SUMMARY

Nepal: Scaling Up Electricity Access through

Mini and Micro Hydropower Applications

A strategic stock-taking and developing a future roadmap

WORLD BANK GROUP

ASTAE

Asia Sustainable and Alternative Energy Program

Background

Nepal is currently facing a crippling energy crisis. Despite the techno-economic potential to generate 43,000 MW of hydroelectric power in Nepal, approximately 710 MW of the potential has been developed by the state-owned, vertically integrated electricity utility, Nepal Electricity Authority (NEA), and private independent power producers. The total domestic generation capacity is merely 760 MW for a population of 27.8 million and an area of 147,181 km^2.

About 70 percent of the population in Nepal is estimated to have connections to on-grid (about 45 percent) and off-grid (about 25 percent) electricity. Load shedding in the grid is up to 12 hours per day. The remaining 30 percent of the country's population, mostly in rural and remote areas, have access to neither on-grid nor off-grid electricity.

Development of renewable energy technologies (RETs), both on-grid and off-grid, has become crucial to increase energy access for better overall development, poverty reduction, and shared prosperity. Isolated RETs such as micro hydropower can substantially improve the rural economy.

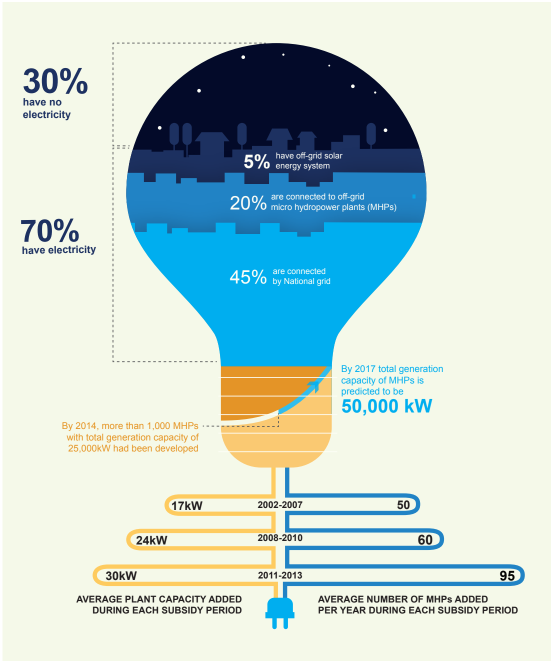
History of Micro Hydropower in Nepal

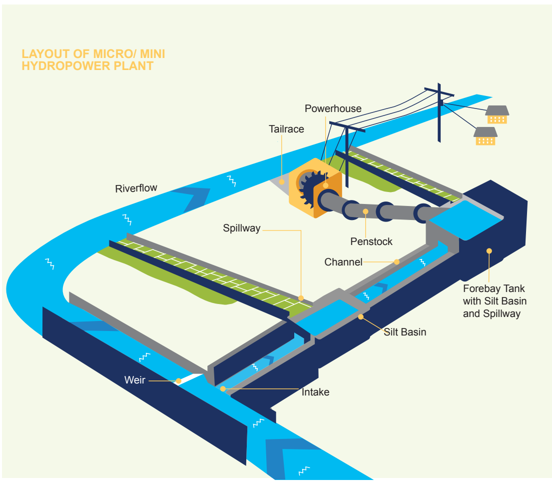
Micro hydropower plants (MHPs) have been serving off-grid rural households in the hilly regions since they were introduced in Nepal in the 1960s.

The Alternative Energy Promotion Centre (AEPC) was established in 1996 as a central body of the Government of Nepal (GoN) to promote alternative energy, especially in the rural areas. By 2014, more than 1,000 MHPs with a total generation capacity of 25 MW (or 25,000 kW) had been developed. Of the 25 percent off-grid electrified households, MHPs supply approximately 20 percent and solar home systems supply the remaining 5 percent. Over the years, the average MHP size has increased steadily - from 17 kW in 2002 to 30 kW in 2013.

By providing a US$21.5 million grant under the Power Development Project from 2003 to 2013, the World Bank, in collaboration with the United Nations Development Programme (UNDP), supported the AEPC in constructing 321 MHPs. The installed capacity of 7.5 MW provides electricity access to 77,634 households.

