areas and given substantial population in remote areas not suitable for grid extension, off-grid renewable energy systems are seen as a key means of reaching the 40% of the rural population still lacking access to electricity. As such, both the Government of Nepal and donors have been putting substantial efforts into expanding the deployment of renewable energy technologies. Notable progress has been made. Yet, due to many difficulties, it has been slower than targeted.

Historical Role of Donor Programs in Growth of Rural Renewable Energy in Nepal: Donor support has played a leading role in the development of off-grid renewable energy systems in Nepal over the past 17 years. In 1996, UNDP initiated large-scale donor support in the sector with the launch of its Rural Energy Development Program (REDP). The data for FY2009/2010 and 2010/2011 for micro-hydro and pico-hydro stations illustrate the significant role played by donor programs in overall capacity additions (see Table11). In this case, two programs, UNDP's "Transition RERL" (a project developed to serve as a transition from the very successful REDP to the project proposed in this document) and DANIDA's Energy Sector Assistance Program (ESAP) supported the majority of stations in each category installed in each of the two years.

Table11: Role of Two Major Donor Projects in Micro-Hydro and Pico-Hydro Capacity Installed in Nepal in FY2009/10 and FY 2010/11

Item	FY 2009/2010	FY 2010/2011
Micro-hydro		
Capacity installed	1.545 MW	4.016 MW
Total number of stations installed	62	140
Number supported by ESAP	37	90
Number supported by Transition RERL	11	29
ESAP/Tr. RERL supported sub-total (number)	48	119
ESAP/Tr. RERL % of total number	77%	85%
Pico-hydro		
Capacity installed	0.39 MW	0.37 MW
Total number of stations installed	115	103
Number supported by ESAP	115	103
ESAP % of total number	100	100

Source: *Renewable Energy Data Book 2011* (op. cit.).

Renewable energy technologies were actually initiated in Nepal in the late seventies through the private sector with government and donor support. Yet, commercial supply of electricity from such initiatives was not very successful. As a result, in the nineties, the concept of the community owned and managed micro-hydro plants was initiated by the government, through the support of donor-funded projects, to achieve community electrification. The first of these donor projects was UNDP's REDP, implemented between 1996 and 2011 to support rural energy system development, including micro-hydro, through a community mobilization approach. Over a period of 15 years, REDP achieved an installed capacity of 7.5 MW of micro-hydro through its community-based approach. In 2003, the World Bank joined UNDP as a partner organization providing financial assistance to the Government of Nepal and AEPC for replicating micro-hydro system activities in ten more districts. About three years after UNDP's project, the Energy Sector Assistance Program (ESAP) was set up by DANIDA in 1999. ESAP also put substantial emphasis on micro-hydro, though did not use the community mobilization model of the UNDP project. About 8.5 MW of micro-hydro was installed through the two phases of ESAP. The government through its own efforts added micro-hydro plants for an overall total of 18 MW (or two additional MW to REDP's and ESAP's sub-total of 16 MW).

Table12 summarizes key donor projects in off-grid renewable energy over the past twenty years. REDP (including "transition RERL") and ESAP have been the most significant donor projects in the micro-hydro area. In the PV area, ESAP has given the most significant support to SHSs; and the EU's Renewable Energy Project has supported institutional solar for income generation, public services, and water pumping. In addition to the large donor programs listed in Table12, the Government of Nepal has also had some smaller renewable energy programs, some self-funded and some with other donors.

Table12: Donor Projects in Rural Renewable Energy since the mid-1990s

Project	Time Period	Donor	Technologies	Approach/ Comments
1. Renewable Energy Development Program (REDP)	1996-2011	-UNDP -World Bank	-Micro-hydro -Biogas -Improved cook stoves -Solar water heaters	Local level capacity building; community mobilization models
2. Energy Sector Assistance Program (ESAP)	1999-2012	-DANIDA -Norwegian Embassy	-More efficient biomass tech for cooking and heating -SHSs -Micro-hydro	Introduction of lending to micro-hydro sector, support for both micro-hydro and SHSs
3. Renewable Energy Project (REP)	2003-2012	EU	-Institutional solar for public services, water pumping, and income generation	Public services include schools, hospitals, etc. Pumping for both drinking water and irrigation

Status of specific technologies: In this sub-section, we provide a brief discussion of the current status of the renewable energy technologies that will be addressed in the proposed project. These technologies, all off-grid power generation technologies, include mini-hydropower, micro-hydropower, village-scale solar PV systems, institutional solar PV systems (such as those used in schools and health clinics), and solar PV agricultural pumping technologies. Later in this document (Section 2.1) we explain the rationale for selecting each of these technologies for inclusion.

Mini-hydropower status: While AEPC data indicates about 40 mini-hydro installations with a total installed capacity of about 15 MW, mini-hydropower today in Nepal is a sub-sector in which activity associated with new installations has been almost completely absent over the past decade. The only exception is the 400 kW Haluwa Khola Station supported by private sector and UNDP commissioned in 2011. The majority of Nepal's mini-hydro was built in 70s and 80s by the Nepal Electricity Authority (NEA) to electrify the administrative headquarters of various districts. Most of these plants are operating at losses. NEA has leased some of these plants out to private sector to abate losses and many of them are now grid connected.[16]

NEA's experience with mini-hydropower has not been good. It stopped its activities in the sub-sector due to high management costs that resulted in heavy operating losses. NEA is gradually handing over these stations to the private sector, which has resulted in improved performance.

Aside from the NEA mini-hydro stations, there are only four others and all of these are off-grid. They range in size from 400 kW and above. Two of these were installed over a decade ago with aid from Switzerland (400 kW) in Salleri and Austria (750 kW) in Namche. Both are located in the Solukhumbu District and are owned and operated by the beneficiaries.

When AEPC was established in 1996, its mandate in hydropower only covered stations of up to 100 kW. Now, however, its mandate has been expanded to include stations up to 1 MW. The Haluwa Khola station represents the only station over 100 kW to be implemented by AEPC.[17]

Table13below presents a rough breakdown of the installed capacity and number of operating mini-hydro plants into the following categories: still operated by NEA, leased by NEA to the private sector, or developed and managed by non-NEA entities.

[16]*Development of Framework and Guidelines for Promotion of Mini-hydro in Nepal*, June 2012, Energy Development Services P., Nepal (commissioned by AEPC/RERL)
[17]Energy Development Services, 2012, op. cit.

Table13: Estimates of Nepal's Installed Mini-Hydro Capacity by Ownership and Management Type

Ownership	Management	Off-grid or grid connected	No. of Stations	Installed Capacity
NEA	NEA	Mixture	25	10.66 MW
NEA	Private Sector	Off-grid	7	1.43 MW
NEA	Private Sector	Grid connected	4	0.83 MW
Private Sector/Community	Private Sector/Community	All off-grid	4	2.03 MW
Total for all types of owners hip/management		----	40	14.95 MW

Sources: *Development of Framework and Guidelines for Promotion of Mini-hydro in Nepal*, June 2012, Energy Development Services, Nepal (commissioned by AEPC/RERL). For NEA managed stations, estimate by RERL formulation team based on combination of AEPC data and data from Energy Development Services report.

Micro-hydropower status: Clearly, under AEPC and with donor support, there have been strong increases in the number of installed micro-hydro stations over the past decade. Table9shows the number of stations installed each year between FY2000/01 and 2009/10. During this period, the number of stations installed per year ranged from 34 to 98 and the average was about 54. In FY2010/2011, the number of installations jumped to 140, substantially larger than any year in the previous decade.

Village solar PV stations: PV stations that power a full village or a subset of villages through a micro-grid are not common in Nepal. The three such systems were installed in the late 80s through French Government development support: 30 kW at Kodari, 50 kW at Gamghadi, and 50 kW at Simikot for supplying electricity for basic lighting in these very remote areas. The Kodari project has been dismantled and remaining two projects are also not functioning properly. More recently, some efforts have been made to provide PV power to clusters of households (e.g. about 12 households) with a single 75 to 80 watt panel, though applications in these cases are also limited mainly to lighting. APV-wind hybrid village power system of capacity 2 kW solar PV and 1 kW wind has been installed in Nepal recently in Nawalparasi district (HurHure) to supply electricity to a village. The costs were found to be high and PV systems provide most of the power.

Institutional solar PV: Institutional PV refers to PV serving institutions, such as a hospital, health clinic, or a school. Common applications are refrigeration of vaccines, FM radio, and computers for schools, with the last application appearing to be by far the most common. According to AEPC data, up through July 2011, there were 299 institutional PV systems operating in Nepal spread across 42 of the nation's 75 districts. Of these, 210 were installed prior to mid-2006, with the other 59 installed since then. An important supporter of such systems over the past decade has been the EU's Renewable Energy Project (REP) between 2003 and 2012. The projects implemented under this project were 100% supported by grants.

During the two years FY2009/10 to 2010/11, thirty-eight such systems were installed.
Of these, 36, the vast majority, were installed in schools to facilitate computer use. The average size of these systems was 871 watts. The other two installations over those two years

were one for FM radio (1.5 kW) and one for a health clinic's refrigeration of vaccines (3.33 kW).

PV agricultural pumping: According to AEPC data, 81 solar pumping systems are operating in Nepal. Of these, 64 were installed prior to mid-2006, with the other 17 installed since that time. The systems are installed across 22 of Nepal's 75 districts. During the two years FY2009/10 to 2010/11, only two PV pumping systems were installed. Each was 1.5 kW.

Conclusion on status of off-grid renewable energy in Nepal: Findings with regard to off-grid renewable energy in Nepal provide insights that support the rationale of an off-grid rural renewable energy project generally and thosethat facilitate the design decisions to be made. First, off-grid renewable energy in Nepal has proven its ability to play a significant role in the country's overall power provision. It is making substantial contribution and has the potential to make more, particularly in remote areas where grid extension does not make sense. Further, unexploited potential inmost renewable energy segments is vast, particularly hydropower and solar PV with potential of wind being still unexplored for the lack of wind data. The current installed capacity reflects only a very small proportion of country's potential. Donor supports have proven to have played substantial role behind the development of Nepal's off-grid renewable energy over the past decade.

In terms of insights for project design, the predominant theme of the findings in this section is that off-grid renewable power development to date in Nepal has focused on the small size installation. The question is thus, whether moving towards the next step up in size will bring economies of scale, faster progress, wider coverage, and more income generating opportunities for local people. In particular, development of mini-hydro stations has been virtually dormant during past 20 years, while development of new micro-hydro stations has spear-headed. Installation of solar PV home systems (SHSs) has been vibrant, while village PV systems are rare and those cases that do exist tend to be limited to lighting or other very low power consumption activities. Institutional solar PV and solar PV pumping have seen more progress than village PV systems. Yet, experience and support is still much more limited compared to SHSs.

1.3 Productive-use of off-grid renewable energy

The frequently found enterprises in rural communities (where there is no grid/off-grid power) are agro-processing mills which generally include hulling, grinding and expelling. In some rural areas, water mills provide the grinding service; such water mills are generally owned and operated by marginal families in the community. In some other places, agro-processing mills are diesel powered. These mills are owned and operated by relatively well-off families. In some areas, hand-made paper enterprises are in operation which uses firewood for processing the raw materials. Income generating activities such as tailoring and rural carpentry are based upon human-power. Other enterprises such as knitting, basketry, etc. are also human-powered.

With the establishment of micro-hydropower systems in rural areas, the scenario for livelihood opportunities are changing. It is true that the electricity generated from micro-hydropower plants has been primarily used by households for lighting followed by operating few household gadgets like radio, TV and mobile. However, in many micro-hydropower sites, electricity-based enterprises have emerged contributing to the plant load factor as well as to the livelihood opportunities. The most frequent enterprises are the agro-processing mills such as rice mill and oil expelling mill. The existing diesel-powered agro-processing mills quickly switch to electricity. Other enterprises include poultry, dairy and those based on forest resources (e.g. saw mill, juice making). In addition, modern consumer services such as photocopying, communication centres, electric/electronic repair centres are also emerging quickly in many places. The power consumed by these enterprises generally range from 0.5 kW (poultry farm, photocopier) to 7.5 kW (rice mill). The total contribution to plant load factor from productive uses in micro-hydropower schemes could be substantial compared to total power available as could be perceived from the following examples from Baglung district. The first example is the Budhathok micro-hydropower plant (60 kW), which has been providing electricity to run several productive use enterprises in its service area, they include three units of grinder/huller mill (7.5kW each), 20 poultry farms (0.5 kW each), and three telecommunication towers (5kW each). The second example is the Nishi Khola I micro-hydropower plant (48 kW) supporting five grinder/huller mills (7.5kW each), 25 poultry farms (0.5kW each), one furniture (7.5kW), one photo studio (0.5kW), and one computer institute (1kW). Annex 6 shows the type of potential productive uses at micro-hydropower plants promoted by REDP and ESAP.

Despite such encouraging and emerging scenario, most of the micro-hydropower systems are observed to have low level of load factors, which is attributed to absence of adequate enterprise development in the vicinity of the these plants. According to one of the estimates, electricity produced from micro hydro is limited to around 19% for lighting purpose and remaining 11% for other activities[18].

According to Mini Grid Outlook[19], out of 261 manager level employees in 247 MHP, 54 are women. Similarly, out of 464 operators, 24 are women. A total of 1605 people have been employed after establishment of micro-hydro schemes (directly and indirectly through end-use of electricity), of which 206 are women. Impact study of 20Mini Grid Electrification (MHPs) was carried-out by AEPC/ESAP in 2011 and found that MHPs result in positive impacts for women in terms of their involvement in household decision making process. The study reported 2% increase in the involvement of women on decisions related to children's education, general health and female health. Likewise involvement of women on decisions related to household finance is found to be 4% points higher, and participation of women in social gatherings is 3% higher with MHP intervention.Though the compiled data does not

[18]Source: Final Report Analysis of Potential Enterprises in Area Electrified by Micro-Hydropower, AEPC, August 2012
[19] Mini Grid Outlook (1999 to 2012), AEPC/ESAP, 2012
[20]Impact of Mini Grid Electrification, AEPC/ESAP, 2012

exist, a REDP document[21] claims achieving increased number of women managed enterprises having been witnessed in the program areas.' Case studies are presented on successful women-managed rural carpentry business in Kavre district and local community comprising of indigenous people, other ethnic communities and Women's Cooperative owned and operated 100 Watt FM station established in Kharbang, Dagatung Danda VDC in Baglung.

Compared to micro-hydropower plants, the mini-hydro systems are expected to offer greater opportunity for enterprise development, for instance, due to availability of abundant and more reliable power. In the demonstration mini-hydro projects, a number of potential enterprises are expected to emerge soon as power becomes available. For example, in the proposed MewaKhola Mini Hydropower Project (500 kW), altogether 48 potential enterprises have been identified. These enterprises include agro-processing mills, rural carpentry, bakery, metal works, computer labs& and photo copying centres, etc. Of the estimated total consumption of 1,864,740 kWh/year, about 32% is expected to be used for productive use load from these potential enterprises. Over the years, this figure could increase substantially if the productive end-use promotional activities are implemented. Similarly, in Giri Khola Mini Hydropower Project (210 kW), demand of electricity for agro-processing mills, hotel and grocery shops, rural carpentry, computer centre and cable network service have been identified contributing to a load factor of around 200 kW. In Upper Junbesi Mini hydro project, the most likely productive use of electricity is by hotels. Out of 20 existing hotels, 10 hotels are expected to use electricity on much regular basis and in substantial quantity for cooking, room heating, electric geysers, air conditioners and other appliances. Two *Gumba*[22]*s* are also expected to use electricity for cooking and water heating.

There are several energy-based enterprises owned and operated by women. Many of these have provided employment to a number of women. With the incomes from such involvements, studies have shown that women's involvement in decision making relating to household finances have improved.

The electricity of solar PV systems, particularly, the solar home systems, is also used mainly for lighting and charging mobile. Operation of TV with bigger solar home systems (say 60+ Wp) is also sometimes reported. With a bigger sized solar PV system, the productive use scenario could be improved. For example, the solar mini grid electrification project (10.5 kWp) in Gauda village of Saptari district is planned to provide electricity lighting to 40 households and also provide opportunity for operating low watt fans, TV and other electrical appliances along with a 1 kW hulling machine[23].

