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ENERGY INSIGHT

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PEEDA

Editors: Biraj Gautam & Tapendra Chand

Message from the

CHAIRPERSON

The role of non-government organizations is indispensible for a country like Nepal and is considered as one of the major actors in the socio-economic development. The northern countries and international agencies consider NGOs as alternate institutional mechanisms for the transfer of resources to the needy community and also for understanding the reality of the developing countries. Initiatives taken by NGOs in all sectors including that in energy and environment have significantly contributed to the upliftment in living standard of rural people through just and right-based approach in promotion of energy systems.

People, Energy & Environment Development Association (PEEDA) is an NGO dedicated to improve livelihoods of communities, particularly the poor, by collective utilization of renewable energy (RE) resources, while ensuring due care for the environment. It mainly focuses on institutional development, promotion of cooperation to undertake projects, advocacy and targeted research. We believe that poverty will substantially be reduced through effective, socially responsible and environmentally sustainable RE development.

Since its establishment, PEEDA has been undertaking innovative initiatives esp. pertaining to hydropower development through initiation of PPHP concept and promotion of three institutions e.g. -Hydro Lab P. Ltd. established for hydraulic modeling, Hydro Consult Engg. Ltd. established for providing quality engineering consultancy services and Center for Energy and Environment Development. PEEDA is also undertaking developmental projects and carrying out research activities.

I am greatly delighted that PEEDA has been able to publish a publication that serves both promotion and knowledge sharing among wider stakeholders. I hope that this publication would assist in increasing awareness on the sector. I would like to acknowledge the efforts of PEEDA management team in bringing out this annual publication. Lastly, I would also like to extend my sincere thanks and gratitude to the Executive Committee, members, development partners and all other stakeholders for their invaluable contributions to PEEDA.

Thank you!!!

Murali Prasad Sharma
Chairperson, PEEDA

Message from the

CHIEF EXECUTIVE OFFICER

Access to energy for all is universal right. However, about 25% of Nepalese are still away from electricity, mostly modern energy sources. There are plenty of resource options that can be utilized to provide energy access to them. It is proven that decentralized energy generation system is a quick and effective way of addressing energy access to rural Nepal. In this context, Nepal's energy system needs to be adapted into a more sustainable one based on a diverse mix of energy sources, addressing the pressing challenges of security of supply and climate change.

PEEDA has been conducting various energy and environment related activities and projects over the last 20 years. PEEDA has been exploring and executing concepts and technologies that could impact lives both on shorter and longer terms. PEEDA is currently executing five projects and has been playing a significant role in the development of sustainable energy in Nepal.

After conducting numerous activities and research, PEEDA has taken this opportunity to disseminate information. It is also imperative to bring together other works on Renewable Energy and environment so that a collaborative effort could be instigated for sustainable development. Hence, this yearly publication called “Energy Insight” has articles and research papers on various technologies as well as concept notes on different relevant projects.

After successful publication of “Energy Insight” last year, this is the fourth attempt to deliver the findings to the concerned stakeholders. However, I do acknowledge that there might be plenty of shortcomings both with regards to the content or the concept as such. I sincerely do hope that your valuable comments, suggestions and timely advices would help us to put together a better publication in the years ahead.

I greatly appreciate the individual authors who voluntarily contributed by sharing their views and findings in this publication. Finally, I would also like to sincerely thank the Chairperson, the Executive Committee, my colleagues, partners specifically Bread for the World (BfdW) and the publishers for their support in bringing out this publication. Last but not the least; I would like to thank Bread for the World (BfdW) for their financial contribution for the publication of this magazine.

Thank you!!!

Biraj Gautam
Chief Executive Officer, PEEDA

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Dr. Narayan P. Chaulagain,
Energy Efficiency Expert

1. Background

While a well-functioning transport system is a key to Nepal's economic progress, it can also be its bottleneck. Despite its positive contribution, the transport sector has in the past shown a certain resistance to policy changes and still poses as one of the highest final energy consumers in Nepal. Increasing transport sector energy demand is one of the main challenges for energy security and climate change. Globally, the transport sector consumes approximately one-fifth of global primary energy and is highly dependent on oil (OECD/IEA, 2012a). Appropriate policy interventions can enhance the efficiency of energy use in the transport sector leading to greener and more sustainable transport system. A reduction in transport sector energy consumption can provide significant benefits for energy security, improved health, better environment, economic development and reducing individual user fuel costs. Therefore, improving energy efficiency in this sector is a matter of urgency.

Nepal's Transport sector alone consumes about 58% of the total petroleum products followed by residential sector (WECS, 2013). Sector-wise, about 85% of the total energy consumed in the transport sector is contributed by the road transport and only 15% by the air transport. According to fuel type consumed by the transport sector, the largest share has been made by the diesel (60%) followed by petrol (24%). By vehicle type, trucks and passenger cars together consume 50% (25% each) of the total energy consumed in the transport sector followed by bus (16%) and mini-micro bus (7%) whereas two wheelers consume about 8% of the transport sector energy consumption. Kathmandu valley alone consumes about 52% of the total transport sector energy of Nepal followed by other big cities and urban centres like Birgunj, Biratnagar, Pokhara, etc. The rapidly increasing number of vehicles and vehicular movement has caused an almost 13% annual average growth in the transport sector energy consumption during the period of 1994 to 2013 AD (WECS, 2013), which might even be accelerated due to rapid economic growth in the future. Nepal's air quality was ranked 177th out of 178 countries, according to Yale's 2014 Environmental Performance Index[2] , better only than Bangladesh. Without properly addressing the transport sector management, the situation will very likely be worsened in the future.

In this regard, improving energy efficiency in the transport sector is very much vital in order to make transport sector more cost-competitive, cleaner, greener and more sustainable. Improved energy efficiency in the transport sector reduces transport cost, significantly improves air quality, increases road safety (standards) and reduces travel times.

2. Issues and Challenges

Transport does not mean just cars; rather it covers a bigger category like buses, bicycles, trucks, railways etc. Nepal does not have its own

1. The views and opinions expressed here are the author's own and not necessarily reflect the views of the organization he is associated with.

2. Source: http://www.theguardian.com/cities/2014/mar/21/air-pollution-kathmandu-nepal-liveable-smog-paris

vehicle manufacturing unit so far and therefore, the vehicles or the accessories related to them have to be imported from other countries. Existing vehicle import policy allows import of only the vehicles meeting Nepal standard for mass emission (Euro 1) and not older than 5 years. The current fuel efficient technologies are already cost-effective and available widely in the global market. Their benefits outweigh the additional costs over vehicle life. However, they are yet not widely used in Nepal because of the existing barriers including policy gaps. These barriers exist while purchasing and using fuel efficient vehicles and translate into a slow turnover of vehicle stocks compared to fuel supply price dynamics. Existing policies and practices do not necessarily encourage the use of bicycle or public mass transport. The planning of physical infrastructure including housing and roads in urban or semi-urban areas of Nepal has not adequately considered the benefits of transport sector energy efficiency.

Consumer education and knowledge on the benefits of energy efficiency and possible measures to improve it are limited. Policy intervention could address some barriers related to potential behavioural shortcomings. One of the behavioural shortcomings involves the low priority that users of passenger vehicles give to fuel efficiency, even though fuel-efficient vehicles benefit consumers through reduced spending on fuel consumption. Consumers might not take fuel costs fully into consideration during vehicle purchase and be reluctant to pay additional costs for fuel efficiency improvement (OECD/IEA, 2012a). Vehicle owners or drivers hardly get trained on how to improve vehicle efficiency or on how to drive more efficiently. Regular servicing, repair and maintenance of the vehicles are still not a common practice.

Enforcement of existing policy and rules for prohibiting vehicles not meeting the emission standards as well as for promoting energy efficiency is another problem. Effective monitoring mechanism to ensure the enforcement of existing rules, to regulate the transport management and to recommend new measures is yet to be fully functional.