The GoN, in collaboration with development partners that support Nepal's rural and renewable energy sector, designed the National Rural and Renewable Energy Programme (NRREP). The NRREP, being implemented by the AEPC for five years (2012 - 2017) as a single program modality, aims to install an additional 25 MW of micro/ mini hydropower to provide electricity to an additional 150,000 rural households by 2017.





Problems with Rural Electrification in Nepal

Although the AEPC promotes standalone MHPs and the NEA manages the distribution lines for rural electrification, coordination between the AEPC and NEA is limited since they are under different ministries: the AEPC is under the Ministry of Science, Technology and Environment and the NEA is under the Ministry of Energy. The AEPC supports MHPs, assuming an economic life of minimum 15 years, in areas where the NEA grid is unlikely to be extended within five years. The NEA, however, makes grid extension plans on a yearly basis. Therefore, it is hard to predict how grid extension will affect MHPs in the long term.

As the NEA extends its grid to rural areas, many MHPs will become redundant if they are not connected to the grid. At present, 34 MHPs with net capacity of 1.0 MW (or 1,000 kW) have been affected and 56 MHPs with net capacity of 1.7 MW (or 1,700 kW) have high potential to be affected by the grid extension. There are minor extensive productive end users (such as grinders, hullers, oil expellers, and saw mills), who are reluctant to switch from MHPs to the NEA grid because of unreliable and poor quality (or prominent problems of load shedding). However, the majority of people prefer the NEA-supplied electricity. Therefore, if the

SYAURE BHUMI MICRO HYDROPOWER PLANT - A CASE STUDY

The Syaure Bhumi MHP in Nuwakot District is one of 34 MHPs affected by the grid extension. The Syaure Bhumi MHP was successfully constructed with generation capacity of 23 kW in June 2013, but it has never been in operation. During its construction phase, the NEA grid reached the project area and the potential consumers of the Syaure Bhumi MHP project (240 households) opted to receive services from the national grid. At that time, the project was on the verge of completion and after its completion the project has been idle: about 182,160 kWh of available electricity remains unused every year.

For the development of the Syaure Bhumi MHP, the community has taken a loan from a private bank. Currently, the community is unable to pay even the loan interest since the MHP has not been generating any income and revenue.

The NEA used to be reluctant to have grid connections to MHPs having capacity less than 100 kW. In July 2014, however, the NEA instituted the policy to purchase power from MHPs with less than 100 kW capacity. Then, the community submitted to the AEPC a request for support to the Syaure Bhumi MHP grid connection (such as installation of a synchronizer and a transformer) to sell the electricity to NEA, as a pilot case.

The findings and recommendations of 'Addressing Public and Private Sector Opportunities for Scaling up Decentralized Renewable Energy Access' by the World Bank will provide timely support to the GoN, AEPC, NEA, and local communities for planning new MHP projects and designing grid connection of MHPs, including the Syaure Bhumi MHP.

right policies for connecting MHPs to the grid are not in place, these plants will be forced to shut down and then abandoned.

To understand the barriers and opportunities for scaling up micro hydropower projects and to provide recommendations on how such scaling-up can be achieved, the World Bank conducted a study on 'Addressing Public and Private Sector Opportunities for Scaling up Decentralized Renewable Energy Access'. The study analyzes issues pertaining to the micro hydropower sector, provides policy and operational recommendations to the Government, and proposes guidelines for the World Bank's future strategy regarding scaling-up of the micro hydropower sector.

Key Findings and Recommendations

1) Prioritize MHP as the most cost-efficient off-grid rural electrification method.