1.4 Barriers to Energy Access and to a Low Carbon Development Path

Off-grid systems are currently the preferred solution for bringing electricity to the 40% of Nepal's rural households that lack access to power. They offer a solution that, due to the

[21] Achievements of REDP, REDP, 2011
[22] Buddhist monastery
[23] Source: Feasibility Study Report On Solar Mini grid Electrification Project GobarGauda, Saptari, AEPC, May 2012

prohibitively high cost of grid-extension to remote mountain areas, institutional barriers to grid extension to less remote un-electrified rural areas, and extensive load-shedding, the main grid cannot. Renewable off-grid systems in particular offer the means to achieve energy access on a low-carbon path. Further, having a reliable source of electricity and large enough installed capacity, could present new income-generating opportunities

Yet, despite advances with micro-hydro and other forms of off-grid renewable energy, such as solar home systems, progress in reaching the rural population without electricity has been slower than targeted. For example, due to various challenges, micro-hydro plants can take three years to construct. In addition, in the case of the estimated 15per cent of the rural population with access to off-grid renewable power the electricity end-uses are generally limited to domestic lighting and small appliancedue tolow capacity systems. Consequence is the limited revenue resulting in lack of funds for proper repairs and parts replacement.

In assessing the challenges to increased energy access and achievement of a low-carbon development path in rural areas of Nepal still lacking electricity, key barriers are identified and overarching thematic areas are developed. The thematic areas that emerged from the barrier analysis are: (1) physical access issues, (2) affordability (upfront cost) issues, (3) financial sustainability (cash flow for systems maintenance and repair), (4) technical capacity for less disseminated technologies (such as mini-hydro and larger scale PV), and (5) lack of awareness of the potential benefits of less disseminated technologies. Lack of favourable policy (particularly for less disseminated technologies) was also highlighted in the analysis.

Further findings from the barrier analysis with regard to these thematic areas are as follows: Due to insurmountable costs of grid-extension to remote inaccessible areas, off-grid systems are seen as the means for addressing the first thematic area, physical access issues. Off-grid renewable systems in particular allow access while enabling a low carbon development path and replacement of emission emitting fuels. As for affordability issues, the second thematic area, these stem chiefly from (a) lack of capital for investment, (b) high costs of systems, and (c) low household disposable income. Sustainability issues of installed systems (particularly community systems), the third thematic area, result from (d) low utilization and the particularly low level of productive uses of electricity. Productive uses,were they exist in abundance, could help sustain systems through tariff revenues, with businesses possibly being charged higher rates than households. Further analysis below focuses on the subthemes of (a), (b), and(c) and (d) combined, as well as addressing the themes of (e) lack of technical capacity and (f) lack of awareness.

Cost issues: High costs of technology are due to several issues. First, high transport costs are endemic to Nepal's challenging, mountainous terrain. The predominant focus to date on smaller scale off-grid systems means that economies of scale are not leveraged. Further, both construction materials and renewable energy system technologies have high costs, partly due to the necessity of imports. When domestic options are available, these are not always cheaper than imports. Efforts to date to localize technology may not have sufficiently assessed Nepal's potential areas of competitive advantage. Also, domestic manufacturers of

components that may potentially be cost-competitive lack the scale needed to achieve their own economies of scale and serve the needs of a strong pipeline of projects. Further, lack of technical skills and knowledge may actually serve to keep costs high and slow the pace of manufacture and installation. The foregoing issues apply to both off-grid hydropower and off-grid solar PV technologies (together, the focus of this project as explained in Section 2.1). PV technologies, despite great reduction in cost in recent years are still more expensive than off-grid hydropower.

Cost estimates per installed capacity vary by source, but generally show Nepal's costs are higher than those of nearby countries. Below in Table, the range of costs and estimated average cost per kW for micro-hydro installed capacity are given by country. These estimates are provided in an AEPC-commissioned study. The study concludes that current micro-hydro plants built under AEPC are too small and that cost reduction potential exists. Scale of planned installations is determined by an agreed amount of installed capacity per household multiplied by the number of households. It does not take into account potential increases in consumption over the years and does not allow substantial income-generating applications. Further, the resulting small station capacities are not cost effective for grid connection once the grid does arrive. The study emphasizes the need for modernization, specialization, and standardization in the local manufacturing sector. It recommends that tender procedures undergo serious review and that the industry be transformed from a project-by-project "artisanal" approach to a viable industry. For example, a supplier of parts could be asked to supply standardized parts for ten stations at a time rather than on a one-by-one basis.[24]

Table14: Comparison of Up-front Micro-hydro Cost per kW Installed

Country	Cost range (per installed kW) in USD	Average cost (per installed kW) in USD
Nepal	4,000 – 14,000	8,000
China	1,000 – 6,000	3,000
India	2,000 – 6,000	4,000
Sri Lanka	2,000 – 5,000	3,000
Vietnam	1,000 – 20,000	3,000

Source: *Micro-Hydropower in Nepal: Enhancing Prospects for Long-term Sustainability*, Alex Arter, November 2011.

From Table, it is clear that attention needs to be paid for reducing the cost of off-grid hydropower in Nepal. One of the options to reduce the costs, the report concludes, may be to choose Chinese equipment even if it is usually linked to higher routine Operation and Maintenance (O&M) costs. The study also found that up-front costs of micro-hydro stations had increased 50% in Nepal in recent years, necessitating the increase in level of subsidy provided and thus reducing the total number of villages that can be assisted. Finally, the study suggests that detailed standardization following the Chinese model may provide the best potential for lowering domestic manufacturing costs.[25]

[24]*Micro-Hydropower in Nepal: Enhancing Prospects for Long-term Sustainability*, Alex Arter, November 2011.
[25]Arter, Ibid.

Other studies assume the potential for a lower average cost per kW going forward. For example, Clemens et al in a 2010 UNDP-AEPC study project that required investment for reaching the target of an additional 150 MW of off-grid hydropower is a "financially modest" USD 435 million or about USD 70 per beneficiary. This estimate implies an average up-front cost of installed power of USD 2,900 per kW. The USD 8,000 per kW indicated inTable14 seems too high based on the prices quoted for some recent projects. Currently costs appear to vary between USD 4,000 and USD 6,000 per kW.

Financing issues: Related both to high costs and to low system income once installed, difficulty in getting systems financed is probably the overriding barrier facing increased energy access through off-grid renewable energy systems. Both financial institutions providing credit and equity investors are averse to the risk presented by off-grid renewable systems. They lack ability to evaluate the risk, but at the same time have reasonable concerns about the commercial viability of systems. Financial tools and policy mechanisms could be ways to address some of these issues, but such financial tools are mostly absent and the policy framework incomplete to address systems of various scales and technologies. Indeed, subsidy policies tend to be biased towards smaller systems, thus inhibiting the cost benefits that might be achieved from the economies of scale of larger systems. Further, there is an absence of precedence – of systems financed in a commercially viable fashion -- so that financial institutions and equity investors are especially hesitant to finance projects.

To date, most off-grid renewable power systems in Nepal have been developed with subsidy from the government and/or donors. Currently, the Government of Nepal's Alternative Energy Promotion Centre (AEPC) with support from various donors provide subsidy to these projects accounting for about 40% of the costs. Yet, even this level of subsidy has so far not been adequate to spur development to the pace AEPC now targets for the sector. The other 60% of the financing is typically provided by the developer (via debt and equity financing) and community/rural electric cooperatives, which generally provide part of their equity contribution in-kind through labour.

Details on the subsidy system are provided in the discussion on policy presented in Section 1.4, with the recently revised subsidy scheme (2013) presented in Table 15 (off-grid hydropower) and Table16(PV). While the new subsidy policy has improved the situation in some ways, it continues to be biased towards smaller systems or those that provide less capacity of output per household. Thus, the preferred systems under the subsidy model are precisely those less suitable for income-generating activities. At the same time, the subsidy policy provides for an additional productive use subsidy, but this is much less on a per kW basis than the maximum subsidy that can be achieved by low per capita capacity systems. Finally, the revised version of the policy (2013) specifically states that subsidies will only be for community financed systems, thus instituting a new policy barrier for private sector financing of such systems.

Credit-providing financial institutions' reluctance to get involved in the financing of off-grid renewable energy systems can be divided into economic and non-economic reasons. Some of the economic reasons for their hesitance in the case of community systems include lack of productive end users and low load factor, poor repayment track record, dealing with low income households, credit worthiness of rural households served, problems in tariff collection, and high overheads associated with smaller loan portfolios. In addition, the remote location of sites, difficulty in monitoring project development, lack of technical and administrative human resource in rural areas, and political instability are some of the non-economic considerations that keep financial institutions from participating in the sector. Also, their lack of knowledge on market opportunities in the renewable energy sector and how to set up a framework for future carbon finance activities hinders the development of appropriate loan products for the sector.

Many of the reasons for the hesitance of private sector equity investors to invest in off-grid renewable energy projects are similar to those that make banks hesitant to extend credit to such projects. Equity investors will be most concerned about confirming commercial viability. Therefore, precedents demonstrating such viability will be important to them. Triple-bottom-line funds[26], impact-financing, or similar investors may serve as a transition to attracting other equity investors to the sector through their support of initial projects. To date, however, even these players have either yet to be convinced of commercial viability or perhaps even made aware of opportunities.

These headwinds notwithstanding, financial institutions that provide credit have been participating in a limited way in the development of the sector. ADBL (Nepal's Agricultural Development Bank Limited) was the first commercial institution to provide commercial financing in off-grid hydropower systems in Nepal, starting with credit provision to such projects in the 1980s. The bank as of end of FY2008-09 had invested about USD 2 million in 1,084 projects with a total installed capacity of about 6.3 MW. The establishment of the Clean Energy Development Bank, a bank focused on renewable energy, which has the aim of providing affordable and flexible financing solutions to exploit the potential of off-grid hydropower, is a positive development for the sector.

Financial sustainability and utilization: Even highly or fully subsidized systems may face issues of long-term financial sustainability in the absence of on-going revenues to pay for system repair, maintenance and parts. Yet, utilization levels (and therefore revenues collected) tend to be low. Low utilization stems both from peoples' lack of ability to pay and the absence of excess system capacity that could meet needs beyond minimal daily consumption. Productive applications – use of energy for income-generating purposes – could be a way to increase utilization and therefore the income and financial sustainability of systems, but more

[26]Triple-bottom-line is intended to advance the goal of sustainability in business practices. The three measures include: profit (the economic value created by the company, or the economic benefit to the surrounding community and society), people (the fair and favorable business practices regarding labor and the community in which the company conducts its business) and planet (the use of sustainable environmental practices and the reduction of environment impact).

excess power would be needed than is the norm with most systems being installed in Nepal today.

A recent AEPC-commissioned study found that over 50% of 26 micro-hydro sites assessed lacked financial sustainability. In the study, "financial sustainability" is defined as having actual cash flow greater than expenditures on repairs and maintenance. The study concluded that larger systems are more likely to be sustainable. The study also concluded that to increase sustainability, tariffs should be collected based on consumption (rather than collecting a monthly flat fee), productive end-use should be encouraged, and larger schemes should be promoted.[27]

Improving the cash-flow of mini-hydro projects will require a sustainable increase in system load from productive applications which will further require the development of enterprises and uses that are themselves financially viable. Entrepreneurs will not only need to know how to produce their product or service well, they will also need to have financing to start their businesses and market linkages to ensure these are successful. The decision of what to produce in the first place will, in addition, need to be a wise one. So far, while there has been some effort at promoting productive applications at micro-hydro sites, impact has been limited. The small scale of these systems means that the productive applications cannot have too large an energy requirement. Further, work to date has been mostly ad hoc.

To achieve a higher level of productive use, a more systematic approach is needed. Such an approach should ensure: (1) appropriate selection of productive use sector, (2) capacity building or information access in that sector if needed, (3) micro-financing of productive applications, and (4) the development of market linkages. On the financing side, an important issue is that many of the more remote locales (classified as Hilly and Mountainous) are not covered by micro-finance institutions. These locales may have local cooperatives that offer limited credit, but work is needed to enable these organizations to operate more fully as financial institutions or cooperate with micro-finance institutions and banks from less remote areas.

By promoting productive end-use of energy, it will not only address the financial sustainability of off-grid renewable energy systems, it will also address two other major issues faced in rural Nepal -- low agricultural productivity and limited off-farm employment opportunities. While agriculture accounts for only about 35% of GDP, an estimated 75% of the population is engaged in the sector.[28] Increasing productivity in agriculture is a key challenge. Therefore, a productive applications strategy should consider the basic economic situation of rural communities in Nepal and address related barriers. Experts see a greater need and potential for irrigation and vertical lifting of water, an area that renewable energy systems could well support.

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[27] *Micro-Hydropower in Nepal: Enhancing Prospects for Long-term Sustainability*, Alex Arter, November 2011
[28] *Nepal Economy Profile 2012*, Index Mundi.

Likewise, productive use enterprises, particularly those of scale, could generate off-farm employment opportunities. Currently, the "brawn and brain drain," the out-migration of Nepalese, especially youth, for mostly unskilled or semiskilled employment in foreign countries, continues unabated. This trend is attributed to the lack of sufficient job opportunities in Nepal. Remittances from Nepalese working overseas, which account for 22per cent of gross domestic product, generate more foreign exchange than exports.[29] There is an urgent need to create domestic employment opportunities, especially for the poor and deprived in rural areas, and to counter declining productivity and production caused by migration. Some case-stories published in media, demonstrates earnings in Nepal can be equally competitive

Technical capacity and lack of awareness: Technical capacity and lack of awareness are also important thematic areas in assessing barriers to the adoption of renewable energy technologies in Nepal. Inadequate technical capacity is a contributing factor to high costs. Therefore, developing standards, building capacities for cost-competitive domestic manufacturing of appropriate parts, and enhancing capabilities of installers and other service personnel will help in reducing costs.

While analysis implies cost-advantages and greater potential for income-generating opportunities from larger scale systems, such as mini-hydro and village PV, awareness of these advantages is lacking. Thus, emphasis is focused on replicating achievements with smaller scale systems (micro-hydro and SHSs) without recognizing the potential long-term advantages of larger systems. Increasing awareness among policy makers, donors, and local communities will be important to ensure that full consideration is given to the options of various locales in developing off-grid power systems. Further, to address financing barriers discussed above, awareness of financial institutions and equity investments needs to be raised. They need to be educated on the risks and benefits of such systems and need to see demonstration of financial viability and related models before their support can be obtained.

1.5 Policy and Institutional Environment for Renewable Energy

This section discusses the Government of Nepal's institutions, policy, and targets related to off-grid renewable energy. The Alternative Energy Promotion Centre (AEPC), under the Ministry of Science, Technology and Environment is the key government organization for the nation's off-grid renewable energy efforts. There are two key policies, the Rural Energy Policy of 2006 (much of which is still yet to take effect through the promulgation of associated acts) and the Subsidy for Renewable (Rural) Energy. The latter was first issued in 2006, a revised version was issued in 2009, and a second revised version currently (as of February 2013) in draft form with finalization expected soon. In terms of targets, the Government has both long-term (20-year) targets for renewable energy in general and

[29] *Developing countries to receive over USD 400 billion in remittances in 2012, says World Bank report*, World Bank press release, Nov. 20, 2012.

medium-term (5-year) targets for off-grid renewable energy to be achieved under AEPC's National Rural Renewable Energy Program (NRREP). More details on institutions, policy, and targets are given in the sub-sections below.

1.5.1 National institutions relevant to off-grid renewable energy

Compared to on-grid large hydropower projects, smaller off-grid systems face less bureaucratic barriers and benefit from the focus of responsibility in a single organization, AEPC. Yet, inadequate government institutions in rural areas present obstacles to rural communities wanting to adopt renewable energy technologies.

For off-grid systems, the Alternative Energy Promotion Centre (AEPC), under the Ministry of Science, Technology and Environment, (MoSTE), is the key government body. MoSTE promotes the sustainable development of the country through environmental protection. The AEPC is an autonomous institution under this Ministry. Established in 1996 for the development and promotion of renewable and alternative energy technologies in Nepal, AEPC's overall objective is to popularize and promote the use of renewable energy technology to raise living standards of the rural people, to protect the environment, and to develop commercially viable alternative energy industries. AEPC is also hoping to bring livelihood improvements to rural citizens by promoting small industries and enterprises based on alternative energy technology. To achieve the foregoing, AEPC helps the Government formulate national policies, plans, and programs on renewable energy and facilitates their implementation. Since its establishment, AEPC has been implementing sector support activities such as subsidy disbursement, human resources development, monitoring, studies, etc. It is also responsible for quality control, monitoring, and evaluation work.