Policies that promote fuel efficient technologies and improve tested and in-use fuel efficiency, including fuel economy standards, fiscal measures, information and education programmes, will play a critical role in maximising fuel efficiency improvements. Significant improvements in fuel efficiency can be achieved with necessary policy interventions. Energy efficiency policy interventions include fuel efficiency labelling, standards and fiscal measures. Policies to improve transport fuel efficiency should encourage transformation of the new vehicle market by addressing market failures, information gaps and the higher upfront costs associated with more innovative technologies. It is impractical and costly to improve the efficiency of existing vehicles and vehicle stocks turn over only every 10 to 15 years (OECD/IEA, 2012a). Therefore, in the context of Nepal, policies must focus on improving the efficiency of the new vehicles and limiting the use of less efficient old vehicles. Information dissemination and display measures such as fuel economy and emission labelling; vehicle fuel economy and emission standards; and fiscal measures such as vehicle taxes, tax incentives and fuel taxes are some of the required policy interventions which possibly could improve the energy efficiency in the transport sector. Policy and industry needs are to be addressed at the national level and collaboration on fuel efficiency is to be increased at the international level by aligning targets and policy designs-particularly countries in the same region. Similarly, initiatives on research, demonstration and deployment of advanced fuel-efficient technologies are still needed (OECD/IEA, 2012b).

Energy efficient transport policy can help Nepal harness potential benefits of improving energy efficiency in the transport sector through reduction of fuel consumption, vehicle emissions and air pollution. Therefore, the benefits of improving energy efficiency in transport sector are not just limited to saving in energy consumption rather contribute to sustainable transport system, better energy security, stronger economic development, increased air quality and ultimately, increased quality of life. Fuel efficient transport policy could help in implementing existing national emission standards and help in developing new standards based on the regional and international standards and practices.

Current prevailing illegal practice of syndicate of the transport entrepreneurs has been seen as one of the biggest barriers in introducing any new policies. There is a strong need of strengthening the implementation, enforcement and monitoring of the existing policies and regulatory provisions, which is equally important as establishing new policy measures.

3. Existing policies and Regulatory provisions on vehicle Energy efficiency

The environment protection act (1997) and rules (1997) prohibit the pollution of environment beyond the limit of prescribed standards through any measures including the emission from the vehicle use. Motor vehicles and transport management act (1993) and regulation (1998) also tried to include the standards to control emission. There are already policy provisions to limit the vehicle speed based on the vehicle category, road type and vehicle movement areas. Similarly, there are standards of permissible emissions from the vehicle based on the vehicle type. Only the vehicle meeting the Euro-1 standard and not older than 5 years can be imported in Nepal. Besides, diesel 3-wheelers have been banned in Kathmandu valley; second-hand/reconditioned vehicles are banned for import; only unleaded petrol can be imported; and there is 10% annual tax increase for vehicles older than 15 years. Similarly, there are already attempt to ban the use of commercial vehicles older than 20 years in Kathmandu valley.

4. Measures of Policy Interventions

Primarily, the measures of the policy interventions should be targeted in overcoming existing barriers, viz. institutional barriers; market barriers; barriers related to reliable and comprehensive information for ensuring effective education of policy-makers and the public; etc. Generally, the principal of 'Avoid-Shift-Improve' should be followed (VAN W McGrory, 2009), i.e. i) avoid or reduce the need of travel; ii) shift to more efficient modes of transport; and iii) improve the energy efficiency of transport vehicle technology.

4.1 Measures to Encourage Transport System Efficiency

Expansion of roads alone would not be sufficient to reduce the traffic congestion of roads without properly addressing the factors creating more demands of the vehicles. Therefore, measures to reduce the number of vehicles entering into the road, like promotion of effective public transport, car sharing etc. should be applied parallel to building and expansion of roads. Similarly, proper land-use and urban planning can also help in achieving better energy efficiency in the transport sector. Incentivising mixed-use urban development plan with long-term vision to ensure that retail, commercial and residential are developed together to reduce the need for car trips will enhance the transport system energy efficiency. Similarly, developments of bicycle-lanes, mass public carriers, underpasses, covered walkaways (which create safe and comfortable environment for pedestrians as alternative to driving) also discourage the use of private motorised vehicle and encourage the use of non-motorised mode of transport.

4.2 Measures to Encourage Trip/Travel Efficiency

The measures, like a)improving ridership on existing mass transit systems (e.g. Sajha Yatayat, new bus stops with solar PV lights, affordable fares, better connections, and enforcement on the limits of passenger numbers per vehicle); b) funding repairs and expansions of mass transit systems through tax revenue on land; shifting towards more sustainable modes of transport by encouraging people to choose public transport or zero emission mobility and discouraging the use of motorised transport; c) establishing more affordable, frequent, and smooth public transport; allocating road spaces (more sidewalks, dedicated lanes for buses and bicycles); and d) implementing vehicle size and weight standards on roads to shift freight transport to better energy-efficient modes will encourage the travel efficiency.

4.3 Measures to Encourage Vehicle Fuel Efficiency

The measures like implementing and adopting the existing standards for fuel economy; developing more stringent standards; prioritising the harmonisation of new standards with existing ones in the region or coordinate with neighbouring economies to facilitate manufacturers' compliance with new standards, etc will help in improving vehicle fuel efficiency. Likewise, establishing testing procedures for measuring fuel efficiency of vehicles and adopting them; and applying an incentive based "green-plate" checking system of the vehicles as it has been implemented for "drink-drive" checking can support to achieve the better efficiency. Similarly, fuel efficiency labelling, incentives and taxes to boost vehicle efficiency and accelerate the market penetration of new efficient vehicle technologies can improve the efficiency.

Apart from the engine efficiency, the operational efficiency of vehicle also plays a big role in transport sector efficiency. The measures like, adopting fuel-quality standards; designing drivers' education, training including development and dissemination of public awareness materials on energy efficient driving; enforcing programmes to improve driving behaviours, which can raise a vehicle's effective fuel efficiency significantly; etc. will increase the operation efficiency of the vehicle.

5. Conclusion

In order to improve the transport sector energy efficiency, a set of measures, such as smart infrastructure planning (which may reduce the need of travelling); encouraging use of non-motorised and public transport; and encouraging the use of more efficient vehicle and more efficient driving, are needed to be developed and adopted. Improved energy efficient transport sector can deliver additional co-benefits in addition to the energy saving, e.g. reduced fuel cost, decreased emissions, improved air quality, reduced travel time, better environment and improved quality of life. These benefits ultimately can contribute to sustainable economic growth of the country. However, establishment of strong and effective enforcement of control mechanism is a precondition for getting positive results of the suggested interventions and policy measures.

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Short-Lived Climate Pollutants and a need for their mitigation in Nepal

Prof. Amrit Man Nakarmi (Ph.D.)

Introduction

Short-Lived Climate Pollutants (SLCP) are climate enforcers that have relatively short lifetime in the atmosphere ranging from weeks to years (table below). The main short-lived climate pollutants include black carbon (BC), methane (CH_4) and tropospheric ozone (O_3) and some hydrofluorocarbons (HFCs). These short-lived climate pollutants are also dangerous air pollutants, with various detrimental impacts on human health, agriculture, and ecosystems. SLCPs are the major contributors to the anthropogenic global greenhouse effect after CO_2.

Atmospheric lifetimes of SLCPs and long-lived greenhouse gas CO_2

Pollutant		Lifetime
Carbon Dioxide		Decades to centuries; about 20% will persist for many millennia
SLCPs	Black Carbon	3 – 8 days
	Methane	12 years
	Ozone	4 – 18 days
	HFCs	15 years (average mix)

Source: (UNEP, 2011; EESI, 2013)

Over many years, the major causes of the global warming and climate change have been focused on CO_2 emissions. However, SLCPs for decades have been ignored as the major contributors to the climate change. The impacts of SLCPs have been less known and have been a factor of limited awareness for a small group of specialists and public policy makers. Despite SLCPs being major projected contributors for the climate change, no significant steps have been taken to mitigate the effects.