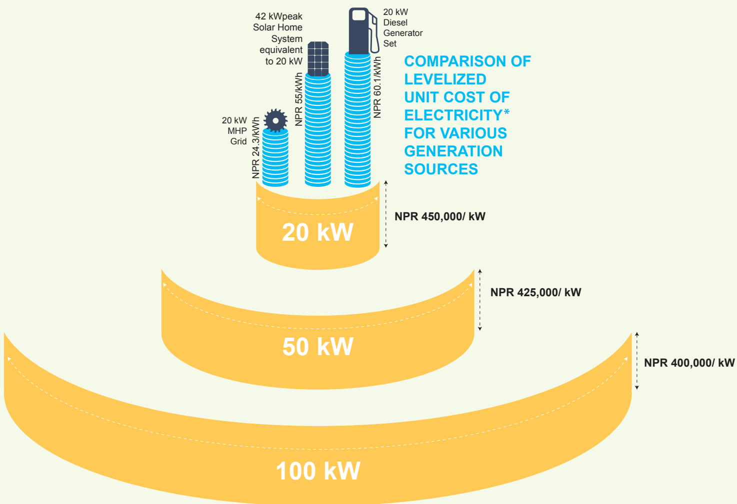
For delivering the same level of services as a typical MHP in rural Nepal, other methods (such as diesel and solar) are more than twice as expensive. Therefore, MHPs should be the first choice to deliver off-grid electrification where they are technically feasible.

2) Continue subsidy support for MHPs to ensure delivery of economic benefits to rural areas.

Although rural electrification through MHPs returns economic benefits approximately three times larger than the investment and operating costs, MHPs are not financially viable in the conventional sense. Therefore, the subsidy should be continued to support the MHPs' development.

3) Scale up MHPs by aggregate demand and optimize site potential.

Smaller plants are usually less viable and cost more to set up than larger plants. The current demand-driven MHP planning, based on a community request, leads to development of several small MHPs in the same area serving adjacent communities and underutilization of the hydropower potential of the site. The focus of planning for MHPs should be changed from merely meeting the current power requirements of the community to optimizing site potential by aggregating demand (or communities to be electrified) and promoting end use (or local business use).



CAPITAL COST OF STANDALONE MHPS

NOTE: US $1 = NPR 100 (US CENT 1 = NPR 1)

* Levelized Unit Cost of Electricity (LUCE) is the ratio of discounted operating cost plus capital expenditure to number of kWh generated over the life time of a generation facility

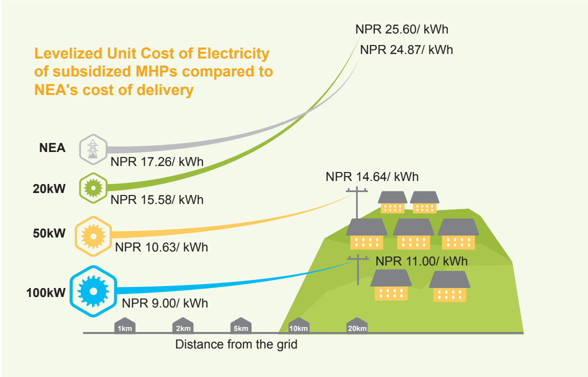
4) Build grid-compatible MHPs.

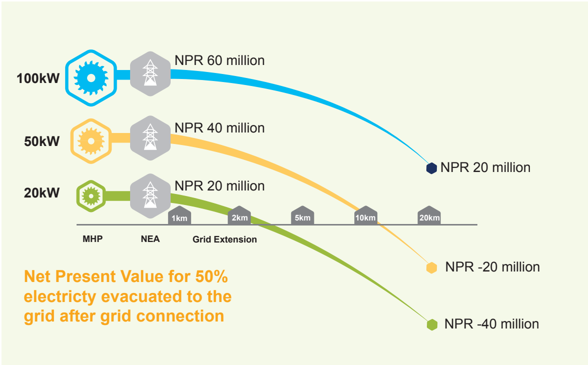
Once the national grid arrives in an MHP's service area, grid connection is unequivocally the next step forward. Therefore, new standalone MHPs, especially those larger than 50 kW, should be designed to be grid compatible. For example, all new MHPs need to have an off-grid distribution network meeting the NEA standards and household metering systems enabling their existing customers to make a smooth transition from a power-based, non-metered tariff that is currently adopted to the NEA's energy-based, metered tariff system.