AEPC strives to serve as a one-stop shop for stakeholders, including the community, entrepreneurs, suppliers, and consultants. It is involved in raising awareness of and promoting renewable energy systems, providing the credibility needed to attract donor funding, administering subsidies, and setting standards and guidelines for quality assurance.

AEPC has been implementing renewable energy projects with support from bilateral and multilateral development partners, including ADB, Danida, DFID, the EU, KfW, Norwegian Ministry of Foreign Affairs, SNV, UNDP and the World Bank. The implementation modality for most of these projects in the past has been that development partners have individually or in groups supported different projects implemented by AEPC. Based on these experiences, the Government and development partners have now agreed to jointly implement a single program modality to support the Nepalese renewable energy sector. The modality is known as the National Rural Renewable Energy Program (NRREP), and specific components of this program will form part of the baseline activities of the proposed UNDP-GEF RERL project.

Other government agencies or authorities related to renewable energy in Nepal include the following:

- Ministry of Finance: Responsible, among other things, for allocation of national resources, management of public expenditure, mobilization of both internal and external

resources, and performance of public investments. All government allocations and donor assistance for the off-grid renewable energy sector are managed by this Ministry.

- Ministry of Local Development: Responsible for strengthening the governmental system for local bodies. It works to enhance decentralized institutional arrangements for local development from different aspects.

- Nepal Electricity Authority (NEA): As the government utility, plans, constructs, operates and maintains generation, transmission, and distribution facilities in Nepal's power system. It also purchases power from private developers and exchanges power with India to meet the nation's needs. In the past, NEA has installed some off-grid systems, but these operate at substantial loss. As a result, new ones are no longer being pursued. Some of the systems built are either not operating or have been leased out to private parties. NEA at this point has no interest in pursuing off-grid systems and is generally not considered relevant to off-grid projects unless such projects hope to connect to the grid in the future. Yet, having leased out some of its old mini-grid systems, it may be interested in leasing out more over time.

- Ministry of Energy: Oversees the development and management of national grid-connected electricity systems and, as such, is not relevant to off-grid projects. The Ministry, however, is responsible for utilization and management of water resources of the country, especially for electricity production and management.

1.5.2 National Policies directly relevant rural off-grid energy

The two key legislative instruments for rural off-grid renewable energy are the Rural Energy Policy (2006) and the Subsidy for Rural (Renewable) Energy (2000), with revisions in2006, 2009, and 2013).In addition to these two key legislative instruments, other potentially relevant policies, acts, and ordinances include: The Hydropower Policy and associated Electricity Act of 1992, the Local Self Governance Act, the Hydropower Policy of 2001, and the Financial Ordinance of 2005. Below we review the two key instruments, as well as briefly introducing the others.

<u>The Rural Energy Policy 2006</u>: The Rural Energy Policy aims to promote clean and reliable energy for poverty reduction and environmental conservation. It seeks to do this by supporting increased access, linking rural energy development with employment creation, and promoting use of rural energy for social and economic activities. It promotes decentralization in the planning, implementation, monitoring, and evaluation of rural energy development. It further promotes more involvement of the community, local bodies, non-governmental organizations, and the private sector. It fosters the establishment of central and local rural energy funds, capacity building at all levels, increased focus on use of energy for socio-economic activities, and strong linkages with other sectors like health, education, irrigation, drinking water, small and medium enterprises, and ropeways. The policy tries to integrate into one policy document various aspects of rural energy development in Nepal like subsidy policy, resource mobilization, human resources development, and institutional mechanisms.

Yet, the Rural Energy Policy has not yet been fully enforced with a corresponding Act.

Despite the many legislative items in its contents that deal with renewable energy systems, only the Subsidy for Rural (Renewable) Energy (issued to address one of the Policy's legislative items) and the Financial Ordinance (discussed below) have in practice played a significant role in increasing private sector participation in renewable energy technologies. Formulation of acts to support the Policy are, nevertheless, said to be actively underway.

Subsidy for Renewable (Rural) Energy 2000 (revised 2006, 2009 and 2013): The Subsidy for Renewable Energy is integrated with the subsidy provisions mentioned in the Rural Energy Policy, creating legal obligations to support the subsidy aspects of the Policy. There have been three revisions since the original version was issued.

The aim of the Subsidy is to accelerate the adoption of renewable energy technologies in Nepal and it has been doing so over the past several years. The Subsidy policy has also provisions to support wind-solar hybrid stations and small independent wind turbines, though the amounts of subsidies for wind-related projects are not specified. The Subsidy lacks provision for support of village-scale PV systems when these are not part of a wind-PV hybrid village system.

Government subsidy levels over the last 12 years for off-grid hydropower are provided in Table and Table16. The current subsidy for equipment and installation is determined on per household basis as well as on per kW basis (capped by households per kW and subsidy per kW). Thus, the preferred systems under this subsidy model are less suitable for income-generating activities due to the above ceilings. There is an additional provision for subsidy for productive uses, but the amounts specified are inadequate for promoting wide range of productive end-use applications.

Subsidies are also available for solar home systems, small solar home systems, institutional PV systems, and PV water pumps. There is currently no subsidy for village-electrification systems, clearly a disincentive for development of such larger systems. Further, for each of SHSs, institutional PV systems, and solar water pumps, the subsidies have a cap related to scale or total price, thus posing a disincentive to larger systems. The subsidy for SHSs is capped at a fixed level for systems over 50 W. Institutional PV systems are subsidized at 75% of cost, but at a maximum of 1,000,000 Nepal Rupees (or about USD 11,500). Solar water pumps have a more generous subsidy for larger systems, but this is still capped at NPR 1,500,000 (about USD 17,250).

The subsidy policy has been one of the most important government initiatives providing incentive for attracting companies (mainly mechanical manufacturers and installers) to the renewable energy sector. These subsidies, however, have to date been mostly donor funded and prone to donor funding interruptions. This has had an extremely negative effect on the sector, because uncertainty is created and customers tend to wait for the subsidy even if they

are capable of installing systems without subsidy. The Government has not been successful in its policy of gradually reducing the subsidy. While donors plan to support continuation of the subsidy over the short to medium term (next five years), their longer term interest is to replace subsidy fund provision with provision of revolving credit funds.

In spite of some positive move in favour of larger energy systems in the 2013 revisions, the current subsidy policy still favours smaller systems. This bias is considered necessary to make the policy pro-poor. Yet, the bias works against larger systems that may bring income-generating opportunities and thus revenue for the energy systems, which would be positive in terms of system financial sustainability. Further, the recent revision of the Subsidy Policy (2013) has made the development of renewable energy less favourable for the private sector. For example, the subsidy for development of mini-hydro (larger than 100 kW, but less than 1 MW) is available only if the system is developed or owned by the community or cooperative. This was not the case in the past. Table15 and Table16 show how subsidies for micro and mini-hydropower and solar PV systems, respectively, have evolved over past 13 years through three revisions.

Table15: Summary of Subsidy Arrangements for Micro/Mini-hydro through various Revisions of Subsidy Policy

All amounts in NPR

Capacity	2000	2006	2009	2013
Pico Hydro	55,000/kW (up to 3 kW)	8,000/HH but maximum 65,000/kW (up to 5 kW)	12,000/HH but maximum 97,500/kW (up to 5 kW)	Subsidy/HH: 15,000[a], 14,000[b], 13,000[c] Subsidy/kW: 90,000[a], 80,000[b], 60,000[c] Not exceeding/kW: 165,000[a], 115,000[b], 125,000[c] (up to 10 kW)
Micro/Mini (3 to 100 kW in 2000 and 5 to 500 kW in 2006 & 2009)	70,000/kW (3 to 100 kW)	Up to 10,000/HH but not exceeding 85,000/kW (5 to 100 kW)	15,000/HH not more than 125,000/kW (5 to 100 kW)	Subsidy/HH: 25,000[a,b,c] Subsidy/kW: 130,000[a], 100,000[b], 70,000[c] Not exceeding/kW: 225,000[a], 225,000[b], 195,000[c] (/kW subsidy will be based on minimum 5 HH per kW)(10-100 kW)
Community/Cooperative owned Mini hydro	-	-	-	Subsidy/HH: 20,000[a], 18,000[b], 16,000[c] Subsidy/kW: 120,000[a], 100,000[b], 70,000[c] Not exceeding/kW: 220,000[a], 190,000[b], 170,000[c] (/kW subsidy will be based on minimum 5 HH per kW)(100 to 1000 kW)
Rehabilitation of MHP more than 5 kW	50% of the cost or Maximum 35,000	Up to 10,000 per incremental HH but not exceeding 85,000 /kW	50% of installation cost no more than 62,500 /kW	Minor Damage: Up to 10,000/kW, Maximum 200,000 per plant Major Damage and Rehab of old system: Up to 50,000/kW Maximum 1,000,000
MHP for institutional and community use			97,500/kW Plant up to 5 kW	Subsidy/kW: 130,000[a], 100,000[b], 70,000[c]
Additional subsidy for transportation of equipment and material of the MHP project	21,000/kW (distance more than 5 days) 8,750/kW (Distance of 2 to 5 days)	Nearest road head: more than 50 km: 3,000/HH 25-50 km: 1,200/HH	500/km/kW not exceeding 30,000/kW	-
Additional financial support for productive use of energy			10,000/kW but not exceeding 250,000 per project	Maximum of 100,000 per individual enterprise or 30% of investment Maximum of 300,000 per community enterprise or 50% of investment

Note: [a, b, c] are VDCs categorised by the Government; For all the projects getting transportation subsidy, the subsidy amount will be calculated as 1 kW per 8 households maximum

Source: Subsidy Policy for Renewable (Rural) Energy 2000, 2006, 2009, and 2013

Table16: Summary of Subsidy Arrangements for Solar PV systems through various Revisions of Subsidy Policy

All amounts in NPR

Type		2000			2006			2009			2013		
1	Solar Home System	10 Wp	20 Wp	>30 Wp	10-18 Wp	> 18 Wp	5 Wp WLED Based	10-18 Wp	> 18 Wp	5 Wp WLED Based	< 10 Wp	20-50 Wp	>50 Wp
	Category A	Additional 50% of category C			7,000	10,000	50% or NPR 1250 whichever is less	7,000	10,000	2,000	5,000	7,000	10,000
	Category B	Additional 25% of category C			6,000	8,000		6,000	8,000		4,800	6,200	9,000
	Category C	50% of the cost not exceeding NPR 8,000[30]		8,000	5,000	6,000		5,000	6,000		4,500	6,000	8,000
Category Description													
	Category A	VDCs Category A by GON			Karnali and adjoining districts[31] and VDCs Category A by the GON						VDCs Category A by GON		
	Category B	VDCs categories as Category B by GON											
	Category C	Remaining Districts			Accessible VDCs						VDCs Category C by GON		
2	Institutional Solar PV System and Solar Water Pump												
	Subsidy for public institution	75% of the cost			75% of the cost			75% of the cost			75% of the cost not exceeding 1,000,000		
	Subsidy for lighting of public places							75% of the cost not exceeding NPR 15,000			Same as Solar Home System		
	Subsidy for solar PV Pumping	75% of the cost up to 500 Wp			75% of the cost up to 1000 Wp			75% of the cost not exceeding NPR 1,000,000 for 1.5 kWp			75% of the cost not exceeding 1,500,000 (Community based only)		

Source: Subsidy Policy for Renewable (Rural) Energy 2000, 2006, 2009, and 2013 GON

[30] The subsidy amount will be reduced every year by 10% for >30 Wp of category C and it was done till 2005

[31] Humla, Jumla, Kalikot, Dolpa, Mugu, Rolpa, Rukum, Jajarkot, Bajhang, Bajura, Achham, Dailekh, Darchula

1.5.3 Other relevant policies, acts, and ordinances

- Hydropower Policy of 1992: A pioneering effort of the Government to attract private sector investment in hydropower, the policy delineates specific incentives for promoting hydropower. Yet, the challenge of increasing access of the poor to electricity is not addressed in the policy.

- The Electricity Act of 1992: Provides legal teeth to the provisions of the Hydropower Policy of 1992. Yet, it does not address off-grid renewable energy development at all.

- The Local Self Governance Act of 1999: Gives local bodies the right to manage micro-hydro and other energy programs. This Act also established the right of a local body over natural resources within its territory. There are still, however, ambiguities related to the authority of the national versus local governments in terms of use of hydropower resources and imposing taxes, royalties, and fees for this.

- Hydropower Policy of 2001: Further specifies facilities and incentives to attract private investment and accelerate rural electrification. The policy envisages the establishment of a Rural Electrification Fund. It also specifically stipulates that part of a1% royalty from hydropower plants above 1 MW will be provided for rural electrification to the Village Development Committee (VDC) affected by the hydropower infrastructure. Specifically, 50% of the royalty goes to local governments. 12% out of the 50% goes to the district(s) where the plant is located and 38% to the other districts in the zone where the plant is located. (Nepal is divided into 14 zones and 75 districts.)

- Financial Ordinance of 2005: Provides a customs duty exemption facility for renewable energy systems. Yet, there are no tax exemptions for micro-hydro plants or their accessories. This is mainly because components for micro-hydro (such as generators, steel sheets, and ball bearings) can also be used for other applications.

- Financial Ordinance (decreed annually): Has been providing customs duty and Value Added Tax exemptions for renewable energy systems. Yet, the micro-hydro has been unable to make use of these provisions. This is mainly because of the complication that parts used in the manufacturing of micro-hydro (such as generators, steel sheets, ball bearings, etc.) can also be used for other applications. Solar PV and solar thermal system imports, in contrast, are benefitting from these provisions.

1.5.4 National Plans and Targets Related to Renewable Energy

The long-term national goal of the Government of Nepal is to supply at least 10% of total primary energy consumption in the country from renewable energy within 20 years. In addition, the 20-year targets call for an additional 30% of the population to be electrified through renewable energy applications by installing at least one renewable energy-based system in every household. (Given that about 33% of the population today lacks access to electricity, this target implies most of that group would get access to power through renewable sources within the next 20 years). A master plan for renewable energy in Nepal

over the next 20 years is currently being formulated and is expected to include revised targets.[32]

The Government of Nepal has endorsed the Millennium Declarations, and thus is committed to meeting the Millennium Development Goals. Under the target to reverse the loss of environment (Target 9), one indicator has been included for Nepal regarding rural energy. The indicator is the proportion of the population using wood as their main fuel. This indicator has dropped from 75% in 1990 to 68.4% in 2009.

The Government has also joined the UN Secretary-General's Sustainable Energy for All initiative in mid-2012. Thus, the Government has committed to achieve universal modern energy access for all Nepalese citizens, double the rate of energy efficiency improvement, and double the share of renewable energy in the total primary energy supply by 2030.

Medium-term targets for off-grid renewable energy are included as a part of NRREP and represent targets to be achieved over the program's five-year lifetime. Targets are given in Table17 below. Targets are ambitious and in most cases far exceed the rates of installation or renewable energy technologies achieved in the past.

Table17: Nepal's Five-Year Off-Grid Renewable Energy Targets, also the Targets of the Five-Year NRREP Program (FY2012/13 – FY2017/18)

Technology or Application	Target
Mini and micro-hydro power	25 MW
Community electrification	150,000 households benefitting
Solar home systems	600,000 systems
Productive uses of renewable energy	1,300 new MSMEs established, employment increased by 19,000

Source: *NRREP Nepal Program Document*, June 2012, Government of Nepal and core donors
Note: MSMEs are micro, small, and medium sized enterprises, in this case facilitated by the availability of electricity or other energy from off-grid renewable energy systems.

1.5.5 Policy Environment on Productive Use (Energy Based Enterprises)

Over the last decade, the concern - 'productive use of renewable energy' - has gradually gained policy prominence including in the development plans. While the periodic plans have lagged, the Rural Energy Policy (REP) 2006 and renewable energy subsidy policies have given increasing attention to promoting productive use of renewable energy. At par with this, in the Industrial Policy 2011 has also recognized the need to promote productive use of renewable energy, which was lacking in the Industrial Enterprises Act 1992. Most of the productive uses of renewable energy fall under the micro enterprise category as defined by the Industrial Policy 2011.

[32] *Economic Survey: Fiscal Year 2011/2012*, Ministry of Finance, Government of Nepal, 2012

The prevailing Industrial Enterprises Act 1992 defines cottage industries as traditional industries utilizing specific skill or local raw materials and resources that are labour intensive and practiced traditionally and are often linked to art and culture. The cottage industries also cannot employ electric machines beyond five kilowatts. Another category of industry is small-scale industry that is defined as having fixed asset of up to an amount of thirty million rupees. The Act has no separate definition for micro enterprises.