Addressing the SLCPs has now become an important issue not only because it can help reach the climatic target but also is closely linked to many development goals, directly and indirectly. Reducing SLCPs emissions would have positive impacts on health, energy, food security, sustainable transport, waste management, and climate. Due to a unique mix of emission sources and varying socio-economic and cultural conditions in different countries, national level actions plan for controlling SLCPs has been emphasized (UNEP, 2011). Sharma (2014) has given options for mitigation of SLCPs at regional and local levels in Hindu Kush Himalayan region. In the meantime, the SLCPs having transboundary impact, the issue should also be raised in regional and global levels. A study was conducted to prepare a pursuable, effective strategic action plan to mitigate emissions of priority SLCPs in Nepal and their precursors from different sectors, and to reduce their negative impacts on public health, food security and climate change.

Methodology

A definite block of work plan was developed for the study based on SLCPs National Planning Guidance Document by Climate and Clean Air Coalition (CCAC). The phases undertaken are:

- Initiating planning process & stakeholder consultations
- Assessing SLCPs in the national context
- Identifying opportunities to reduce SLCPs and estimate benefits of emission reductions
- Developing action plan with priorities for SLCPs abatement

There are various tools and software available that can be used for scenario analysis. Viewing the dire need of study of emission and technological implications of GHG and SLCPs, CCAC's SLCPs NAP toolkit for the formulation of the national action plan was used for the study. The toolkit is based on the Stockholm Environment Institute's (SEI) Long-range Energy Alternatives Planning (LEAP) system with an Integrated Benefits Calculator, which focuses on the health and crop benefits of reducing air pollution. LEAP allows users to build SLCP-relevant emissions models and implement SLCPs control strategies, while IBC links the emissions from LEAP to the GEOS-Chem adjoint global chemical transport model to estimate the concentrations of particle pollution and ozone and then estimates benefits for health, crops and climate implications.

The LEAP framework on the study is primarily divided into Energy and Non-Energy sectors which are dependent on macroeconomic and demographic factors. Along with these, technological and resource database are also fed into the system, firstly to create a base model and then future scenario development. The status of the SLCPs emissions in Nepal in 2015 has been derived using the LEAP modeling framework (see table below). The study period is taken from 2010 to 2050.

SLCPs and particulate matters (tons) from different sectors in the year 2015 (Calculation, 2016)

(In tons)

	Black Carbon	$PM_{2.5}$	Methane
Agriculture	575	748	57
Commercial	871	4,599	3,380
Industrial	1,590	4,958	363
Industrial Process Emissions	1	163	-
Livestock Farming	-	-	607,965
Rice Cultivation	-	-	126,633
Open Burning	4,662	64,732	41,418
Residential	25,428	145,716	120,046
Transport	6,426	16,948	265
Waste Management	73	1,103	129,983
Total	39,626	238,967	1,030,110

Results and Discussions

Various scenarios for Nepal were developed from 2010 to 2050 using CCAC's NAP toolkit for mitigation of SLCPs which is based on Stockholm Environment Institute's (SEI) Long-range Energy Alternatives Planning (LEAP) system. LEAP includes flexibility of including both energy and non-energy emissions within a single modeling framework. Besides, it contains an Integrated Benefits Calculator (IBC), which focuses on health and crop benefits of reducing air pollution. Two major scenarios have been developed viz. – Reference Scenario and Policy Scenario at GDP growth rate of 7% and population growth of 1.35%. The reference scenario is based on assumptions that current trend and existing policies will continue in the future as they are now. Different policies and activities based on documents and guidelines from CCAC are intervened with the focus on clean and renewable energy and other mitigation measures in non- energy sector. Some of the major strategic measures are full electrification in urban and high penetration of electricity in rural areas, high penetration of clean cooking technologies like improved cookstoves, promotion of mass transport and electric vehicles like buses, cars, trains and monorails, replacement of tradition brick kilns with modern brick kilns like zigzag, VSBK and Hoffman, electrification in all end- uses in manufacturing, commercial, and services sectors, feedstock improvement, herd management, intermittent aeration of rice fields, and control and ultimately ban on open burning. Policy scenario is developed assuming these strategic action measures.

Policy Scenario outputs indicate that BC emissions can be drastically reduced from their corresponding values in 2030 and 2050 respectively if compared to the reference scenario. Similarly, CH_4 and $PM_{2.5}$ emissions will decline by huge quantities in 2030 and 2050 compared to the reference scenario. An uncertainty analysis at 95% Confidence Interval, using Monte Carlo simulation for 10,000 iterations, indicates that Black Carbon estimates in the reference scenario have a range of 35 to 53 ktons in 2030 and 64 to 78 ktons in 2050 respectively. Similarly, $PM_{2.5}$ and methane have a range of estimates 241 to 313 ktons and 1.4 mtons to 2.4 mtons in 2030 respectively. The range of values for $PM_{2.5}$ and methane in 2050 are 351 to 419 mtons and 2.95 to 5.2 mtons respectively. In the policy scenario, the range of estimates for Black Carbon is 6 to 12 ktons and 5 to 9 ktons in 2030 and 2050 respectively. Similarly, the estimates of PM2.5 and methane are drastically reduced both in 2030 and 2050 in the policy scenario.

Compared to the reference scenario, premature mortality can be reduced by 11,000 in 2030 and 29,000 in 2050 respectively if policy intervention were done as per the action plan. Similarly, crop losses of 253,000 tons and 1.7 million tons (of major agriculture produces like rice, wheat, maize, and soybean) can be reduced in 2030 and 2050 respectively as per the policy scenario. Without any interventions, the additional emissions from Nepal, including CO_2 and SLCPs, can contribute to the global warming by 1.46 mK in 2030 and 4.18 mK in 2050 respectively. But with the decrease in major SLCPs in the policy intervention, the global temperature impact will be reduced to 0.7 mK and 0.9 mK in 2030 and in 2050 respectively.

The average country concentration of $PM_{2.5}$ in 2015 is 47μg/m3 in 2015, out of which 30% is from national anthropogenic emission but over 50% from the transboundary emission. In the policy scenario, national emission of $PM_{2.5}$ can be reduced by 2 times in 2030, but Nepal cannot mitigate transboundary emissions without regional and international cooperation. To address these measures, Nepal should have membership in regional and international organizations such as CCAC for cooperation in mitigation of SLCPs in the country. If the measures as per the national action plan are implemented and proper institutional set up created, the economic analysis indicates total benefits surpassing social costs by almost 3 times. Overall, Nepal should initiate without any delay its activities in mitigation of SLCPs and as a result, it will be far more beneficial to the country.

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Mechanical development of the PT series of turbine in Nepal

Joe Butchers (joe.butchers@bristol.ac.uk)
Electrical Energy Management Group, University of Bristol

At the pico-hydro scale (<5kW), the development of 'Peltric sets' was an effective solution to utilise high head and low flow sites. Across Nepal, there are many sites with a much lower head, which could be used for pico-hydro generation. Canals for traditional water mills and irrigation canals are common across Nepal; these canals often provide sufficient flow for a pico-hydro turbine however there is no turbine type that is currently in common use.

In 2001, Nepal Hydro Electric (NHE) began developing a series of propeller turbines with the purpose of using low head sites available in existing irrigation canals. The design was effective for use in low head sites in Nepal for the following reasons:

- High specific speed allows direct drive with a 1500rpm induction motor as a generator (IMAG)
- Using a load diverting governor e.g. running at a constant load overcomes the need for guide vanes or blade actuation which allows the use of a simple vertical shaft propeller turbine (Alexander et al, 1993)
- Draft tube allows the electrical components to be set well above flood plain level

NHE manufactured 4 PT02s (Propeller Turbine 0.2kW), 3 PT03s and 7 PT1s. Figure 1 shows an NHE 0.2kW turbine. The system was treated as a prototype device with detailed monitoring and testing throughout this period.