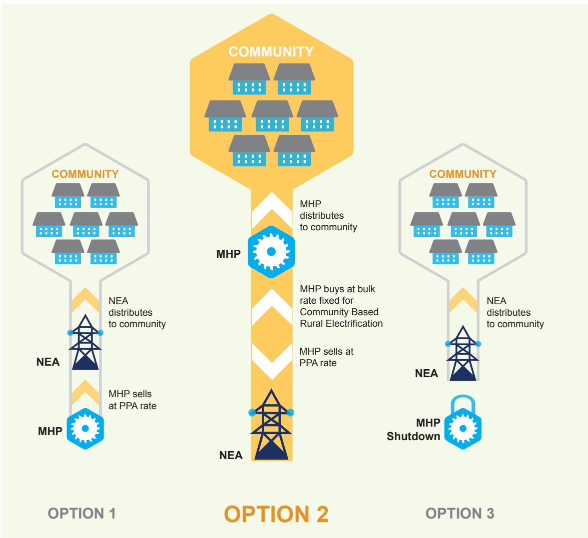
Since the cost of interconnecting MHPs is high and unrelated to their capacities, it would be more efficient to deliver power to a larger set of consumers from a single scaled-up MHP rather than install several small MHPs (the formation of the mini-grid by connecting multiple MHPs is not financially viable).

5) Give preference to connect MHPs to the national grid.

The NEA should give preference to purchasing power from MHPs by connecting them to the national grid since delivering electricity through an MHP is more economical than delivering electricity through the NEA's grid. The cost of delivery through the NEA's grid in the rural hills is NPR 17 - 25 per kWh (US$1 is approximately equal to NPR 100) depending on the distance of grid extension, and it costs NPR 9 - 15 per kWh by a grid-connected 50 - 100kW MHP. Recently, the NEA's Board of Directors passed the feed-in tariff for MHPs at NPR 4.8 per kWh for the wet season and NPR 8.4 per kWh for the dry season, which are the same power purchase agreement (PPA) rates offered to independent power





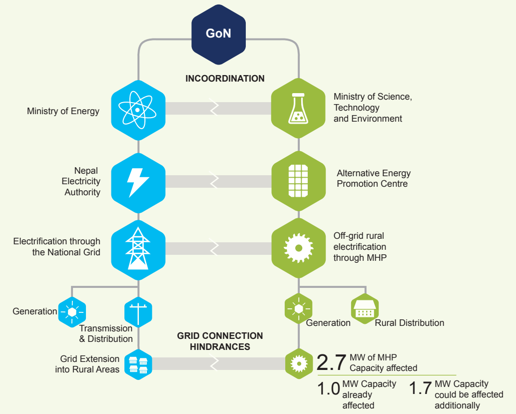


producers of large hydropower plants. Therefore, for every unit of electricity purchased by the NEA from an MHP and sold in the rural hills, the NEA incurs a lower cost and it makes financial sense for the NEA to buy power from MHPs by connecting to the national grid. Intentional islanding with appropriate safety and control mechanisms, however, should be used to provide reliable service to consumers of the grid-connected MHP when there is load shedding on the national grid.

6) **Establish innovative financing instruments to finance grid connection of MHPs.**

The AEPC should facilitate access to low-cost loans (as well as risk guarantee) rather than provide capital subsidy to the rural communities (or the MHP owners) for grid connections of MHPs. Even if only 50% of the generated electricity can be evacuated (or sold to the NEA) from MHP due to load-shedding of the NEA grid, grid connection still offers positive net present value.

7) **Harmonize rural electrification programs by effective coordination between the NEA and AEPC.**



The Government provides subsidy support both to the community-based rural electrification program for extending the national grid to rural areas through the NEA and to MHPs' development through the AEPC. Therefore, it is critical for these two programs to be harmonized so that the subsidies are used optimally and the MHP-grid interface issues are resolved in a planned manner. Most importantly, the NEA and AEPC should collaborate to prepare a national rural electrification master plan.

THE WAY FORWARD

Overall, the study concludes that the AEPC should vigorously pursue scaling up MHPs as standalone installations. Simultaneously, it should work closely with the NEA to gain experience by operationalizing the grid connection of a few pilot MHPs. Based on the experience gained, it should also work on creating an enabling policy and procedure for grid connection of MHPs.

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