On contrary to Industrial Enterprises Act 1992, the Industrial Policy 2011 has introduced the category of micro enterprises. Micro enterprises are defined as enterprises with an investment up to 2 hundred thousand rupees (excluding land and buildings) and employing less than 10 kilowatts of power (electrical/mechanical) and are tax (including custom duty and VAT) exempted.

The Tenth Plan (2002-2007), which is also the Poverty Reduction Strategy Paper for Nepal, considered alternative energy as a powerful tool for alleviating poverty, poverty alleviation being the sole target of the Plan. The Plan set a broad strategy to give priority to the alternative energy to be carried out in an integrated manner ensuring the economic, social and environmental sustainability. While the Plan visualized the linkage between alternative energy and socio-economic development, it lacked concrete provision for promoting productive use of alternative energy. The trend continued in the successive Three-Year Plan (2007-2010). A relatively higher prominence of productive use in Three-Year Plan (2010-2013) which has an objective statement for productive use of renewable energy as part of the socioeconomic activities of rural communities.

The Subsidy for Renewable (Rural) Energy, 2000 and its revision in 2006 had no provision of subsidy support for productive uses of renewable energy. They were heavily focused on increasing access of rural people to alternative renewable sources of energy. However, as can be seen from the 'Guidelines for Detailed Feasibility Studies of Micro-Hydro Projects', AEPC has been encouraging developers since as early as 2004 to consider productive uses as one of the strong feasibility criteria

The Rural Energy Policy 2006, emphasized on the efficiency of rural energy technology through increased and diversified productive end-use. Mini and micro hydro projects were recognized to be having potential for integration with irrigation, education, health, drinking water, small-scale industry, ropeways and the operation of various enterprises at community and institutional level.

The diversified entrepreneurial use of rural energy for food processing, household equipment, agricultural equipment, irrigation, and drinking water is encouraged in addition to cooking and lighting uses. The policy also envisages subsidy supports to productive uses of the renewable energy which has been realized through successive upward provision of subsidy to productive use of renewable energy in revisions of the Subsidy Policy for Renewable energy in 2009 and 2013. Accordingly, as per the latest Subsidy Policy for Rural (Renewable) Energy, 2013, the enterprises using mini hydro power are eligible to get 30% (but not

exceeding NPR 100,000) of the total investment cost for energy conversion and processing equipment, and/or hardware part of the enterprise. In case of community owned enterprises, the subsidy rate is 50% but not exceeding NPR 300,000. There is also additional subsidy (10% but not exceeding NRP 10,000) for enterprises owned by single woman, widow, vulnerable community, backward, disaster victim, poor and endangered ethnic group. The supports are targeted to micro enterprises as defined in the Industrial Policy 2011.

The National Rural Renewable Energy Program (NRREP) has given sufficient emphasis on productive use of renewable energy under the distinct component of productive energy use (PEU). The PEU Component has additional focus on small and medium businesses around larger plants (though this has not been reflected in the subsidy policy 2013 as indicated above). Strategically, the PEU activities intend to increase income generation as a whole for the community with additional focus on small and medium enterprises which offer the greatest economic impact in the area. In terms of renewable energy options, the PEU activities will have focus on micro and mini hydro schemes because of their power output potential. There is a visualization that economic clusters could emerge around the larger plants and hence priority will be given to larger plants.

1.6 Baseline Projects

The "baseline project" is defined as all activities of relevant initiatives that will be implemented without the GEF assistance. These baseline activities may either serve as a base on which activities of the proposed project will build incrementally, or themselves be closely integrated with the proposed project's activities to together provide incremental benefits. The "baseline scenario" is defined as the situation that would occur over the time period of the project's implementation and beyond in the absence of the GEF project. It is a forecast based on those baseline project activities that would still occur without the project as well as the expected actions of other organizations (such as investors and banks) or individuals in the absence of the proposed project.

As mentioned, the Government of Nepal and key donors in off-grid renewable energy have made the decision to adopt a programmatic approach whereby all government and donor efforts in rural renewable energy will operate under a single umbrella programme, the National Rural Renewable Energy Programme (NRREP). Thus, the NRREP represents the collective baseline activities (i.e., baseline project) in the country on renewable energy development and utilization in the country and specific components of that project, particularly on mini/micro hydro and solar PV power generation will be subsumed into the proposed UNDP-GEFRERL project as baseline activities. Activities of NRREP that are not related to the UNDP-GEF RERL (e.g. biogas and biomass activities) are not considered as part of the baseline project.

Thus, our discussion of the baseline project will include NRREP activities supported by non-earmarked and earmarked donor funds and government funds. UNCDF/CleanStart activities in Nepal supported by and directly relevant to the proposed project will be discussed in a separate subsection.

NRREP and its Components: NRREP has three components, each with broadly defined outputs and activities. NRREP is designed for five years and has targets fixed in terms of installed capacity additions for various renewable energy technologies. Its total budget is USD 184 million.

NRREP will work to improve living standards and increase employment and productivity of rural women and men. It seeks to reduce dependency on traditional energy and support sustainable development through integrating renewable energy with the socio-economic activities of rural women and men.

With the development of a first year work plan, NRREP implementation has begun in earnest. It is important to point out that, for the longer term (years two through five of the program), not all outputs and activities are funded or designed in detail. Thus, as the program evolves and additional activities are defined in detail, core funding may be allocated to these activities or donors may provide specific additional support. As such, the GEF project, with the successful implementation of its activities (baseline and incremental), complement and contribute to the realization of the RE-related targets of the NRREP.

NRREP's three components are: (1) Central Renewable Energy Fund, (2) Technical Support, and (3) Business Development for Renewable Energy and Productive Energy Use. Each of these components is discussed below:

Central Renewable Energy Fund (CREF) Component: The objective of this component is to establish CREF as the core financial institution responsible for the delivery of subsidies and credit support to the renewable energy sector. Targeted to have a size of about USD 113 million, the exact structure of the fund is still not finalized. The CREF Component has two broadly defined outputs as given in Table 18. The CREF will partner with a financial institution for delivery of the credit and subsidies to the beneficiaries. The fund hopes to leverage its credit with financial institutions, so that the financial institutions also provide additional credit to loan targets. The fund will support both manufacturers and installers of renewable energy technology. However, the fund has not prepared specific plans and financing mechanisms to stimulate renewable energy financing. In the absence of outside stimulus to do otherwise, it is likely that the majority of funding from the CREF will be channelled to micro-hydro and solar home systems because Nepal has the most experience in these renewable energy technologies.

Table 18: Targeted Outputs of NRREP's CREF Component

Central Renewable Energy Fund Component Outputs
Output 1.1: The CREF has been endowed with the capacity and powers to successfully carry out its operational mandate in cooperation with other sector organizations and the Alternative Energy Promotion Centre in particular.
Output 1.2: The existing subsidy system is modified to improve its effectiveness and to enhance its focus on women and marginalized groups.

<u>Technical Support Component</u>: The immediate objective of NRREP's Technical Support Component, which will have a budget of USD 40.1 million, is to accelerate renewable energy service delivery with better quality, comprising various technologies, to remote rural households, enterprises, and communities. Several renewable energy technologies will be supported; and institutional support will be provided to AEPC. Possible income-generating activities in areas associated with renewable energy electrification schemes will also be promoted, though this aspect of the Technical Support Component appears to overlap with the Productive Energy Use Component (described below). Particular technologies or other aspects to be supported through the Technical Support Component are highlighted in the *NRREP Program Document* and the ones relevant to the proposed project are given below. These highlighted items are expected to be the areas to receive the greatest emphasis by the Technology Support Component in the baseline scenario.

- Solar energy: Lower cost domestic systems
- Community electrification schemes: Increase in financial viability and electricity available to productive applications
- RE technology supply sector: Increase in quality and other capabilities

The 17 outputs under this Component include a wide range of technologies to be supported. Based on review of the full list of NRREP's 17 outputs, the list in Table 19 below contains those that are relevant to the proposed GEF project. Even though this list shows that NRREP will have baseline activities in the areas of both community hydropower and larger scale solar, given AEPC's past experiences micro-hydro and solar home systems will receive the major focus.

Although the development partners (donors) have indicated that policy formulation support at the central government level will be provided by NRREP, policy formulation initiatives are not explicit in the above 17 outputs.

Table 19: Selected Outputs from NRREP's Technical Support Component Full List of 17 Outputs – those that are Relevant to the Proposed GEF Project

Outputs Relevant to Community Electrification (Emphasis likely on off-grid hydro but may also apply to larger scale PV)
• Project management capacity for community electrification projects is in place and performing, and the number of completed projects increases at a faster rate • Community electrification projects are better designed with regard to the use of the available potential, and operate at a higher load factor to be more sustainable • Community electrification technology is scaled-up (in volume and unit size) and is of a higher standard
Outputs Relevant to Larger scale PV
• Some viable large community Photo Voltaic systems are operational
Outputs Relevant to Cross-cutting gender, Social Inclusion, Institutional, Financing, and Livelihood Themes

- Income generating activities for households using renewable energy are developed and implemented in catchments areas. (Note: Overlaps with Productive Use Component of NRREP)
- District Energy and Environment Units become an integral part of District Development Committees and work to establish linkages between the AEPC and the needs of the rural population whilst promoting the interests of women and marginalized groups
- Regional Service Centres are contracted and their capacity enhanced to facilitate the delivery of renewable energy services and promote linkages at a local level as a resource of the AEPC
- AEPC is recognized as an effective, efficient and Gender and Social Inclusion proactive institution for the promotion and development of the renewable energy sector

Business Development for RE and Productive Energy Use (PEU) Component: The immediate objective of this component, with a budget of USD 8.4 million, is to contribute to income generation and employment potential through promotion of micro, small, and medium sized enterprises (MSME) in rural areas, particularly for men and women belonging to socially and economically disadvantaged groups. The enterprises will be facilitated by the availability of off-grid renewable energy. The objective of this component will be reached through three outputs, as listed below inTable 20.Initial work on this component will focus on a nation-wide study to identify high-potential sectors for enterprise development at community electrification sites.

Table 20: Outputs of NRREP's Business Development

Business Development and Productive Energy Use Component
Output 3.1: Capacities of existing MSMEs are enhanced Output 3.2: New and innovative MSMEs are created and made operational Output 3.3: Appropriate business development services are available to MSMEs in renewable energy catchment areas

NRREP Indicative Budget and Donor Funds: Table 21 below shows the distribution of the total indicative funds of USD 184 million for NRREP among the three components:

Table 21: NRREP Indicative Budget

Million USD

Component	**Indicative Budget**	**NRREP Budget relevant to UNDP-GEF RERL project**
1. Central Renewable Energy Fund	127	31.3
2. Technical Support	40.1	10.7
3. Business Development for RE and PEU	8.4	3.6
Management	5.1	1.0
Studies, audits, and reviews	3.4	---
Total	**184**	**46.6**

Of the total budget, the Government of Nepal is to contribute USD 65 million. This would leave USD 119 million to be contributed by donors.

Out of the total NRREP budget of USD 184 million, about USD 46.6 million will fund baseline activities that are relevant to the UNDP-GEF RERL project.

Table 22 shows both committed funding and expected commitments from donors to activities that will fall under the NRREP umbrella. Some funds, such as those from Denmark and Norway are not earmarked, and are to support the overall program, while other donors will earmark their funds for specific purposes.

Table 22: NRREP Funding Sources

Million USD

Bilateral Donors	TA Pool in USD	Multilateral Banks (SREP and own funding)	Government of Nepal
Denmark: USD 34.7 M (205 M DKK)	SNV – 1.3	USD 20	Subsidies (40% in the 1st year and will increase by 2% annually)
Norway: USD 24.7 M (170 M NOK)	GEF: 5 M		
DFID: USD 7.6 M (GBP 5 M)	GIZ – 6.4		
KfW: USD 19.2 M (EUR 15 M)	UNCDF compact: USD 0.5 M		
Total: 86.2	Total: 13.2	Total: 20	Total: 65
Total: Fully committed ≈ USD 184 M			

NRREP Targets and UNDP-GEF RERL's value add: NRREP targets for the five years of the program were given in Table17 above in the discussion on policy and institutions. Of the seven targets indicated, four are relevant to the GEF project. The UNDP-GEF RERL project will enhance the realization of renewable energy benefits targeted by the NRREP with the removal of the current barriers that hinder private sector financing of, and investments on, larger scale rural-based hydropower projects (relative to the typical micro-hydropower projects) and larger solar PV power generation (relative to the usual solar home systems). Both enhanced systems will also be designed to operate at optimal load factors through the facilitation and enabling of more productive end uses of the electricity that these systems will produce. The NRREP targets are summarized in Table 23 below. While a mini/micro-hydro target and target for households benefiting from community electrification are given, there is no target set for Large-scale solar PV systems; NRREP target includes only individual solar home systems.

Table 23: Government of Nepal and NRREP Five-Year Renewable Energy Targets Relevant to the GEF Project

Technology or Application	Target
Mini and micro-hydro power	25 MW
Community electrification	150,000 households benefitting
Productive uses of renewable energy	1,300 new MSMEs established, employment increased by 19,000
AEPC Capacity Target	
AEPC is recognized by stakeholders as an effective and efficient service institution for development of the renewable energy sector.	

UNCDF CleanStart Support – Earmarked under NRREP for renewable energy financing: The United Nations Capital Development Fund's (UNCDF) CleanStart Program will bring financing expertise to NRREP. CleanStart aims to facilitate access to clean energy through micro-financing for a total of 150,000 low-income households and micro-entrepreneurs in Nepal (with an estimated 600,000 beneficiaries). The Program will have funding of USD 1.3 million and a duration of four years (from 2013- 2016). CleanStart will support up to three financial service providers in Nepal, building their capabilities to provide micro-finance for clean energy. CleanStart's intended emphasis for the initial years of NRREP is on urban or near-urban areas depending on the target markets of the financial institutions. The financial institutions that CleanStart will be supporting are likely to have some coverage in Terai rural areas, and some Hilly areas, which will be the focus of renewable energy installations supported by the proposed UNDP-GEF RERL project.

Under the UNDP-GEF RERL, the baseline activities of CleanStart on supporting micro-financing for productive use of renewable energy (PURE) projects in remote rural areas of Nepal will be enhanced. The cooperative activities will build awareness among micro-finance institutions regarding opportunities in financing the productive use of renewable energy. The geographic spread needed will be achieved either through expansion of partner service areas or through facilitation of their cooperation with local entities in project areas.

The four initially targeted outputs of the CleanStart Nepal's Business Plan are given in

Table 24below. It includes the associated incremental activities that will be carried out under the proposed GEF project. Essentially, CleanStart's activities with its microfinance partners will be extended to encompass financing support for productive use enterprises in areas newly electrified through the support of the GEF project. Activities may also include the facilitation of partnerships between these microfinance institutions and local cooperatives to extend the former's scope to more remote areas.

Table 24: CleanStart Nepal's Targeted Outputs and Associated Incremental Activities to be carried out jointly with the Proposed GEF Project

CleanStart Targeted Output	Incremental Activity to be Carried Out Jointly with Proposed GEF Project
1. Finance for Clean Energy to strengthen capabilities of up to three (3) financial service providers (FSPs) to provide microfinance for clean energy to low-income households and micro-entrepreneurs	a. Technical Support for microfinance partners in providing loans for productive use of energy enterprises in mini-hydro and large-scale solar project areas supported by the GEF project. To be achieved after training (see (b) below) and either extension of FSP's geographic scope or, as in (c), partnerships with local organizations.
2. Technical Assistance for Clean Energy to remove barriers to the sustainable deployment of those technologies and services for which the selected FSPs will provide microfinance	-----------
3. Knowledge and Learning to promote awareness and understanding of the potential for microfinance[33] to stimulate adoption of clean energy, and to develop skills in clean energy microfinance	b. Extend knowledge and learning work to promote opportunities in financing productive use of renewable energy to microfinance institutions. Train microfinance institutions to carry out productive use financing business.
4. Advocacy and Partnership to create an enabling policy and business environment to expand microfinance for clean energy	c. Promote partnership between microfinance institutions and local cooperatives for lending for productive use of renewable energy in more remote areas.

1.7 Baseline Scenario

The following discussions outline the likely scenario by the end of the NRREP project period, which we call the baseline scenario. This would be the scenario in case there is no UNDP-GEF RERL project. The projections are divided topically based on areas of focus relevant to the UNDP-GEF RERL project, so that the baseline scenario may be easily compared to the alternative scenario facilitated by the UNDP-GEF RERL project as presented in Section 2.4 of this document.