Figure 1: shows a PT02 MK1

From 1981, The University of Canterbury, New Zealand, began research into developing a micro-hydro turbine that could provide a "one-family-farm" with a viable power source. The design requirement was that the technology should match the capabilities of rural industrial resources and the needs of remote farming areas (Alexander et al, 1993). These design objectives resulted in a range of turbine designs that were appropriate for application in Nepal. One turbine developed at the University was a propeller turbine with a specific speed of 407 capable of a mechanical efficiency of 73% (Leane, 2009). Inspired by this particular design, NHE developed a PT03 MK2 (Mark 2) design. Figure 2 shows a 1kW PT MK2 turbine. The main focus for the design changes were to improve the performance of the turbine:

- **Scroll casing:** This removed the need for guide vanes which had been prone to blockages.
- **Shorter shaft:** The enclosed scroll casing meant the generator could be mounted on to the casing. This removed the need for a long shaft which had caused alignment problems.
- **Bearing:** A shorter shaft meant that the only bearings required were those inside the generator.
- **Water seal:** A spinning plate attached to the shaft creates sufficient centripetal force in the water to overcome the pressure in the surrounding flow.

Figure 2 shows a PT1 MK2

NHE manufactured several PT03 MK2 turbines but as the company grew, it was decided in 2005 that production of pico-hydro turbines was no longer financially viable. The technology remained unused until 2009 when the People, Energy and Environment Development Association (PEEDA) acquired the rights. PEEDA partnered with Oshin Power Services (OPS) to produce PT MK2 turbines. In collaboration, turbines have been scaled, built and installed at 0.3kW, 1kW and 3kW.

During the production of the first PT1 MK2, the fabrication of the scroll volute casing required machining. The size of the fabrication and its non-uniform shape created significant vibration when rotated in the lathe, see Figure 3. The machining operations on this part took over 70 hours and had to be sub-contracted to a machinist with a larger engine lathe.

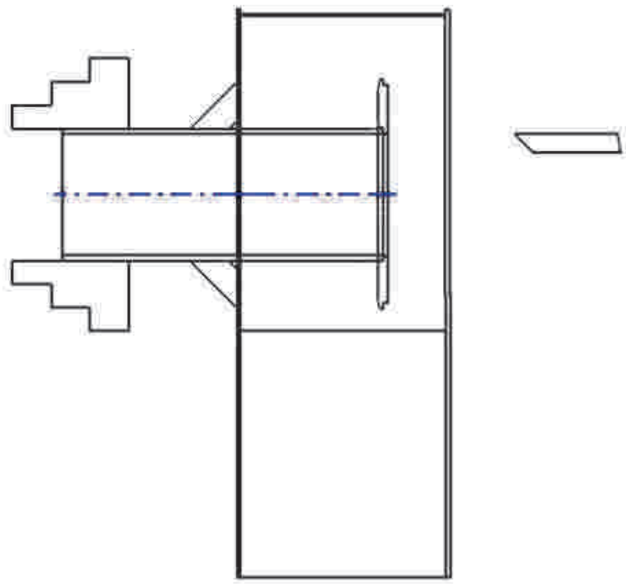

Figure 3 shows the volute casing mounted in the lathe.

Prior to the production of the second PT1 MK2, a re-design was conducted with manufacturability as the focus. As OPS is a typical small Nepali manufacturing company, it was decided that the objective should be that all parts could be made “in-house”. When manufacturing the second PT1, precision machining of the runner housing took place prior to fabrication with the volute casing. Then two jigs, shown in Figures 4 and 5, were used to align the upper volute plate with the runner housing and to align the generator assembly with the volute casing.

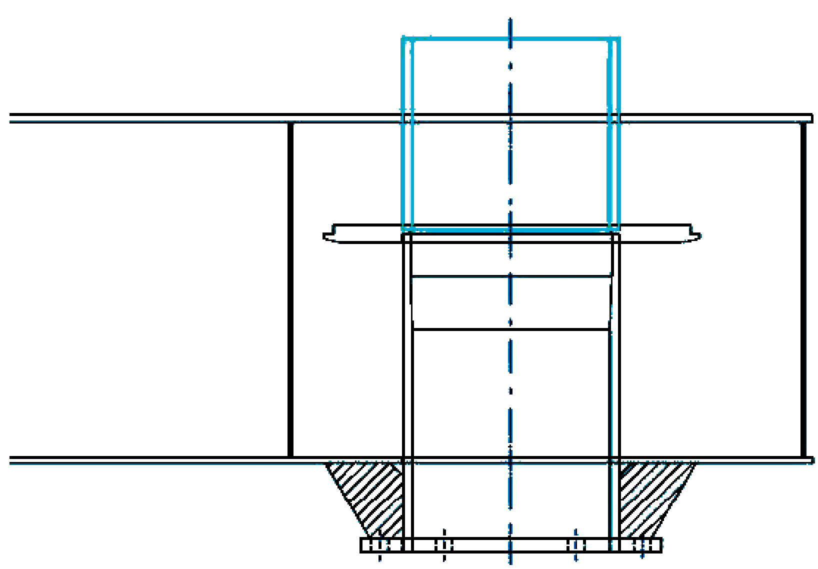

Figure 4 shows the jig (in light blue) which is used to align the top plate with the runner housing

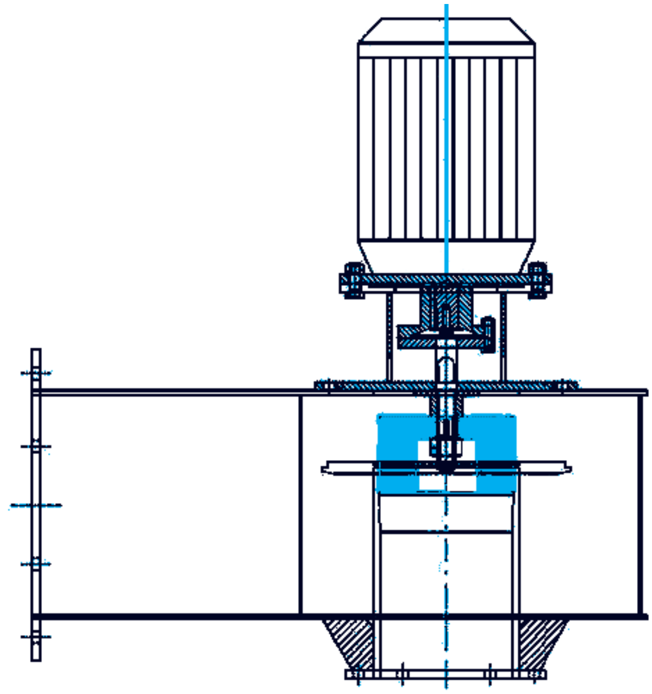

Figure 5 shows the generator assembly with jig (in light blue) attached to align the assembly with the runner housing