Micro and mini-hydro installations: In the baseline scenario, significant achievements are expected to be made in the installation of micro-hydro plants, but mini-hydro installations are likely to be very few. AEPC and partners have much experience in micro-hydro, but only experience with a single mini-hydro station. Because mini-hydro will present new challenges, it is likely that most of the off-grid hydro that will be installed will be micro-hydro. Further, micro-hydro installations may contain a substantial proportion of small systems of less than 60 kW capacities even though these tend to be less financially sustainable and present less opportunity for productive end-use and grid connection if and when the grid arrives. There has been limited development of micro hydro projects above 60 kW because of limitations in

[33] Micro-finance loan size is usually less than NPR 50,000 and in case of renewable energy it can be up to NPR 100,000.

manufacturing capabilities, lack of productive end use possibilities in rural areas and also lack of sufficient financing.

It may be difficult for the Program to meet its five-year target of 25 MW of micro-hydro and mini-hydro installed. The target is quite ambitious in comparison to achievements in the past years. Indeed, in the 17 years since 1996, AEPC has been able, with support from UNDP and the World Bank's REDP and the Danida and Norway's ESAP, to achieve about 18 MW of installed micro-hydro capacity. Thus, achieving 25 MW in five years means the pace will have to be ramped up considerably. Yet, recent data does show that in FY2010/11, about 4 MW of micro-hydro was installed; rising from 1.5 MW installed the previous year. Thus, it is possible that an average installation rate of 5 MW per year will be attainable, provided suitable policy and financial incentives are in place to attract substantial private sector investment and there is widespread development of sustainable productive end-use applications of electricity. For the purpose of UNDP-GEF RERL project's 10 MW Mini-hydro intervention, base line considered is 10 MW of Micro-hydro. In the baseline with Micro-hydro, only 22% load-factor with limited productive use is assumed to be achieved based on current practice; whereas the project intervention will result into additional 30% load-factor (for a total of 52%) due to intensive and expanded productive-end-use of electricity.

Yet, the baseline scenario does raise concerns about sustainability. With the focus remaining on small sized micro-hydro, financial sustainability of systems once installed is likely to continue to be a problem, as system revenues are often not enough to cover maintenance and repairs. Under NRREP, productive use enterprises will be pursued at micro-hydro sites. Yet, given the small capacities of the stations, excess energy will be limited thus limiting the type and scope of applications that may be pursued. The scale of the enterprises will also remain small due to power limitations. It will be hard to achieve financial sustainability of such systems through increased revenues from productive applications, as productive applications may account for too low a share of the total load. Livelihood benefits will also be lower than that might be achieved with larger systems.

Up-front costs for 25 MW of Micro/Mini-hydro alone would require over USD 60 million investments on top of subsidy fund allocated in NRREP. As commercial viability of systems will likely remain unattained with the focus remaining on micro-hydro, the private sector as well as Banks will continue to be hesitant to get involved in investing in equity and Loan, respectively. Similar will be the case in terms of other renewable energy interventions. Despite desires to gradually wean the system from subsidies, without private sector involvement and commercial financing, this will be difficult.

Domestic manufacturing of components for the mini-hydro sector may not be able to improve its ability to offer a cost advantage, lowering total system costs. Support for manufacturers, while provided, may lack strategic focus to ensure manufacturers that may offer potential cost-savings to mini-hydro installations are targeted.

To address these gaps, the proposed UNDP-GEF RERL project will implement demonstration of PPP models to facilitate cooperation between private sector, public sector, and local organizations in Mini-hydro projects and also implement demonstration of financially sustainable and reliable mini-grid connecting various micro-hydro systems. In addition, the project will support NRREP to implement an additional installed capacity of 2 MW of off-grid large micro-hydro (over 60 kW) power projects demonstrating cost-advantage, feasibility, productive end-uses, and best practice through technical assistance. Likewise, it will support NRREP to implement an additional installed capacity of 7 MW of off-grid Mini-hydro projects demonstrating cost-advantage, feasibility, productive end-uses, and best practice of Mini-hydro through technical assistance.

Solar PV Efforts: In the business-as-usual scenario, the majority of PV efforts are likely to remain focused on solar home systems, with strong support for these from core and possibly ear-marked NRREP donor funding. Additional earmarked donor funding may result in continued support of institutional PV and solar water pumping installations. Yet, with other priorities for baseline activities, achieving financial sustainability of such systems may not receive much focus. Further, without any outputs for village scale PV systems within NRREP, these larger scale applications of PV will continue to remain virtually absent from Nepal. Thus, remote areas without water resources may lack the opportunity of productive applications that such larger systems present.

To address these gaps, the UNDP-GEF RERL project will implement demonstration projects of financially sustainable and reliable Large-scale solar PV projects. In addition, it will support NRREP to implement an additional installed capacity of 2 MW of Large-scale solar PV projects, demonstrating cost advantage over smaller PV systems, feasibility, productive end-uses, and best practice through technical assistance.

Financing mechanisms: Funds disbursed under NRREP may likely be limited to basic loan and subsidy models, without more innovative need-specific financing mechanisms established, such as targeted manufacturer funds, etc. Further, in the baseline project, CleanStart will focus its microfinance efforts on small renewable energy technologies (mostly household scale) in urban and peri-urban areas. While productive applications of renewable energy will be pursued under NRREP, micro-finance may continue to be unavailable to entrepreneurs due to lack of coverage by micro-finance institutions in their areas.

To address this gap, the UNDP-GEF RERL project will design and support the establishment and operation of credit facilities for domestic manufacturers of Mini-hydro component to meet growing orders and be cost competitive. It will also put in place financing instruments for promoting commercial financing for Mini-hydro and Large-scale solar PV projects. Furthermore it will develop training materials on Mini-hydro and Large-scale solar PV projects financing for Banks and financial institutions and create matchmaking platform among Mini-hydro developers and Large-scale solar PV Projects, financing institutions, and equity investors. Furthermore, the project will support increased profitability of existing and

new enterprises through use of electricity from Mini-hydro and Large-scale solar PV projects, establish instruments to incentivize FIs to promote financial products to micro entrepreneurs and end users, and provide targeted investment support to electricity-based enterprises.

Policy Efforts: Under NRREP, good progress will likely be made in formulating and revising general national-level policy to promote off-grid renewable energy as discussed in Section 1.5. Yet, policy specifically promoting Mini-hydro and Large-scale solar PV systems will remain absent.

To address these gaps, the UNDP-GEFRERL project will assist AEPC to develop and adopt policies that enable development of Mini-hydro and large scale solar PV systems using PPP model, including fiscal incentives to attract substantial private sector investment. Furthermore, to enable the inclusion of mini-hydro and large scale solar PV systems into the decentralized planning process, the project will make available adequate information for incorporating such projects into decentralized RE plans. Furthermore, it will provide training and awareness programmes to relevant government agencies and stakeholders on Mini-hydro and large scale solar PV systems development and productive end uses to sensitize them on the benefits, challenges and opportunities of these larger systems.

Capacity Building: Under NRREP, significant capacity building in many areas related to renewable energy will occur. Yet, capacity building specific to mini-hydro component manufacturers and other technical areas serving the mini-hydro segment may not occur. Similarly, capacity building specific to installation, operation and other technical areas serving large scale solar PV systems may not occur. Therefore, with respect to Mini-hydro and Large-scale solar PV projects, capacity building in on-going projects can be considered non-existent and UNDP-GEF RERL project is looked upon for the purpose.

To address these gaps, the UNDP-GEF RERL project will review and update technical challenges, opportunities for capacity building in design, manufacture (for large micro and Mini-hydro), installation, and after-sales service in large micro- and Mini-hydro and Large-scale solar PV projects completed. Based on the findings of the review, the project will support improvement in capacities of (1) project identification, feasibility study and detail design in Mini-hydro and large-scale PV, (2) Mini-hydro-manufacturers in identified areas of manufacturing and in their after-sales services, (3) construction and installation teams within companies to improve quality of installed Mini-hydro projects and large solar PV system, and (4) operation, maintenance and business management of Mini-hydro projects and large-scale solar PV systems.

Productive end-uses:

With the establishment of MHP in rural areas, the livelihood scenario is changing with use of electricity. Use of electricity from MHPs in electricity-based enterprises is limited though gradually emerging resulting plant load factors that are higher as well as contributing to the livelihood opportunities. Agro-processing is the most common enterprises. In many cases the

existing diesel-powered agro-processing mills will quickly switch to electricity. Other potential enterprises include poultry, dairy and those based on forest resources. In addition, modern consumer services such as photocopying, communication centres, electric/electronic repair centres are also emerging in many places.

Despite such potential, most of the micro-hydropower systems are observed to have low level of load factor, which is attributed to absence of adequate enterprise development in the vicinity of the hydro-power plants. This situation is expected to continue in the baseline scenario. Compared to micro-hydropower plants, the mini-hydro systems as proposed in the GEF project are expected to offer greater opportunity for enterprise development, for instance, due to availability of abundant and more reliable power. In the demonstration mini-hydro projects, a number of potential enterprises are expected to emerge as soon as power becomes available.

The electricity generation from solar PV systems, particularly, the solar home systems, is used mainly for lighting and charging mobile phones. With a bigger sized solar PV system as proposed in the GEF project, the productive use scenario is expected to improve. Numerous possibilities related to modern consumer services such as photocopying, communication centres, electric/electronic repair centres and small scale enterprise using small amount of electricity will be opened with availability of electricity from large-scale solar installations.

2 Project Strategy and Design

2.1 Technology Selection and Installation Targets

The selection of which off-grid renewable energy technologies will be supported by the proposed project is a critical aspect of project strategy and design. Technology selection focused on assessment of options with regard to five main areas:

a) Addressing root barriers to expanding energy access and adopting low carbon development pathways, with barriers and thematic areas chosen based on assessment of where the project could have the most meaningful and sustainable impact.

b) Providing both integration and value-add to NRREP by addressing the UNDP-GEF RERL focused area of larger systems which otherwise will be unmet.

c) Achieving project coherence through adherence to a few key thematic areas so as to have a greater impact rather than having a collection of disparate initiatives.

d) Leveraging UNDP experience and comparative advantage, particularly its achievements and know-how developed over the past 17 years in promoting a community model of off-grid renewable energy in Nepal and its emphasis on increasing productive livelihood opportunities.

e) Emphasizing technologies that have had only limited application to date in Nepal, so that the project has the potential to create strong benefits in capacity building, awareness, dissemination and market development.

These five areas are also key considerations with regard to overall project design. The project will focus on two main categories of renewable energy technology, off-grid hydropower and solar PV. Within these categories, it will focus on four segments:

a) Micro-hydro with capacity over 60 kW (only in the first two years of the project, as a transition to mini-hydro),

b) Mini-hydro (100-1000 kW),

c) Mini-grid of over 100 kW (interconnection of existing micro-hydro stations),

d) Large-solar PV systems to serve a) institutional requirements (serving, for example, health clinics and schools), b) Village Electrification, and c) Solar PV pumping.

Among all segments, mini-hydro will receive special emphasis as the technology have the greatest potential to address the project's priority barriers and thematic areas, while micro-hydro with capacity of over 60 kW will be included as a transition to the larger mini-hydro systems. Mini-grid, like mini-hydro, represents an untapped and scaling up from existing current smaller MHPs. Inclusion of Large-scale solar PV represents a concerted effort to provide options to those communities lacking sufficient hydropower resources. It also represents an effort to move Nepal forward technologically into new and future areas of renewable energy development.

Table 25 shows the overall targets for each of the segment to be supported by the project. Except for micro-hydro, all segments include demonstration projects. The proposed project will provide both investment support and technical assistance to demonstration projects. To all other post-demonstration capacity targets, it will provide only technical assistance.

Table26provides more detailed information on annual capacity targets for each technology segments. Financial closure of all capacity is expected by project close in 2018, which means that some capacity, as indicated in Table26as initiated may be under construction at that time.The UNDP-GEF RERL will collect and compile information on expansion of these technology options that may be attributed to RERL interventions.

Table 25: Technologies and Total Capacities to be supported by RERL

Type	*Off-grid hydropower*: 10.3 MW total			*Off-grid PV*: 2.5 MW total		
	Micro-hydro > 60kW <100kW	Mini-hydro >100kW <1000 kW	Mini-grid of existing MHPs >100kW	Village Electrification	Institutional PV (schools, health posts etc.)	PV Pumping (drinking water and irrigation)
Demonstration	----	1 MW	300kW	100 kW	100 kW	300 kW
Post-demonstration	2 MW	7 MW	300kW	600 kW	700 kW	700 kW
Total	**2 MW**	**8 MW**	**600 kW**	**700 kW**	**800 kW**	**1 MW**

Table26: Annual Installation Targets, by Technology Type – RERL

Year	*Off-grid hydropower*						*Off-grid PV*					
	Micro-hydro >60kW (60kW<x≤100kW)		Mini-hydro (100kW<x≤1MW)		Mini-grid of existing MHPs >100kW		Solar PV village electrification		Institutional solar PV (schools, health posts etc.)		Solar PV Pumping (drinking water and irrigation)	
	initiated†	completed†	initiated	Completed	initiated	Completed	initiated	completed	Initiated	completed	initiated	completed
1	1 MW	0 MW	0.0 MW	0.0 MW	0 kW	0 kW	100 kW	----	100 kW	---	150 kW	---
2	1 MW	0.5 MW	1.0 MW	0.0 MW	150 kW	0 kW	100 kW	100 kW#	150 kW	100 kW#	150 kW	150 kW#
3	0 MW	1.0 MW	2.0 MW	0.0 MW	0 kW	150 kW#	100 kW	100 kW	150 kW	150 kW	200 kW	150 kW#
4	0 MW	0.5 MW	2.0 MW	1.0 MW#	150 kW	0 kW	200 kW	100 kW	200 kW	150 kW	200 kW	200 kW
5	0 MW	0 MW	3.0 MW	2.0 MW	0 kW	150 kW#	200 kW	200 kW	200 kW	200 kW	300 kW	200 kW
Total	**2 MW**	**2 MW**	**8 MW**	**3 MW***	**300 kW**	**300kW**	**0.7MW**	**0.5 MW***	**0.8 MW**	**0.6 MW***	**1.0MW**	**0.7 MW***
Total hydropower implemented: 10 MW and 600 kW Mini-grid							**Total PV implemented: 2.5 MW**					

*Remaining 5 MW mini-hydro, 200 kW village PV, 200 kW institutional PV, and 300kW solar PV pumping will be in construction phase at close of project.
† "Initiated" indicates financial closure reached. "Completed" indicates project commissioned.
#This indicates demonstration projects, for which RERL will provide a portion of equity investment. For all other capacity targeted, RERL will support with TA only and leverage co-financing to cover full amount of required investment.

2.1.1 Addressing root barriers and key thematic areas

The technology selection process considered the following root barriers, after some aggregation, for each of the technologies being reviewed. The list of selected root barriers was reduced to four: (a) lack of capital for up-front investment; (b) high cost of systems; (c) lack of financial sustainability of systems, which may be classified as a utilization issue, as greater utilization through productive uses resulting in increased revenues that could increase financial sustainability; and (d) lack of technical capacity and awareness for less disseminated but high potential technologies.

Through the project formulation process, the key thematic areas in which the project is believed to have the greatest potential for impact were determined to be: (1) affordability of up-front costs of systems, (2) financial sustainability (cash flow for maintenance and repair), and (3) technical capacity and awareness for less disseminated, but high potential technologies.

The policy, regulatory, and institutional barriers are identified as cross-cutting/overarching across financial support, capacity building, financing and efficient-use of energy throughout. In the process of analysis, productive uses came to be seen not only as important to address root barrier (c), but also to barriers (a) and (b), as investors who see financial sustainability demonstrated through productive applications will be more likely to consider systems commercially viable and support them in the future.

Given findings regarding electrification needs, the potential of electrification to enhance livelihoods, and the aim of coherence in project design, it was decided to focus on electricity-generating off-grid renewable energy technology options. Various power-generating technologies were then assessed in terms of how they address each of the selected root barriers, with results summarized in Table27 below. Of the options, mini-hydro performs the best overall in terms of potential to address the selected root barriers. It has the lowest per unit cost and demonstrates economies of scale compared to micro-hydro. Because the systems are larger, it also performs better in terms of higher utilisation potential and financial sustainability through better revenue flows. And, as a result of its performance in these areas, the mini-hydro systems clearly have the best chance of demonstrating commercial viability and attracting commercial financing. Mini-grid (an upgrade in which independent micro-hydro systems are interconnected into one grid) also has higher potential for productive applications as it negates supply-capacity constraint.