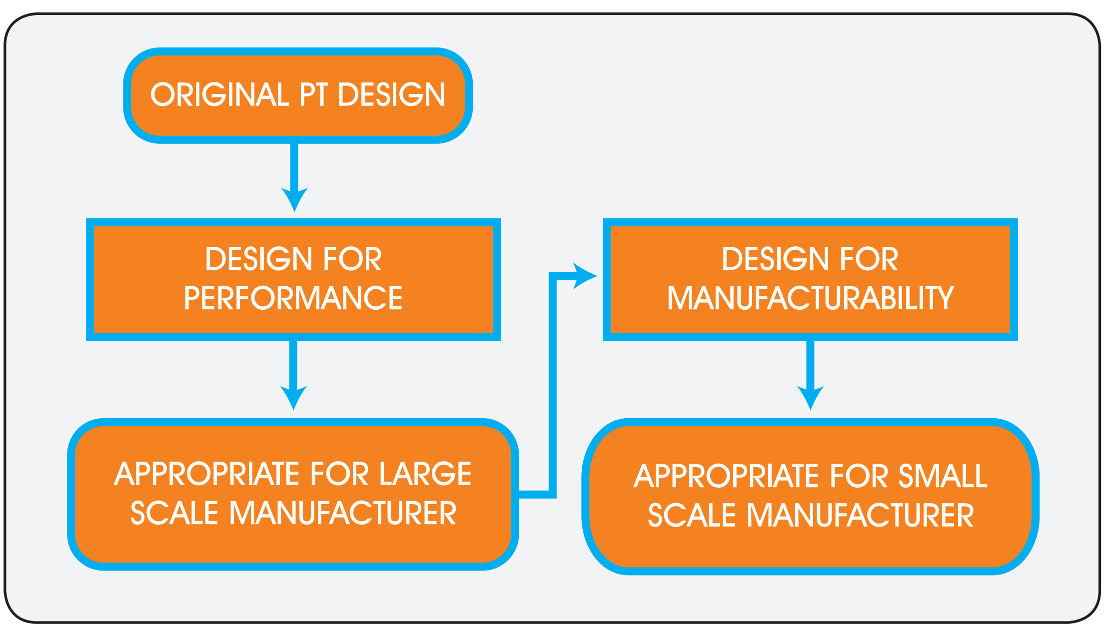

Figure 6 shows a diagram of the process of design change for the PT series

During its lifetime, the PT series of turbines has undergone two major re-designs. The first change resulted in a significant improvement in performance meaning the turbine could generate 1kW with a smaller flow and head. To increase the availability of the turbine, a second re-design was conducted to make the turbine easier to manufacture in Nepal. This is shown graphically in Figure 6. By ensuring all manufacturing could take place at OPS, the design is now more readily useable by a greater number of manufacturers. The result of these two major re-designs is a robust, efficient turbine appropriate for manufacture in small workshops. Currently, there are only 2 PT1 units and

1 PT3 unit operational in the field. These units must be closely monitored to assess their performance over time. To increase the number of PT turbines manufactured, it is proposed that the whole system design undergoes a “design for cost” process so that methods can be found to bring the price in line with ‘Peltric sets'.

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Improving Agricultural Profitability with Solar Powered Cold Storage for Small Farm Holders

Biraj Gautam* & **Tapendra Chand****
*Chief Executive Officer, PEEDA
**Project Officer, PEEDA

Background

In the present context of Nepal, majority of farmers in the rural villages have small quantity of land for farming (average land per household ranges from 0.2 – 0.25 hectare). Hence, these small farm holders have average production of few kilograms of vegetables per week. The farmers of nearby city can sell it immediately. But for the farmers in the remote locations neither there is guaranty of sell in the village nor it is viable to go to the nearest market to sell the produce in smaller quantity. This has direct impact on their opportunity of earning. However, collection of the produce from many farmers in a village can be a good amount to be carried to the market and making the money for the rural poor. It is also difficult to harvest the vegetables by all the farmers in the same day. Thus, circumstances that allow collecting farm produce at the time of harvesting and keeping that fresh for the longer time until a volume is accumulated would allow farmers sure short market. Thus, such cold storage is expected to improve livelihood while also creating local employment opportunities. Moreover, this will encourage famers towards vegetable farming and horticulture as well. So, the idea here is to promote such solar powered cold storage as a collection center as well.

The monthly income and consumption figures across different size class of land holdings show that marginal and small farmers have dis-savings compared to medium and large farmers. For large farm holder's access to the local market is convenient because of their good market linkages and private transportation facility. Furthermore, businessmen in the local market have more faith on large farm holders because of the quantity they supply and also the continuity and the risk bearing capacity. Accordingly, the yearly saving of such large farm holder's is noteworthy. Hence, in order to equip small farm holder's and make competitive as compared to large farm holders, such cold storage should be developed and promoted as collection center as well in the forthcoming days.

In the current scenario of Nepal, the electricity supplied from national grid is sporadic and is not sufficient in many remote areas of Nepal. Cold storage powered by such unreliable supply does not ensure extended storage without degradation on the quality of produce. Hence, powering such cold storage via solar energy could prove beneficial for farmers in terms of reduction in its operation cost and could be a sustainable approach for resolving acute energy shortages.

Technical & Innovative Aspect of Technology

Solar powered cold storage is simple, battery-less refrigeration system and comprises of specially designed compressors which runs at various speeds to adjust to the cooling demand, air cooling system and thermal storage system (maintains back up for 36 hours so that the system keeps on running during non-sunny hours and rainy season). The minimum temperature that can be maintained is 4°C (most horticultural produces require cooling temperature between 4°C to 15°C for sale storage and transient purposes). In total, 2.5-3.5 kW of solar panels can be used.

The cold storage have storage capacity of 5 metric ton and dimension of 10ft*12ft*8ft (L*B*H) which can also be customized as per necessity. The agricultural produce can be stored for 2 to 3 months depending on the demand and supply of local market. Moreover, apart from long-term storage, cold storage can also be used for on-farm or in-production catchment for horticultural crops and vegetables, so that the produce gets cooled during short term storage and likewise, can be located in the transportation vehicle in cool conditions to reduce wastages during transportation.

Solar powered cold storage has no running cost which stores energy in a uniquely designed thermal storage unit that controls compartment cooling in tandem with regular cooling. Last but not least, its intelligent programmable digital control system that sets the system temperature and humidity according to the commodity stored inside it.

The interior and external view of such cold storage is shown below;

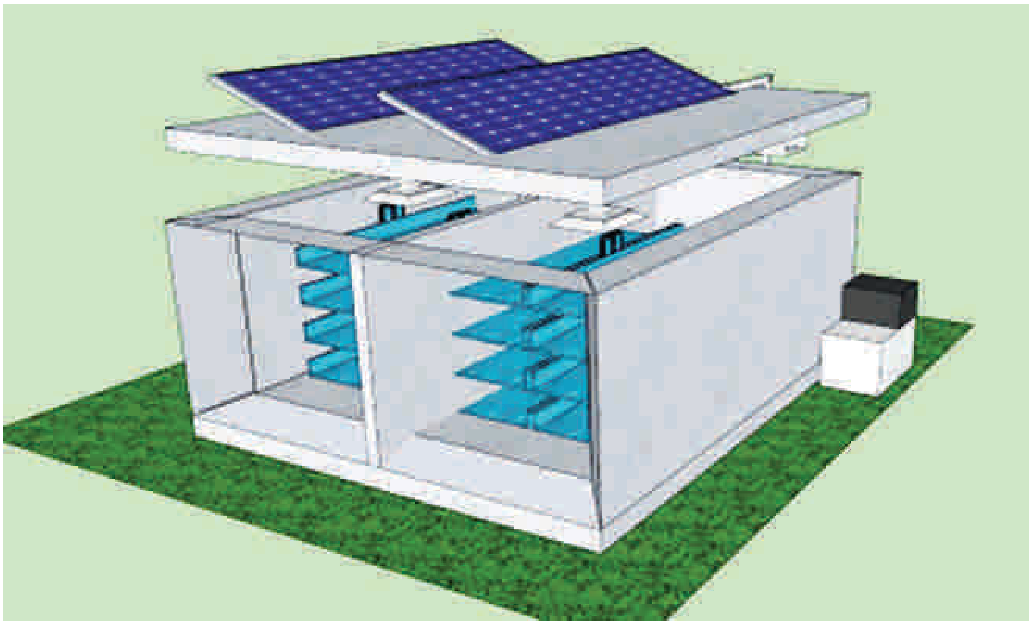

Figure 1: Interior of Solar-powered cold storage (5 metric ton)
[Source: https://www.indiamart.com/proddetail/micro-cold-storage-4514815548.html]

Figure 2: External view of Solar-powered cold storage
(Source: http://villgro.org/ecozen-solutions/)

Environmental Benefits

Such cold storage will encourage local farmers for vegetable and horticulture farming thereby maintaining greenery. Solar powered cold storage will prevent rotting of vegetables and fruits which will consequently prevent the emission of methane gas that is 21 times more harmful than carbon-dioxide contributing to climate change. Moreover, the refrigerant used in such cold storage is environment friendly and is supposed to have no negative impact on the environment.

Using solar as fuel for cold storage would avoid the possibility of diesel being used as fuel to power cold storage which is an avoided cost benefitting the environmental protection efforts.

Conclusion

Solar-powered cold storage system works at zero running cost and is a solution to the wastage of agricultural produce. It works on sustainable technology throughout the year. Using efficient solar panels, a thermal storage methodology controls compartment cooling in tandem with regular cooling. The cold storage unit is well insulated and also comprises of intelligent programmable digital control system that sets the system temperature and humidity according to the commodity stored inside it. Hence, such technology should be promoted for the socio-economic development of farmers residing in remote areas of Nepal.

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Role of Private Sector in Developing Rural Micro-Grid

Kushal Gurung and Ayush Acharya
WindPower Nepal Pvt. Ltd.
Email: info@windpowernepal.com

In Nepal, around 35% of the population still does not have access to grid electricity. And due to the tough mountainous terrain, it is technically and economically challenging to lay conventional on-grid electricity system in every corner of the country. Hence, micro-grids could be the only viable option for these remote and isolated communities.

Micro-grids are discrete, localized energy grid systems, having independent energy sources, load demand management, storage unit and distribution, capable of operating autonomously as well as in synchronous conjunction with an area's centralized electrical grid. A micro-grid design depends on the size, technology, demand, resource availability, social context, and quality and quantity of the service required in an area. Adequately financed micro-grids based on renewable energy resources can overcome many of the challenges faced by the rural communities, and supersede traditional lighting and electrification strategies; driving a community to become self-sufficient.

Due to advancement in technology, micro-grids have become more reliable and are on par with grid quality electricity. Micro-grids provide people with high quality, grid-comparable electricity to operate productive end use (PEU) loads that help local microenterprises generate revenue. Renewable energy based micro-grids also provides a cost-effective substitute to the commercial consumers who rely heavily on diesel generators. It has been accessed that cost of no electricity is about Rs. 40/KWh thus forcing commercial sectors of rural areas to run diesel generators to fulfill their energy demands. The local people of rural parts of the country fully recognize the economic prospects carried by renewable micro-grid projects.

Government of Nepal has been supporting rural micro-grids through its Alternative Energy Promotion Centre (AEPC). Up until recently, they were only promoting community led projects and only focused on micro-hydros. And these microhydros would become defunct once the national grid reached there. But now they are opening up to concept of private sector led projects, i.e. Energy Service Company (ESCO) model; accepting other technologies like solar and wind energy; and moreover, the system specifications are designed to be grid compatible so that the power plant could be connected to the national grid, if needed. As per the latest Renewable Energy Subsidy Program 2073, AEPC now provides 60% subsidy for up to 100kW rural micro-grid projects- either from micro-hydro, solar or wind. They also have special provision for projects between 100 to 1000kW, for which it has partnered with the World Bank and Asian Development Bank. Hence, in terms of policy, the country has officially opened up for private sector led micro-grid projects. However, there are still many challenges to attract the private sector into micro-grid business.

Biggest concern for private sector is the security of its investment, followed by the return on its investment compared to other alternative investment opportunities. Though Nepal ranks second, only behind India among 11 other developing nations, in terms of readiness for energy access investment, according to one World Bank SE4All report (World Bank, 2014), many private sectors would still be reluctant to invest in rural micro-grid projects in Nepal. Even with 60% subsidy, the internal rate of return on equity (Equity IRR) of a rural microgrid is merely around 10%, if we were to invest 20% equity and rest 20% as a debt at 10% interest rate, and keep the electricity tariff at Nepal Electricity Authority (NEA) rate. The return from micro-grid is less than half than that from an on-grid hydro project, whose expected equity IRR would be more than 17% on average. Furthermore, as the client in micro-grid are usually communities living below the poverty line, the perceived risk of payment default is higher, which could make the debtors and developers equally wary. While on-grid project provides legally binding power purchase agreement between the developer and the power off-taker- Nepal Electricity Authority. And since NEA is a government entity, their odds of defaulting is considered relatively less, such that the Banks are providing debts based on project financing, i.e. without extra collaterals or personal guarantee.

Experiences from community led micro-grid show that there are lots of operation and maintenance related issues due to lack of technical human resources in the community, which could eventually lead into shut down of the power plant. Hence, it is better to promote ESCOs, to run the micro-grids, which has been proven successful in India and Africa (United Nations Foundation, 2014). However, it would be very challenging to promote ESCOs under current scenario, as the return on investment from a microgrid can be perceived too low compared to the risk involved. Hence, there need to be more incentives to attract private developers into the microgrid business. Providing low interest rate on loan; collateral free debt finance; exemption on taxes and import duties on equipment needed in a microgrid project are some such incentives that could help to level the playing field.

In conclusion, it is about time for Nepal to promote private sector led micro-grids as a long run source of electricity in area those not reached out by the national grids. The government should subsidize renewable projects to a greater extent; at least for the time being to attract dealers and financing institutions. NEA should not resist incorporating micro-grids with the major national level grids and give the former equal chance to be in the black. In a nutshell, decentralized electricity supply system, primarily centered towards PEU load, not only creates a better return value for project developers but sequentially also increases the socio-economical potential of rural areas.

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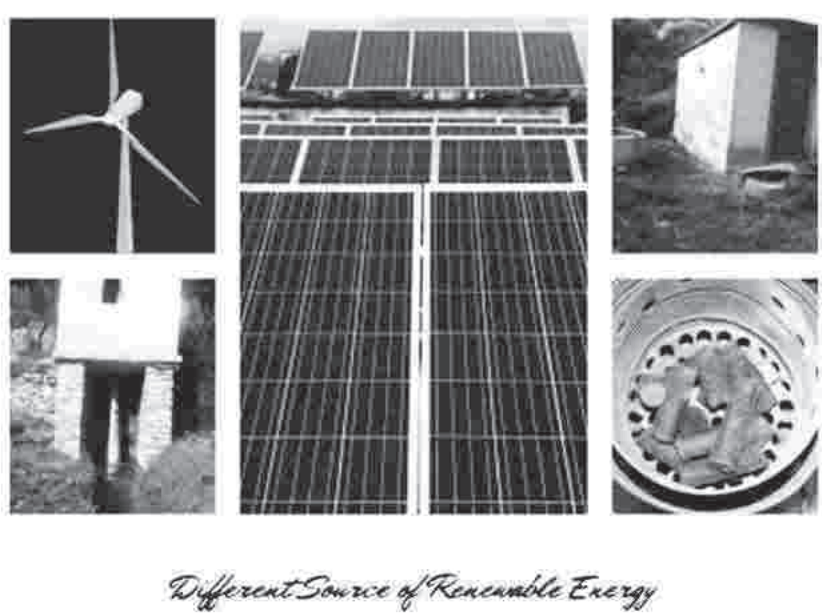
Current Scenario of Renewable Energy & Climate Change

Govinda P. Devkota
(Secretary, PEEDA Executive Committee)
Freelance Consultant
govindadevkota@yahoo.com

Renewable Energy

Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat. Renewable Energy Technologies (RETs) is a synonym for new, renewable and non-conventional forms of energy i.e. the technologies, which use local energy resources (other than commercial fuels) and biomass fuel (firewood, agricultural residues and animal wastes) in traditional forms. The main sources of these alternatives are biomass, (firewood, agricultural residue, dung cakes, biogas, etc) water, sun and air.

The majority of rural populations in Nepal are meeting their energy needs by burning biomass in traditional stoves which has several environmental and public health issues. Nearly all fossil-derived fuels consumed in the country are imported in a refined form, and the perpetual increase in petroleum imports has adversely impacted the existing fragile economy of the country. Despite a huge potential in harnessing various renewable energy resources such as hydropower, solar power, wind energy and bio-energy, these resources have not been sustainably captured due to geographical, technical, political and economical reasons.



Different Source of Renewable Energy

One of the studies conducted by Water and Energy Commission Secretariat (WECS) in June 2014 mentioned in the energy data sheet that the energy consumption and energy use in Nepal from various sector are as given in the following table 1.

Table 1: Energy Consumption and Energy use in Nepal by Sector

Energy Consumption		Energy Use	
Sector	Percentage	Sector	Percentage
Fuel wood	71.06	Domestic	80.36
Agricultural Residue	3.51	Industrial	7.89
Dry Dung	5.08	Business	3.43
Petrol	12.28	Transportation	7.12
Coal	3.93	Agriculture	1.17
Electricity	2.82	Others	0.03
Renewable	1.22	-	-
Others	0.11	-	-
Total	100.00	Total	100.00

Source: WECS 2014

The highest energy consumption is from fuel wood followed by petroleum, dry dung, coal, agricultural residue, grid electricity and renewable. Similarly the energy use is highest in residential followed by industrial, transportation, business and agriculture as shown in the table 1.