While PV systems, due to higher costs, do not demonstrate benefits similar to off-grid hydropower in addressing financial types of root barriers, they do provide the best solution in some areas without access to hydropower resources. For these areas, assessment of root barriers shows that larger-scale systems, which achieve economies of scale and offer more productive use potential, are preferred areas of focus. These, like mini-hydro, have also been less disseminated than their smaller scale counterpart of SHSs and are thus in need of awareness raising and technical capacity building. The learning from EU implemented

Renewable Energy Project and NRREP/KfW's planned initiatives shows desirability of such large-scale solar PV systems.

Utilization and particularly productive use to generate revenues are important to financial sustainability (per root barrier (c)) and to the potential for commercial financing (per root barrier (a)). Thus, it is also instructive to look at how different systems perform in terms of potential applications. The comparison is shown in Table28. Considering cooking (limited to use of rice cookers, hot water-pots and other efficient heating or cooking appliances), lighting, small and large service enterprises, small and large production enterprises, and irrigation, mini-hydro with its larger capacity scored the highest by a significant margin in terms of breadth of application types covered. Since creating a mini-grid increases supply capacity over 100 kW, similar to mini-hydro, does as well as mini-hydro. In general, mini-hydro systems are expected both to cover more households and to provide more power per household. Given that cooking is the number one energy consuming application for rural households, this one aspect of mini-hydro (unmatched by most other technologies) could provide much needed support to reducing conventional biomass use and thus deforestation and net GHG emissions.

Table27: Comparison of Off-Grid Electrification Technologies in Addressing Chosen Root Barrier Areas

Technology/Barrier	High Cost of Technology	Lack of Commercial Financing	Low Utilization, resulting in Financial Sustainability Issues	Low capacity and awareness: less disseminated but high potential
Off-grid hydro				
Pico-hydro	-More expensive per kW than larger systems	-Very unlikely to attract commercial financing	-Too small for productive use	-587 systems installed mid-2000 to mid-2010
Micro-hydro	-More expensive per kW than mini-hydro	-Unlikely to attract commercial financing	-Scale too small for extensive productive use	-536 systems installed mid-2000 to mid-2010
Mini-grid	-Upgrade of existing systems, so not comparable	-Upgrade might attract commercial financing	-Upgrade from separate micro-hydro stations to mini-grid could increase productive use	-Only a few in existence
Mini-hydro	-Economies of scale/transport; less expensive per kW than micro-hydro	-Lower transaction costs to build -Most potential of all technologies to attract private sector	-Greatest opportunities among all technologies for productive use	-Few stations installed in last two decades
Off-grid PV				

Technology/Barrier	High Cost of Technology	Lack of Commercial Financing	Low Utilization, resulting in Financial Sustainability Issues	Low capacity and awareness: less disseminated but high potential
Solar Home Systems (SHSs)	-More expensive per watt than larger systems	-Difficult to attract investment due to lack of system revenues	-Scale too small – limited use, mainly consumptive	-215,211 systems installed mid-2000 to mid-2010
Institutional PV Systems	-Economies of scale/transport, though more expensive than MHP options	-May be able to attract private sector	-More opportunities for productive use than with SHSs, though less than MHPs	-Less experience than SHSs; -38 installed mid-2009 to mid-2011
PV pumping	As above	-May be able to attract private sector	-Great potential to improve agricultural productivity	-2 installed mid-2009 to mid-2011
Village-scale PV Stations	As above	-May be able to attract private sector	-Most opportunity for productive use among PV options, but less than that of mini-hydro	-Rare in Nepal

In the PV category, while institutional PV systems and village PV systems are likely to be smaller and therefore have less excess capacity than mini-hydro systems, it is expected that if they are designed with adequate scale in the case of village PV, some micro enterprises may be possible. Solar home systems (SHSs), with their very small capacity, are the most limited of all the PV options considered. PV pumping, specifically designed for pumping for irrigation and drinking water, clearly is strong in the area of productive use potential. The Table28 shows relative use potential of various technologies.

Table28: Utilization Perspective – Technology Choice

Tech/Utilization	Cooking	Lighting	Services		SMEs		Irrigation	Total No. of Yes
			Small	Large	Small	Large		
Pico-hydro	No	Yes	Yes	No	No	No	No	2
Micro-hydro	No	Yes	Yes	No	Yes	No	Yes	4
Mini-grid	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7
Mini-hydro	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7
SHSs	No	Yes	Yes	No	No	No	No	2
Institutional PV	No	Yes	Yes	No	Yes	No	Yes	4.5
Village PV	No	Yes	Yes	Yes	Yes	No	Yes	5.5
PV Pumping	No	May be	Yes	Yes	Yes	No	Yes	4

2.1.2 Providing Fit and Value-Add to NRREP

Among renewable energy power generation technologies, most of the experience in Nepal to date is with pico-hydro, micro-hydro, and SHSs. With few mini-hydro plants installed in the last two decades and earlier plants operating at loss for NEA, mini-hydro presents new technical and operational challenges that, without technical assistance may result in a continued focus on micro-hydro. Yet, mini-hydro development will actually better enable NRREP to achieve its key goals, including commercial financing, system sustainability (through greater revenues for loan repayment, maintenance and repairs), and productive applications, and contribute to poverty reduction. Similarly, for areas without sufficient hydrological resources, larger PV systems will provide much more potential than SHSs to meet the aforementioned goals.

In terms of NRREP's specific areas of technology focus and targets, there is also a fit. While there is no separate target for mini-hydro, NRREP has a five-year target of 25 MW additional capacities of micro-hydro and mini-hydro together. The project's efforts will facilitate this target being reached through promoting larger systems. While NRREP has not indicated any specific targets for institutional PV, PV pumping, or village PV systems, NRREP's Technical Support Component does indicate that some viable community-scale PV systems will become operational.

Currently, the Government of Nepal (unlike in the past when the PIF was developed and NRREP did not exist) desires to align all new renewable energy programs with NRREP. Hence the targets of UNDP-GEF RERL need to be now aligned with NRREP to work in this sector. The focus for NRREP is achievements of the targets and it is not strongly tied with specific technologies whereasUNDP-GEF RERLproject is tied with technologies like mini-hydro, mini-grid, solar PV and PPP approach.

2.1.3 Achieving a Coherent Niche within NRREP

While the UNDP-GEF RERL project will aim to fit seamlessly within the NRREP umbrella, an overall coherence to its activities will be important for making sure the initiative as a whole is driven forward and is well understood by both those who implement it and those who cooperate with it. The process of technology selection has revealed an appropriate, high-potential niche for the project: The project will focus on off-grid renewable power generation technologies that have received little attention to date in Nepal and that are larger in scale than those that have been the focus of activity for the past decade-plus as identified during the PIF preparation phase. Further, the project will emphasize commercial financing and financial sustainability of systems, to be achieved both through the economics of scale enabled by larger systems and by productive applications as indicated in the PIF.

2.1.4 Leveraging UNDP Experience Base

UNDP, as the key donor to provide extensive support to renewable energy development in Nepal, has defined its expertise and value-add through capacity building and community mobilization. The recent successful projects of Mini-grid in the Baglung district and

establishment of a Mini-hydro project under KiND Project in Khimti river basin in collaboration with Norwegian Embassy are some of the additional milestones achieved by the UNDP in the field of off-grid electricity development in Nepal. The focus on community-sized systems will allow continued leverage of lessons learned in community mobilization. And, the needs of mini-hydro, as a newer technology with which there is not too many success stories in Nepal will call for the leveraging of capacity building expertise. The same will be true in terms of the needs of adopting larger scale PV systems. Finally, as UNDP's new country framework for Nepal puts high priority on livelihoods both in general and as the number one priority for energy work, the more substantial productive applications enabled by the larger scale of mini-hydro systems and larger PV systems also provides the best fit to these priorities.

2.1.5 Facilitating Technologies with limited Application to date

As evidenced in the right-most column of Table28 and also as discussed in Section 1.2, the selected technologies have mostly very limited application to date. They are thus in strong need of dissemination, technical capacity building, and awareness. This is particularly true of mini-hydro. Despite existing capacity of about 15 MW, very few plants have been installed in the past 20 years. Technology is dated and systems tend to lack viable revenue models. It is also particularly true of village PV power stations, with only a few dated systems and a few newer PV-wind hybrid systems having been installed in Nepal.

Of the other technologies, micro-hydro may seem to be an exception, as Nepal has developed extensive experience with the technology over the past 15 years, with over 500 stations installed between FY2000/01 and FY 2009/10. Yet, the size of these MHPs has tended to be small. As has been noted, the smaller systems tend to do less well in terms of cash flow and sustainability. Data for the 62 micro-hydro stations installed between mid-July 2009 and mid-July 2010 shows that the average capacity was 25 kW and that the mode (ordering capacities from smallest to highest and taking the value of the middle ones) was 22 kW. Only five of the 62 systems were over 60 kW. Thus, scaling up suddenly to over 100 kW capacities for a large proportion of its installations may be difficult for NRREP. Thus, in close consultation with AEPC, it has been decided that in the first two years of the project some emphasis will be put on the larger end (>60 kW) of the micro-hydro scale. Thus, 2 MW of the total of 10 MW of off-grid hydro targeted under the project will be larger micro-hydro and the rest mini-hydro.

As for institutional PV and PV pumping, these technologies have received more attention and garnered more experience than village PV power stations, but much less so than SHSs. As indicated in Table7, from July 2009 to July 2011, about 38 institutional PV systems and 2 PV pumping systems were installed. Cumulative installations to date (
Table8) are 299 for institutional PV and 81 for PV pumps. Yet, more work is needed on improving the commercial viability of these systems. Most of these systems to date have been fully grant-financed and financial sustainability has also been an issue.

2.2 Project Strategy and Rationale

The project's strategy and rationale are closely tied to the findings and approach of the technology selection process, as described in detail in Section 2.1. They also build on the barrier analysis of Section 1.4, assessment of the baseline project in Section 1.6, and findings of the situation analysis related to Nepal's energy and electricity situation, particularly the situation of off-grid renewable energy in Nepal (Sections 1.1 and 1.2).

The project will focus on off-grid renewable energy-based power generation technologies. Its core strategy will consist of four interrelated concepts: (1) promotion of larger-scale, less-disseminated systems, (2) achievement of commercial viability and private sector financing of up-front costs, (3) achievement of financial sustainability (cash flow for repairs and maintenance), and (4) establishment of productive use enterprises to raise system revenues and generate livelihood benefits. These concepts are brought together in the project design to strategically address the key thematic areas selected from the barrier analysis for greatest potential impact. The thematic areas are: affordability of up-front costs of systems (due both to high costs and lack of capital), financial sustainability (due partly to low utilization), and technical capacity and awareness for less disseminated, but high potential technologies. The way in which the four interrelated concepts comprising the core of the project strategy will address the root barriers associated with these themes is summarized below:

1. *Promotion of larger-scale, less disseminated systems*: Larger-scale systems address both the issue of high up-front costs and lack of financial sustainability/low utilization. Larger systems achieve economies of scale and thus lower per kW costs. Larger systems can also achieve more excess capacity that can be used in the promotion of income-generating activities. Such activities could in turn increase system revenues and therefore the system's financial sustainability. As explained in Section 2.1 (Technology Selection), an emphasis on mini-hydro (with some transition support of larger micro-hydro), mini-grid (connection of existing micro-hydro stations), Village PV stations, institutional PV, and PV pumping reflect this strategy of moving towards larger scale systems with lower per kW costs and higher potential for productive applications and financial sustainability. Most of these technologies have a low level of dissemination (or of sustainable dissemination) in Nepal, so that technical assistance and investment in demonstrations is justified.

2. *Achievement of commercial viability and private sector financing of up-front costs*: The economies of scale achieved by larger systems will reduce per kW costs and in addition reduce transaction costs and thus making them more attractive to the private sector. With the addition of productive applications to ensure greater revenues over the lifetime of the system, viability may be achieved and private sector participants thus attracted to invest. The technologies selected for this project will all, when combined with standard government subsidies, have greater potential than their smaller-scale counterparts for achieving commercial financing for the remaining equity and debt amounts required.

3. *Achievement of financial sustainability (cash flow for repairs and maintenance)*: Larger systems will have more excess capacity and therefore facilitate uses beyond daily needs. The project will promote these productive uses through enterprise development work. Greater revenues will provide greater cash flow for system repairs, at the same time as net income generation from the enterprises enhances local livelihoods.

4. *Establishment of productive use enterprises to raise system revenues and generate livelihood benefits*: As explained above, the larger systems provide more opportunities for productive uses, completing the circle of enhanced financial sustainability and thus greater commercial viability.

The project component strategy is given below. Activities are divided into four topical areas believed to be best suited to addresses the interrelated issues of: high cost, low dissemination of larger systems, and lack of commercial financing, lack of financial sustainability, low utilization, and livelihood needs.

2.3 Alternative Scenario and Rationale for GEF Financing

In the alternative scenario, with the UNDP-GEF RERL project, the off-grid hydropower systems installed under NRREP's five-year 25 MW target will achieve a much higher level of sustainability. In addition, more timely progress is made towards this target. Commercial viability of systems is demonstrated allowing much more substantial replication and additional capacity. In this scenario, private sector equity financing is leveraged and commercial financing is also more available to projects. Demonstration of extensive use of productive applications (accounting for 50% of system load or more) is achieved. This in turn demonstrates financial sustainability of systems through increased tariff revenues, further enhancing commercial viability and attraction of commercial equity and debt financing.

In terms of PV, given that there are no specific large-scale PV targets under NRREP, in the alternative scenario a greater capacity of large-scale PV is achieved than would otherwise achieved. As part of the intervention to improve the awareness and confidence of the private sector in the cost-effectiveness of PURE projects, demonstrations showcasing the design, engineering, installation and operation of RE-based power systems (100 kW village PV, 100 kW institutional PV, and 300 kW PV pumping) will be carried out. Part of the demonstration is to show how these improved and relatively larger system capacities have much higher level of efficiency and sustainability.

In the following paragraphs, the alternative scenario forecast is described in greater detail, divided topically based on areas of focus relevant to the project. These same areas were addressed in the forecast of the baseline scenario (Section 1.5). The forecast of the alternative scenario applies to the situation at project close (after five years of implementation) and beyond. Implementation is targeted for July 2014- July 2019, roughly the same time period expected for NRREP implementation.

Micro and mini-hydro installations: In the alternative scenario, mini-hydro plants make up a significant proportion (at least 8 MW) of the 25 MW of off-grid hydro installed over the life of NRREP, which could include some mini-hydro projects. In the alternative scenario, AEPC and partners gain much experience with mini-hydro and are able to continue to disseminate the technology, whereas in the baseline scenario they remain focused on micro-hydro. Among micro-hydro installations, in the alternative scenario, a greater proportion of those installed have capacities greater than 60 kW and are more sustainable than the smaller systems proposed in the baseline scenario.

In the alternative scenario, financial sustainability of mini-hydro systems is demonstrated and a much higher level of commercial viability of overall systems is achieved. In the alternative scenario, productive use activities at off-grid hydropower sites are larger in scale and broader in scope. This creates greater income benefits and generates more revenues for power systems than in the baseline scenario, where the size of MHP limits the potential for productive uses.

In terms of up-front costs, with the focus shifting to mini-hydro, commercial viability of systems is demonstrated and disseminated in the alternative scenario. As such, the private sector (beyond triple-bottom line investors) becomes interested and begins to invest in RET projects. Banks also are more likely to provide loans to projects. AEPC is gradually able to reduce hydropower subsidies to better off areas; and funding for systems in such areas can take the form of revolving loan funds.

In the alternative scenario, domestic manufacturing of selected mini-hydro components is able to present a real cost advantage thus lowering total mini-hydro systems costs. Manufacturers, benefiting from loans from the fund established by the project, are able to scale up and achieve economies of scale. This also enables installation of systems to occur in a more timely fashion.

PV Efforts: In the alternative scenario, large-scale PV systems get much more attention than they would otherwise. Institutional PV and PV pumping systems demonstrate greater financial sustainability, providing a model going forward.