1. Biomass

Biomass as a source of energy mainly consists of fuel wood, agricultural residue and animal dung. Fuel wood and other biomass fuels are burnt in traditional stoves of various kinds. Agricultural residue can be converted into briquettes and brunt directly for energy purpose. Conversion of biomass technology into other efficient and convenient energy forms include biogas, improved cooking stoves, briquettes and gasifier.

I) Biogas

Biogas technology was introduced in Nepal some 40 years ago. About 116 companies are being involved in the construction of biogas plants these days and more than 6,000 people have been directly involved in biogas promotion in all the districts. By the end of July 2016 about 363,847 domestic family sized biogas plants (mostly 4 to 10 cubic meter of total volume capacity), 321 institutional plants and 1812 community biogas plants have been installed in the country (AEPC 2016). This has been made possible due to standardization of design as well as biogas appliances, an extensive system of quality control and financial incentive provided to potential users for the installation of biogas plants.

However, still there is a need to develop large size biogas plants especially running from wastes so that the waste could be managed on one hand and energy/electricity could be generated on the other hand. For this there is a need to do research on the cost effective and efficient plant.

II) Improved Cooking Stoves

Improved cooking stoves (ICSs) with efficiency of 18 to 28 percent have been developed in Nepal over some time. Research and development (R&D) have been carried out in these devices since the early eighties. As a result, different types of ICSs have been designed and developed. So far more than 1,245,089 mud brick ICSs and 47,841 metallic ICSs have been distributed all over the country (AEPC 2016). However, their actual uses vary considerably from place to place.

The efficiency of these improved stoves should be good enough so that there is considerable reduction of firewood consumption and no smoke in the kitchen.

III) Briquette

Wood and biomass including agricultural residues are important energy sources in Nepal. If these residues are densified, they can be burnt more efficiently.

This technology was introduced in Nepal in 1982 using rice-husk and sawdust as the main raw materials. It is a pyrolyzing technology and relies on partial pyrolysis of rice husk, which is mixed with binder and then made into pellets by casting and pressing. Another form of briquette making is beehive briquette made out of biomass char such as wood, leaves, twigs and other agricultural residues. Biomass is converted into char by carbonizing in a charring drum, which is a simple drum fitted with a conical shaped grate, a chimney and water sealed arrangement. The biomass char is grind into powder and mixed with 20 to 30 percent by its weight bentonite clay by adding required amount of water. It is then filled completely into the mould and made into briquettes. After drying in the sun for about two days these are ready to use in briquette stove. These briquettes should be easily available with affordable cost.

IV) Gasifier

So far 22 kW electricity have been generated from biomass gasifiers in the country. This technology needs to be promoted in the areas where there is availability of enough raw materials such as rice husk, wood chips, etc to generate power and supply of this power to the community people.

2. Mini and micro-hydro power

Mini and micro- hydro technology has enormous potential to promote environmentally sound sustainable development in hilly region of Nepal. At present, there are more than 58 Micro hydro installation and manufacturing companies and 52 consulting companies in Nepal. So far about 27,874 kW of power has been generated from pico/micro and mini-hydro plants including peltric sets. More than 10,594 improved water mill (IWM both long shaft and short shaft) have been installed all over the country (AEPC 2016). In the past, most of these turbines were installed solely for agro processing. But nowadays they are mostly for electricity generation and end use application.

Micro-hydro plant consists of civil and electro-mechanical components. Civil structure consists of intake, canal, desilting basin, forebay tank, support piers, anchor blocks and powerhouse. Similarly electrical components consist of generator, control panel, ballast heater, transmission distribution system, earthing, poles, stay sets, insulators and load limiting devices. Likewise, mechanical components of a micro-hydro scheme consists of penstock pipe, turbine, valve, drive system and expansion joints.

It is estimated that about one third of the micro-hydro plants installed in Nepal are in smooth operation, about one third not in operation, and another one third not working effectively. Hence, there is a need to rehabilitate these systems.

3. Solar energy

Today there are about 30 manufacturers of solar heaters and the total installed capacity in the country is estimated at 10,000 sq meters of solar panels.

Solar photovoltaic (PV) is not a new technology to Nepal. There are more than 41 pre-qualified companies for the installation of solar home systems. It is estimated that about 617,466 units of Solar Home System (SHS) have been installed in the country. Likewise about

102,019 small solar home system/solar tuki have been installed. Similarly 14,676 institutional PV systems and 1,696 solar pumping systems have been installed. On top of these about 500 solar cookers and 1,895 solar dryers were also developed and propagated (AEPC 2016).

Solar systems installed by various companies needs to be monitored strongly by the third party as some of these systems are not in existence though they are in record.

4. Wind energy

Wind is still one of the unharnessed energy sources in Nepal. There are 17 installation companies and survey and designing prequalified companies for wind energy. Its countrywide potential has not been assessed yet. Some studies have indicated that wind potential for power generation is favorable in Tansen of Palpa, Lomangthang of Mustang and Khumbu regions of Nepal. However, 64 kW electricity have been generated so far and wind monitoring and mapping data are not available for many places.

A study needs to be carried out on the feasibility of the Windmill in various places of the country and wind mapping data to be made available.

The following table highlights the installation of the RETs in the country:

Table 2: Installation of RETs in Nepal

SN	Type of RETs	Unit	Total Installed
1	Pico/Micro/Mini Hydropower	kW	27874
2	Improved water mills	Number	10594
3	SHS	Number	617466
4	Small SHS/Solar tuki	Number	102019
5	Institutional PV system	Number	14676
6	PV pumping system	Number	1696
7	Solar cookers	Number	500
8	Solar dryers	Number	1895
9	Domestic biogas	Number	363847
10	Institutional biogas	Number	321
11	Community biogas	Number	1812
12	ICS (mud brick)	Number	1245098
13	ICS metallic	Number	47841
14	Biomass gasifier for electrification	kW	22
15	Wind energy	kW	64

Source: AEPC (up to 12 April 2016)

It is assumed that 17% of the Nepalese population has been electrified from Mini & Micro hydropower and Solar PV. Likewise, approximately

3.64 million people have been benefited from different renewable energy technologies in Nepal. Renewable energy technologies have helped in reducing emissions.

Even though, Nepal has remarkably accelerated the dissemination of different forms of aforementioned renewable source of energy, there are still some aspects that need to be improved for its sustainable and outcome oriented development. For example; in case of biogas, we are still using the GGC-2047 model which indeed needs up gradation through rigorous research and innovation so that larger community based biogas plants could be developed in the forthcoming days. Similarly, for micro-hydro, the survey, design & installation of the existing capacity of the relevant companies is maximum 100 kW but they need to enhance their capacity to mega watts. Hence, further research is essential for the installation of mini and small hydro and accordingly training is required for capability enhancement. Moreover, even for improved cooking stove the efficiency of different models vary to larger extent which after analysis was found that the real efficiency varies from what has been anticipated earlier. Not only this, even the gasifier that has been installed till today are either not functioning or functioning sporadically. Hence, research is essential for the gasifier as well.

II) Climate Change

The impacts of climate change are in sustainable development and global warming. Sustainable development is defined as development that meets the need of the present without compromising the future generation to meet their needs. Likewise, global warming leads to increased temperature resulting green house gas effect. The observational evidence of climate change is that natural systems are being affected. This is due to human activities having grown since pre-industrial era.

There is high agreement and much evidence with current climate change mitigation policies in Bali Climate change convention. The global mean annual temperature changes relatively and affects on water, ecosystem, food, coasts and health. One of the reports mentioned that 30 % species are at risk due to 2 degree Celsius temperature increment in the atmosphere. It will affect 3 billion people and another 3 million will be dying due to malnutrition.