Financing mechanisms: In the alternative scenario, innovative need-specific financing mechanisms to promote mini-hydro and large-scale PV are developed. This is in contrast to the baseline scenario, in which funds disbursed under NRREP are likely to remain basic loan and subsidy models targeting micro-hydro plants and SHSs.A fund targeted at mini-hydro component manufacturers in the alternative scenario enables these manufacturers to scale up. An equity or credit fund targeted at mini-hydro projects facilitates the process of demonstrating financial viability and attracting private sector investors. In the alternative scenario, CleanStart efforts will have opportunity to include micro-finance support for productive applications rather than focus on small-scale renewable energy technologies in urban or peri-urban areas. With micro-finance available to entrepreneurs, productive use generates a much greater level of revenues than it would otherwise.

Policy Efforts: In the alternative scenario, a specific policy to support the PPP model of mini-hydro financing is issued and implemented. Further, local DDCs develop specific plans for mini-hydro and large-scale PV. Finally, awareness of policy makers for mini-hydro and large-scale PV is raised. This contrasts with the baseline scenario, in which general progress is made on renewable energy policy and revision of the subsidy policy, but policy, plans, and awareness specific to mini-hydro and PV are absent.

Capacity Building: In the alternative scenario, the capacity of mini-hydro component manufacturers in design and manufacture of electro-mechanical parts is raised. Both mini-hydro and large scale PV installers and after-sales service providers also raise their capacities. Further, capacity of operators and business managers of both types of systems is raised. This contrasts with the baseline scenario in which significant capacity building occurs, but that specific to mini-hydro and large-scale PV is unlikely to occur.

2.4 Policy Conformity and Country Ownership

The institutional and policy environment for renewable energy in Nepal is discussed in Section 1.5. The most relevant government organization to this project is AEPC which is responsible for the promotion of all small-scale renewable energy in the nation. The project formulation team has coordinated closely with AEPC during the project preparation process to ensure that the project is aligned with Government objectives.

The UNDP-GEFRERL project supplements the NRREP, which is implemented by the AEPC since July 2012, by addressing the identified barriers to the widespread application of large-scale RETs in Nepal that will support productive end-uses. The design of the RERL project is carefully aligned with the components and outputs of the NRREP for effective implementation. Briefly, the proposed project is aligned with NRREP not only in overall objectives of expanding renewable energy and livelihood opportunities, but also in the following specific ways: The project will facilitate the achievement of NRREP's targeted 25 MW of off-grid hydropower installation over the next five years. It will facilitate the establishment of financing mechanisms, which will enhance the activity of the Central Renewable Energy Fund established under NRREP. The project will play a very important role in achieving specific, as well as enhancing some of the targeted outputs of NRREP such as: financial viability of community electrification systems, scale-up of community electrification, and viable large scale community PV systems. The project will also put strong emphasis on productive applications of renewable energy, an aspect that is clearly stated as a priority of NRREP, but at a limited level if the GEF intervention is not present.

The project also has a high level of conformity to Nepal's Rural Energy Policy of 2006. While only a few parts of this law have been implemented, the law itself can be taken to reflect government priorities in the sector. In particular, the law gives ample attention to employment creation and use of energy for social and economic activities, as well as community involvement. All of these aspects are stressed in the proposed UNDP-GEF RERL.

Given the close involvement of AEPC in the project formulation process and the close coordination of the project's outputs with those of NRREP, the level of country drivenness is strong. This level will remain high throughout implementation. AEPC will be the implementing partner and the project team will be housed in AEPC offices.

3 Project Objective, Outcomes and Outputs

For embarking on a low-carbon path for development in rural Nepal through accelerated sustainable RE development, research has shown that there still exists barriers preventing increased utilization of renewable energy in rural Nepal. The Project Result Framework was drafted predominantly on the basis of GEF approved PIF with necessary changes incorporated with respect to some of the outcomes and outputs. This was necessitated because at the time of PIF, there was no NRREP. The Project Result Framework was extensively discussed with stakeholders including a Stakeholder Workshop held on 7 January 2013 in Kathmandu.

3.1 Project Objectives

The immediate project objective is the removal of barriers for increased utilization of renewable energy resources in rural Nepal. The interventions will add to opportunities for livelihoods, income generation, employment and GHG emission reduction, which will support in economic, environmental, and social development of people in the rural areas; emphasis will be given to women, and marginalized groups. Thereby, the project outcomes will be contributing to the goals of objectives of the millennium development goals.

The project will meet its objective by ensuring 12.5 MW of Large-scale renewable energy projects (Mini-hydro and Large-scale solar PV) implementation. Furthermore, it will ensure that more than 50% of available electricity generated is utilised for livelihood and quality of life improvement.

3.2 Project Components and Outcomes

The barrier analysis above has shown that (1) high cost of technology, (2) lack of commercial financing, (3) low utilization of produced electricity, resulting in financial sustainability issues and (4) low capacity and awareness leading to less dissemination of high potential technologies are the major barriers for increased utilization of renewable energy in rural areas. Furthermore, it has been shown that Mini-hydro and Large-scale solar PV projects are the most appropriate technologies to address the above issues. Following four project components are identified to address the barriers with respect to Mini-hydro and Large-scale solar PV projects. Subsequently, outcomes are defined relating to the each project components.

The complete support system and activity flow of the UNDP-GEF RERL project is depicted in Figure 3.

3.2.1 Component 1: Enhancement of RE investment environment

Component Description

This component is designed to address policy barriers in attracting more private and public sector investment in these sub-sectors. The outcome of the Component is enunciated as follows:

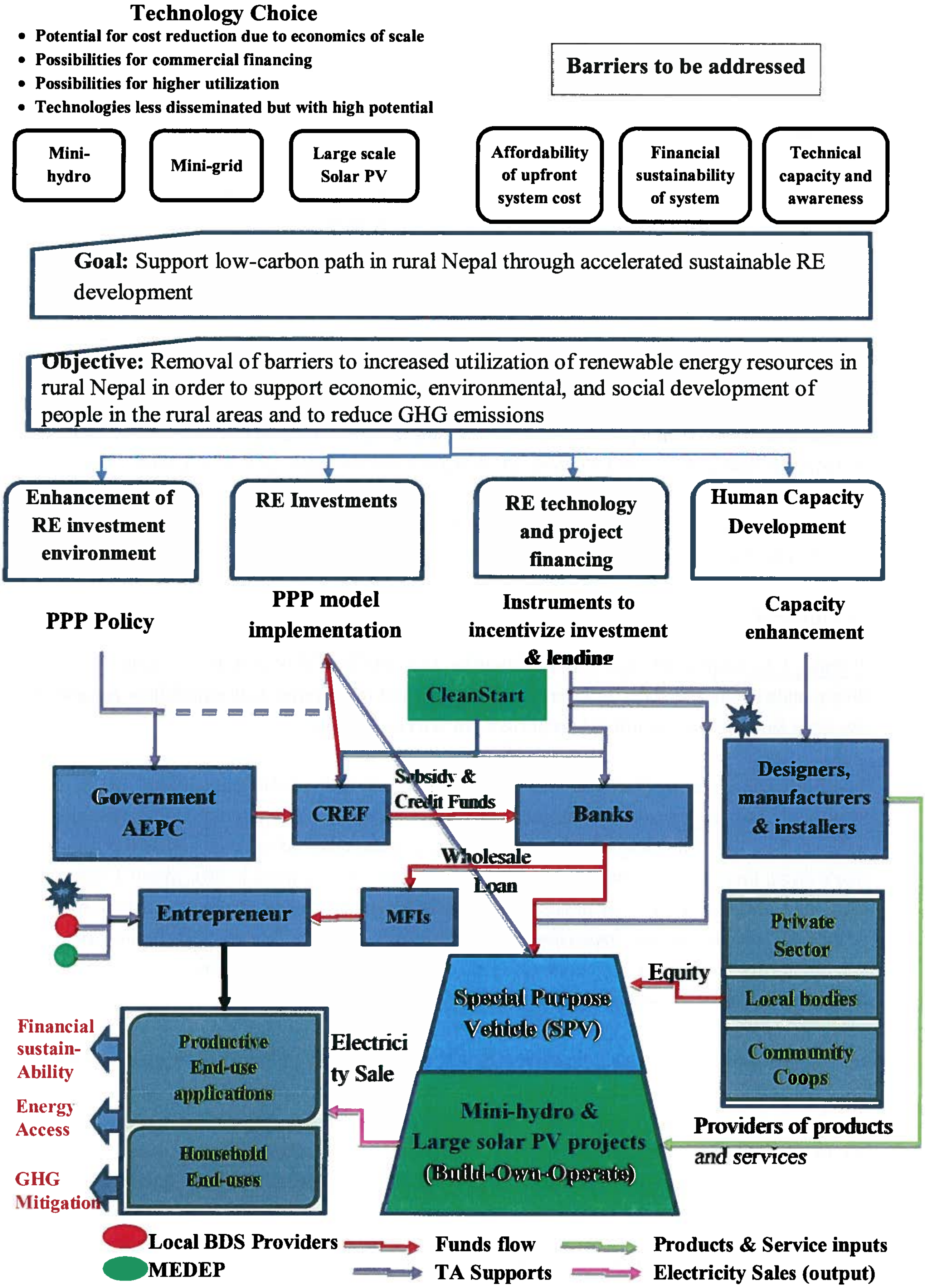
Outcome 1: "Strengthened legal, institutional and policy environment to support RE and other low-carbon technology development & utilization."

Indicators for this outcome are: (i) Number of RE-based power generation projects that were proposed and developed as influenced by the strengthened policy regime on RE and low carbon development by end of project, (ii) Number of district energy plans developed that include mini-hydro and large scale solar PV power generation installations by Year 3, and (iii) Number of policies and legal frameworks that are supportive of RE-based energy production were approved and enforced by Year 3

The project will realise the outcome by: i) ensuring the approval and enforcement ofa private sector investment friendly policy for PPP model, ii) building capacities of the District Development Committees (DDC)to develop local plans for Mini-hydro and Large-scale solar PV,providing comprehensive methodology and information, which is expected to help in their planning process, and iii) providing orientation and training to government officials, and other relevant stakeholders about the sub-sectors and the relevant policies.

The formulation of the Mini-hydro PPP policy should be integrated with Nepal's Rural Energy Policy (2006) which is in the process of revision. The policy formulation should be followed by demonstration of the implementation of the PPP model in actual projects, along with suitable financing mechanisms, capacity building of manufactures, developers and operators of Mini-hydro projects, and promotion of and support to productive end uses of Mini-hydropower. See Section 3.3 for the description of activities. This approach will ensure the sustainable development of Mini-hydro projects in Nepal, which can then be replicated in a Large-scale. The in-depth presentation of PPP model envisaged for Mini-hydro projects is provided as Annex 2.

Figure 3: Project TA supports and fund-flow



Similarly, where communities can be more formally organised, such as through a registered cooperative, and where private sector is absent to invest in Mini-hydro and large-scale solar system to meet rural energy requirements, a community owned model to develop and operate such energy facility can also be supported.

Component Strategies

In this component, the focus is on enhancing the investment environment for mini-hydro and larger scale PV technologies by providing policy supports to the government along with supports for policy planning and enhancing information availability for policy decisions. At the central government level, this technology-specific focus is particularly important to note, as more general policy work is being supported by other efforts within NRREP. With regards to policy intervention, the project will support formulation and adoption of a policy that will create positive environment for a public-private partnership (PPP) model to flourish and attract investment in mini-hydro and large-scale solar PV systems. As for planning, the project will support the local District Development Committees (DDCs) in developing local mini-hydro and large-scale PV plans by making resource information available. The project will also emphasize making this information available to investors. Capacity building of government officials at all levels, as needed, is also included to make them more aware of the benefits and requirements of mini-hydro and large-scale PV systems.

Component Outputs

<u>Output 1.1:</u> Approved and enforced policy that enables PPP model for mini-hydro and large-scale solar PV development, including fiscal incentives and suitability for possible changes in Nepal government structure (to federal system)

The output is a set of approved and enforced policies that enable mini-hydro, micro-hydro, mini-grid, and large-scale PV projects to be developed with private sector investment. To achieve this, the following will be carried out: (1) Revision of current subsidy policy to be made more favourable to attract private-sector investments in mini-hydro, micro-hydro, mini-grid, and large-scale PV projects; (2) Establishment of private-public partnership (PPP) policy for private sector investment in mini-hydro projects[34]; and, (3) Establishment of specifications and policy to ensure grid connection of mini-hydro, micro-hydro mini-grid, and large-scale PV projects once the grid arrives to the local area.

- *(1) Subsidy revision:* The current government subsidy policy (2013) is pro-poor and at the same time attracts the private sector to "provide quality products and services in rural areas". It is also links subsidies with loans and increase agricultural productivity and promotes more non-farm livelihood activities by increasing the number of micro, small and medium sized enterprises. Yet, there are a number of aspects of the policy that limit its

[34] Modality and concept on how PPP can lead to success in achieving project objectives is described under Outcome 2b, designed to provide technical assistance for realizing investments into Mini-hydro, Large-scale solar PV, etc.

effectiveness in attracting the private sector and promoting livelihood activities of larger scale. The activities to deliver this output will address these aspects, which include: (a) capacity and per household usage limitations of the subsidy policy, (b) lack of inclusion of micro-hydro mini-grid in the subsidy policy, (c) lack of eligibility of private-sector invested projects for the subsidies, (d) flat-rate subsidy for productive uses, and (e) lack of specific subsidy for village-scale PV. See Section 3.3 for description of Activities.

(2) New PPP policy: The targeted PPP policy will clearly provide government commitment to attracting and retaining private sector investment in mini-hydro projects. It will include incentives, simplification of government processes, assurance against nationalization, protection against change of law, etc. See Section 3.3 for description of Activities.

(3) New grid connection specifications and policy: The project will put in place a policy for future grid connection of mini-hydro, micro-hydro mini-grid, and large-scale solar PV projects to address the potential of grid extension to the local area. The project will develop specifications for grid connection, so that new projects can comply with these from the design stage. The project will further ensure that these projects will remain sustainable with the advent of the grid by putting in place a feed-in tariff for them, which will ensure electricity, is bought by the State from these projects. The project will work with NEA to realize the aforementioned specifications and policy. See Section 3.3 for description of Activities.

Output 1.2: Methodology and database developed and made available for incorporating mini-hydro and large scale solar PV systems into district RE plans

This output will ensure the availability of resource data for Mini-hydro and Large-scale PV projects at the district level, thus providing attraction to the private sector. The needs assessment or market-demand for energy produced from Mini-hydro and Large-scale PV for 15 districts will be carried out. The assessment will first be carried out in five districts as follows:

- One district in each of the five Development Regions of the country
- Where possible, these districts should be the same as those in which RERL demonstration projects are being carried out.

The mini-hydro resource assessments will include information on the available resources and also the potential productive use applications of electricity in the district. The Large-scale solar PV systems' feasibility will include potential sites identification in the district, based on availability of landmass and analysis whether solar PV is one of the least cost renewable energy options. The project will also prepare methodologies for resource and needs assessment so that they can be replicated in more districts. The above two assessments prepared for each district will provide sufficient information for the respective DDC to be able to include mini-hydro and large-scale solar PV systems in its plans.

Once assessment preparation is complete for the first set of districts, the remaining ten districts will be selected based on interest shown for this activity. The project will call for applications from the districts on a prescribed form to be developed by the project. The applications will be evaluated primarily based on the level of DDC commitment. Replication in the remaining districts will be mainstreamed with AEPC/NRREP's relevant activities.

Output 1.3: Completed training and awareness programs for relevant government agencies and stakeholders on mini-hydro and large scale solar PV systems development and productive end uses

Currently, because of frequent transfers, both central government officials and district level officials are usually unaware of the potential benefits of, sustainability strategies for, and policies regarding larger off-grid hydro and PV systems. In addition, due to the emphasis to date on smaller systems, they are less familiar with mini-hydro and large-scale PV systems. This output will be realized through training and awareness enhancement programs that address the knowledge gap of stakeholders regarding the latest policy and information on mini-hydro and large-scale solar PV systems development and productive end uses. The training will focus on both central and district-level officials on the basics of the various technological options and the benefits of larger systems, including the potential and challenges of integrating productive uses to achieve financial sustainability of larger systems. The training will also educate them about the various financing structures possible, including the benefits of the PPP model. They will be informed about current policy provisions and other incentive mechanisms in place. In addition, awareness of the central as well as district level government officials will be increased from the aspect of energy needs of the women and vulnerable groups for living, livelihood and community services

At the central level, trainees will consist of officials from AEPC, Ministry of Science, Technology, and Environment, Ministry of Finance, Department of Electricity Development, etc. At the district level, training will focus on local development officers, DDC planning officers, and district energy and environment office personnel. These training and awareness programs will be carried out in the same fifteen districts for which the project support preparation of the resource and needs assessment described in Output 1.2 above.

Among the activities that will deliver this output include the preparation of three case studies of mini-hydro best practices and three case studies of large-scale solar PV systems. Based on these case studies and based on documents prepared as a part of the activities to deliver Outputs 1.1 and 1.2, at least five training/awareness events will be conducted to train and orient relevant government agencies and stakeholders on mini-hydro and large-scale solar PV system development and productive end uses.

Such knowledge dissemination will enable the targeted stakeholders to support and actively promote mini-hydro and large-scale solar PV development, which will in turn help the project to achieve its targeted outcome of an enhanced investment environment in these areas.

3.2.2 Component 2: RE Investments

Component Description

This component will address barriers that need to overcome so that Mini-hydro and Large-scale solar PV projects are implemented through an appropriate ownership and operation modality. The sizes of the target energy projects are much larger than what has traditionally been implemented (micro-hydro) and still being planned under the baseline project. The latter still faces difficulties in mobilising funds for equity. The efforts to mobilise community for equity in the form of collective action alone will not solve lack of equity issue.

The energy development projects to be funded as demonstrations are on Mini-hydro and Large-scale solar PV projects for village electrification powering household end-use services, enterprises, institutional and community services, water pumping for drinking and irrigation.

The total capacity of all Mini-hydro demonstrations is 1000 kW. These are meant to showcase the feasibility of Mini-hydro projects andattract the private sector to invest in such initiatives through, 1) suitable policies to support public-private partnership, 2) suitable levels of financial supports and financing instruments to provide a level playing field for investment in off-grid Mini-hydro as compared to other similar investment opportunities, and 3) ensuring a regular cash flow to the project through development and implementation of productive end use applications of hydroelectricity.

Similarly, the solar PV demonstration projects will address barriers to Large-scale rural solar PV systems, viz. institutional, high capital cost and technical capacity barriers.

In addition, to making a point that larger system capacity will enhance possibility of higher utilization of energy produced, demonstration mini-grid projects interconnecting existing micro hydro projects of about 300 kW will be implemented.

The Component 2outcome is increased investments in RE. The relevant outputs that will contribute to the realization of this outcome are divided into two groups, those that are due to the: (2a) investment supportto demonstration projects; and, (2b) technical assistance to demonstration and post demonstration projects.

Outcome 2: Increased investments in RE

This outcome will be achieved through the implementation of demonstrations, which will showcasethe project development model in terms of organization, formation, financing, construction and operation. The demonstration is all about conception, financing and operation of the renewable energy projects.

The first type of outputs that will contribute to the realization of Outcome 2 (i.e., 2a) caters to the needs of enhancing the financing environment for the demonstrations. The selected demonstrations will receive investment supports in terms of making each of them attractive

for Special Purpose Vehicles (SPVs) to invest in equity and finance from Banking and Financial Institutions (BFIs) as detailed in the description of Outputs (2a). The identified financing tools are Mini-hydro Credit Fund, Insurance Premium Support Fund, seed-money for Maintenance Fund, and Limited Interest Relief Fund. These tools are elaborated in Component 3. Under Component 3, the development of financial instruments to support the implementation of the demonstrations consisting of three Mini-hydro projects with total capacity of about 1 MW; mini-grid connecting various micro hydro system of 300 kW and financially sustainable and Large-scale solar PV projects including village electrification (micro-grid), water pumping for drinking water supply and micro irrigation and institutional installations for health posts, schools, and village enterprises totalling 500 kW in total in installed capacity[35]. In the future, these mini-grids may also bring incomes to the communities through integration with the national grid -- income that would not have been possible had the smaller micro-hydro stations been maintained independently.

Activities to deliver the category 2b outputs will be implemented in a coordinated manner with activities that are designed to produce the category 2a outputs. These activities will involve the provision of technical support to each demonstration from feasibility study to commissioning and setting up of O&M systems (outputs 2b.1 to 2b.3). Post-demonstration technical support will be provided (outputs 2b.4 to 2b.6) along with the financial support from the national programme - Central Renewable Energy Fund (CREF).

Building on the experience and expertise gained from the implementation of the demonstrations, support to the post-demonstration projects will be facilitated through normal assistance available from the national programme, i.e., NRREP. It is expected that the success of the demonstrations will provide evidence of the financial viability of larger systems, which will bring about a multiplier effect in terms of additional investments and implementation of post-demonstration projects.

The achievement of Outcome 2 will be manifested by financial closures for:

- 10 MW of Mini-hydro projects by the end of the project period - This includes successfully commissioned 1 MW of Mini-hydro from 3 demonstration projects and 2 MW of Micro hydro of size larger than 60 kW; and,
- 2.5 MW of Large-scale solar PV system including successfully commissioned demonstration projects of various sizes totalling 500 kW.

Selection of Mini hydro Demonstrations: The selection will focus mainly on commercial viability, social impacts and GHG abatement potential. A list of Candidate Projects along with their salient features for Demonstration and Post-demonstration projects has been prepared and presented in Annex 3.

[35] Technical supports will be provided to these demonstration projects and they are described separately under Outcome 2b

Component Strategies

The focus of the activities under Component 2 is on demonstrating the commercial viability and financial sustainability of larger off-grid renewable energy systems and thereby advancing their dissemination. The demonstrations will prove/show the viability of commercial financing of mini-hydro through a PPP modality combined with productive applicationsfor ensuring utilization and revenues are high.

Private Public Partnership (PPP) and Special Purpose Vehicle (SPV) modality:

In terms of project organization and implementation, Private Public Partnership (PPP) modality is assumed to provide the highest possibility of sustainable implementation and operation of the project. The PPP model is discussed in more depth in the Annex 2. In addition to funds for equity, the private sector also brings in operational efficiency necessary for sustainability. Development actors are often tempted to add another dimension of "P" meaning people or Community. However, for our purpose the word "Private" in Private Public Partnership is assumed to represent not only institutionalised private sector (i.e., a registered private company) but also formal institutions formulated with wider participation of communities like cooperatives as long as the motive includes profit making. However, if there are informal organisations in the project areas they should be encouraged to get formally institutionalised at least as a cooperative prior to engaging in the energy development projects.

Detailed description of the equity composition of the proposed SPV is given in Annex 2. As described in the Annex, the proposed equity composition will be:

Public sector (25 percent of equity)

- District Development Committee (15%)
- Village Development Committees (10%)

Private Sector (75 percent of equity)

- Individuals/Promoters (51%)
- Local people (Beneficiaries) including co-operatives (24%)

The Special Purpose Vehicle (SPV), a legal entity owning and operating the Mini-hydro and Large-scale solar PV projects, will be established to implement the PPP modality. The SPVs are owned jointly by entities within the private and public sectors including communities through local cooperatives. The composition of ownership of the SPV should be such that it attracts the formal private sector (additional funding source) for the investment, i.e., allowing the formal private sector to own the majority stake so that the SPV can be operated efficiently as a commercial operation. The SPV will rely on substantial commercial financing and productive end-use applications, facilitated by activities in another project component.

A SPV, in Nepal, is generally understood to be any legal entity that has been established for a sole purpose. The normal practice in Nepal for an SPV is to form a company under Nepal's

Company Act, 2006. Forming a Company is a very common and established practice in Nepal in general, and also specifically for the small and mini hydropower sector. The proposed SPVs will be another such company with the special feature that it cannot undertake any business that is not part of the project. There is no additional transaction costs associated with an SPV as opposed to a "normal" company, and there are no investment limitations on SPV.

Therefore, the component strategies are:

- Implementation of the PPP model through the establishment of a legal Special Purpose Vehicle (SPV). Mini-hydro demonstrations (with combined capacity totalling 1 MW) will be implemented to promote commercial financing and expedited construction through technical assistance to additional 7 MW of mini-hydro projects as post-demonstration projects.
- In the first two years of the project, provide technical assistance to facilitate the installation of 2 MW of micro-hydro projects of size above 60 kW, as a transition to larger systems.
- Conduct demonstration on how the connection of nearby isolated micro-hydro stations into mini-grids (local-grid connecting micro-hydro projects totalling 300 kW) will enable more extensive productive use and thus greater system revenues.
- Support demonstration of financial sustainability of larger PV systems, including village scale PV (700 kW total, including 100 kW demo), institutional PV (700 kW total, including 100 kW demo), and PV pumping (700 kW total, including 300 kW demo).

Outputs for Outcome 2

Output 2a.1 Commissioned mini-hydro demonstration projects totalling 1 MW through PPP Model

This output will be facilitated by financial support to a SPV that will be created based on a PPP model to enhance cooperation between public sector and private sector in building, owning and operating Mini-hydro projects in rural areas in a financially sustainable manner. Public sector will be represented by the District Development Committee (DDC) and local Village Development Committee (VDC) and private sector by local community organizations like cooperatives and private investors. In Nepal, the proposed PPP model using a private sector controlled SPV is relatively new. As available funding from traditional sources and capacity in the public sector to implement many projects at the district level remain limited, it is natural for the public sector to seek partnership with the private sector as an attractive alternative to improve the supply of electricity. The public-private partnership (PPP) model will be an effective way to supplement limited public sector capabilities (both technical and financial) to meet the growing demand for electricity in rural areas.

A limited company (Special Purpose Vehicle, SPV) is envisaged to be registered with the office of the company registrar. This company (SPV) will be a corporate body for ownership, implementation and operation of the Mini-hydro projects. With the presence of a separate corporate body, SPV, to own, build and operate Mini-hydro projects, bank / FI will feel comfortable to provide loans to Mini-hydro projects and expected to overcome various barriers relating to risks, financing, loan repayments, and sharing of rewards. The role of local institutions such as the DDC and VDC will be important in building partnership with the private entrepreneur. From among the Candidate Projects, following 3 Mini-hydro projects are selected for Mini-hydro demonstration:

The list of the demonstration projects to be supported is given in Table 29.

Table 29: List of the Mini-hydro Demonstration Projects

SN	Project	District	VDC	Installed Cap, kW	Households
1	MewaKhola MHP	Taplejung	Khokling	500	3913
2	GiriKhola	Jumla	Hanku	200	1840
3	Upper Junbesi SHP	Solu	Junbesi	250	935

The financial analysis has been updated based on UNDP-GEF RERL demonstration project modalities including financial support as envisaged (Refer component 2a and 3a). The key technical and financial parameters of these three projects are given in Table 30.

Table 30: Key Technical and Financial Parameters of Mini-hydro Demonstration Projects

SN	Projects	Installed Capacity (kW)	Gross Head (m)	Number of HH	Project Cost (2013 '000 NPR)	Subsidy Anticipated ('000 NPR)	Equity ('000 NPR)			Loan ('000 NPR)	Return on Equity %	FIRR
							Private	Public	Communit			
1	Mewa Khola	500	17.5	3,913	218,288	85,000	20,393	9,997	9,597	93,302	20.7%	9.4%
2	Giri Khola	210	61.0	4,274	81,249	46,200	5,362	2,629	2,524	24,534	34.7%	17.3%
3	Upper Junbesi	250	61.0	935	83,969	43,700	6,161	3,020	2,899	28,188	29.9%	14.4%

The Government of Nepal has a provision for making renewable energy sector value added tax (VAT) free. Due to implementation complexities, VATs in case of Micro and Mini-hydro projects are expected to be refunded to project developers on claiming after project completion. Funds received as VAT refund (VAT is usually accounted into project costs) will be transferred to maintenance fund.

Within the assumptions of 30:70 equity-loan ratio and prevailing subsidy arrangement (Subsidy Policy, 2013), all three projects have demonstrated very attractive financial result that should help in attracting private sector and financial sector to invest in mini-hydro demonstration projects. Return on equity of MewaKhola Mini-hydro is found to be 20% and project's internal rate of return (IRR) is about 9.4%, whereas remaining two of the

demonstration showed more attractive financial returns as depicted in the Table 30 above. Detailed financial analysis of Mini-hydro demonstration projects are given in Annex 2.

Output 2a.2 Commissioned mini-grid demonstration projects totalling 300 kW

To deliver this output, financial support will be provided to enhance the feasibility of the demonstration of financially sustainable and reliable Mini-grid connecting various micro-hydro systems totalling 300 kW.

For Mini-grid projects to be financially viable it is necessary that micro hydro projects are near the electricity users to reduce the cost of transmission lines. In addition, existence of potential market to utilize total electricity supply capacity is necessary. Major problems that a mini-grid project may face are management of conflicts, complexity in operation and adopting commercial tariff.KailashKhola Mini-grid project (Local-grid[36]), in Achham, a district far-western development region with capacity to synchronise 12Micro-hydro projects with total installed capacity of 398kW has been selected from a list of 4 candidate mini-grid projects based on its potential for financial sustainability. The local government's commitment and other technical, social and market situation the project's viability is unquestionable. The current UNDP RERL project is collecting information and conducting feasibility study of the project.

Output 2a.3 Commissioned large-scale solar PV demonstration projects totalling 500kW

This output will be delivered with financial support provided to enhance cooperation between private sector and public sector (PPP Model) for the demonstration of financially sustainable and reliable Large-scale solar PV projects (500 kW total).

Large-scale solar PV projects to be considered under the project will include Solar-PV Village Electrification, Institutional Solar PV systems for schools and hospitals and Solar PV pumping systems for drinking water and irrigation. To qualify for the demonstration as Large-scale solar PV project, the project must have been endorsed as a feasible project by the Technical Review/Evaluation Committee (TR/EC) of the AEPC.

The selection will focus mainly on commercial viability, social impacts and GHG abatement potential. A list of Candidate Large-Scale Solar PV Projects along with their salient features for Demonstration and Post-demonstration projects has been prepared and presented in Annex 3.

[36]The term Mini-grid is defined in NRREP as an off-grid electricity distribution system with its own generation system and a local transmission distribution system with more than one generation system is defined as local-grid. However, to continue with what has been defined as mini-grid in UNDP-GEF RERL Project PIF, term Mini-grid is used to represent a local transmission distribution system with more than one generation system.

From among the Candidate Projects, four Large-Scale Solar PV Projects have been picked up as initial demonstration projects which are listed in the Table 31; more projects amounting to 500 kWp will be identified and supported during the inception phase of the project along with validation of information on these 4 demonstration projects. Any new opportunity available for demonstration project should also be investigated and included in the Candidate Project List during inception phase.

Table 31: Large-scale Solar PV projects

SN	Project	District	VDC	Installed Capacity, kWp	Number of Households
1	Solar Mini grid Electrification Project	Saptari	GobarGauda	10.5	70
2	Community Solar Electrification	Sindhupalchok	Gumba	1.8	54
3	RamiteKhola Solar PV Electrification	Morang	RamiteKhola	30	50
4	Awalching Solar PV Electrification	Surkhet	Awalching	10.5	75

Compared to Mini-hydro projects, level of details and design methodology is not harmonized in the case of Large-scale solar PV projects. The above four demonstration projects were selected on a preliminary feasibility study. However, a detailed feasibility study or revalidation based on prefixed criteria and prevailing subsidy policy during inception period will be carried out by the GEF RERL Project Implementation Team. It is expected that the financial feasibility will be ascertained for proper financial engineering of these projects. The UNDP-GEF RERL project formulation team has prepared a financial simulation model for Large-scale solar PV village project and pumping project for drinking water and the model is presented in Annex 2 (PPP for RE Implementation and PPP Financing). As per the simulation model findings, both village electrification and pumping for drinking water are found to be financially attractive for implementation through the PPP model; creating a SPV may be a strong possibility. Village electrification project demonstrated 25% IRR and Pumping project demonstrated about 30% return from the project. Given the equity-loan ratio of less than 1, the return on equity would be even more, which provides opportunity to further tweak the assumptions to make it more cost effective for end-consumer.

Output 2b.1: Demonstrated PPP models facilitating cooperation between private sector, public sector, and local organizations through establishment of Special Purpose Vehicles (SPV) in three selected mini-hydro projects (1 MW)

This output comprises of installed Mini-hydro demonstrations with collective total capacity of 1 MW and funded through PPP model. These demos will show that Mini-hydro projects developed in areas with possibilities for substantial productive end use opportunities can be developed successfully under the PPP model with substantial private sector equity participation, commercial financing and productive end use applications. This can make the Mini-hydro projects financially sustainable and attractive to private sector participation.