This will also result in decreasing number of rainy days but increasing rainy days with more intense precipitation. This may lead to increasing glacier melt and change in precipitation pattern and lead to significant impact to hydro-power.

There is a need of capacity development for adaptation, knowledge generation and knowledge application. Some of the adaptation issues in Nepal are:

- Highly vulnerable
- Poor infrastructure, exposed to natural hazardness
- Low adaptive capacity

Hence, there is a need to expand awareness level, low level preparedness to cope with additional risk, over burdened communities and constraints in systemic process. There are sectoral specific challenges in agriculture (fewer rain higher intensity), health (increase diseases), biodiversity and forest (species in danger), and disaster management (additional investment).

As we know to reach the emission reduction levels set in Copenhagen, and to guard against the negative impacts of climate change, action is needed now and will imply societal changes at all levels and countries. The cost estimations for these changes are immense yet can be good investments and produce benefits even under current climate scenarios. Although there is a rapidly evolving array of different sources and financial mechanisms to meet these costs, access to resources has not been equal and is still largely limited to north-north transactions. UNDP can play a key role in helping developing countries in identifying, combining, and sequencing access to these different resources.

III) Conclusion

- There are various sources of renewable energy technologies such as biomass, water, sun and wind. These technologies will help to reduce emissions while using renewable.
- Approximately 3.64 million people have been benefited from different renewable energy technologies in Nepal.
- Global warming increases temperature resulting green house gas effect. The observational evidence of climate change is that natural systems are being affected. This is due to human activities having grown since pre-industrial time.
- There is a need of capacity development for adaptation and some of the issues are capacity building and sectoral specific challenges in agriculture, health, bio-diversity and forest, disaster management and policy/ advocacy.
- There is need of R&D in renewable energy technology and enhancement of capacity of the company people for survey, design and installation of the technology.

Hence, there is a need to disseminate the use of RET and the impact of climate change information to school/college students by incorporating in the curriculum or by organizing talk programme or debate or essay competition. Likewise, awareness could be created to public through radio/TV and politician by sharing information through application of RETs and policy makers/planners by organizing seminars/report/publications etc. There is also a need of networking with concerned organizations for sharing and updating information. We can take advantages of adaptation fund with the application of RETs.

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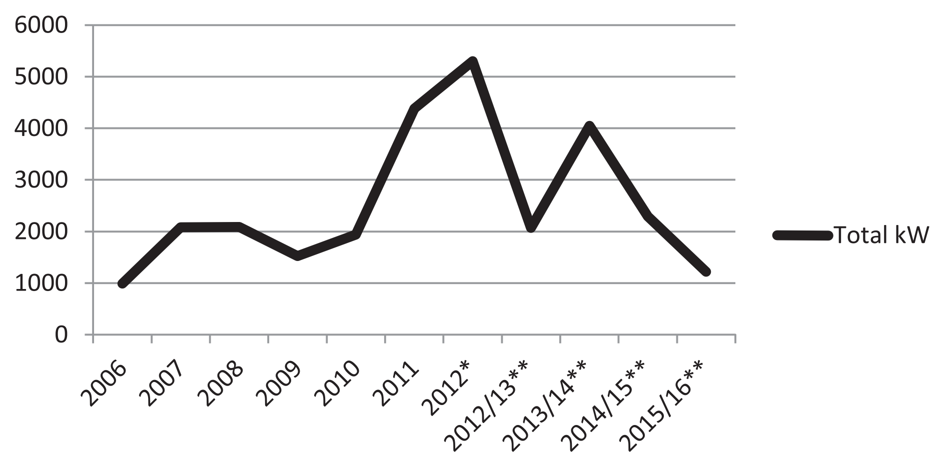
Changing business models for decentralised electrification through hydro power in Nepal

Dr. Kavita Rai, Independent Renewable Energy Expert
kavita_rai@outlook.com

Hydropower has been the backbone for both on-grid and off-grid electricity in Nepal for many decades. Rural and peri urban regions continue to be benefited from hundreds of decentralised micro hydro systems, below 100kW for a range of services including lighting, cooking and productive uses. The Alternative Energy Promotion Center (AEPC) database estimates over 54MW has been achieved through micro and some mini hydro (>100kW to 1MW), although the actual working conditions of the listed hydro systems are yet unascertained. Trends for micro hydro development from 2006 – 2016 (see figure 1) show it peaking in 2012, and subsequently by 2016 almost back to 2006 levels. A consistent international development partner funding towards subsidy (amongst others) especially over the past two decades has helped maintain the growth of the sector; and the major withdrawal over the past year has meant a slow down of installations, clear evidence of the direct co-relation between subsidy and project installation.

Figure 1: Installation trend of mini-micro hydro 2006-2016



Source: AEPC website (accessed 8th September 2017)

For a majority of the decentralised micro and mini hydro systems installed in Nepal, the business model has remained the same - fully grant driven projects or majorly subsidised systems for communities to own and manage the sustenance of service delivery. In the 80s and 90s, community mobilisation efforts were carried out, and rural technicians and managers were trained to maintain the decentralised micro hydro systems. Government subsidies focussed on this model as the public resources needed to reach a common pool for services, where profit was not a motive.

After a few decades, where 81.7 percent of rural population has access to electricity[3], there is an urgent need to drive towards new and

[3] Data for year 2014. Cited from World Bank, Sustainable Energy for All (SE4ALL) database from the SE4ALL Global Tracking Framework. https://data.worldbank.org/indicator/EG.ELC.ACCS.RU.ZS?locations=NP

innovative business models for many of these off-grid decentralised systems. The advancing rural economy and the imminent federalised political structure will mean a rise in electricity demand in rural and peri urban regions. Provision of sustainable solutions through decentralised electrification provides a direct correlation towards lesser usage of fossil fuels for services including lighting, cooking and productive local economy. In the eventual progress towards grid electrification, what would be the key changes in business models needed over the next decade?

The fundamental change or re-orientation is that decentralised hydro electricity systems need to work towards profitability, not just breaking even. This would mean a shift of business models from a community owned and managed system to a fully private or mixed ownership model, the latter being public-private, community-private, co-operative-private amongst others. While these business models are not new in Nepal, their uptake has been slowed down considerably because the general tenet is that electricity in rural areas needs to be a benevolent good. In addition, lack of upfront capital, commercial investments and technical professional experts at localised levels are continuing barriers. There are some key mitigative solutions towards this. Firstly, as larger populations and regions are connected to the national grid, there is an urgent need to map and prioritise the potential and available pockets of resources for developing micro and mini hydro systems within a specified timeline. Investors need a surety of return and a time bound market opportunity would be highly important. Secondly, design and development of decentralised electrification needs to combine technical advancement and process efficiency. Using smart technologies, assurance of a grid connection, risk insurances are becoming highly relevant and important. Thirdly, promotion of productive end uses, especially utilisation of off-peak load requires more attention and support. Fourthly, ownership and management needs to be operationalized by a skilled professional workforce. A study conducted by the UNDP-Renewable Energy for Rural Livelihood (RERL) and Practical Action Consulting in 2016-17 has shown that mini hydro systems in rural areas that are managed by a professional team such as the 400kW Salleri Chialsa plant in Solukhumbu has overall better performance and sustained services to its consumers.

Another key re-orientation is to rethink an increase in the size of projects for decentralised energy. As demand grows, lighting is not the only service needed. Consumers have a wider need especially when purchasing power increases. This means that a country like Nepal may need to look towards a push for larger mini hydro systems that can cater to this need. It must be noted that micro hydro installations may still be needed in the far flung regions where the grid will not reach for the next one or two decades.

However, the exact portfolio of mini hydro projects still remains small and not detailed till date. A report in 2012 stated that there were nine mini hydros (total 1.55MW) leased and operating off the grid while four mini hydros (total 830kW) were on-grid (Energy Development Services, 2012). Independent power producers (IPPs) are currently developing mini hydro systems mostly above 500kW, approximately 12 systems in various stages of development (data derived from IPP Association Nepal and Department for Electricity Development from RERL-PAC, 2017). The 183kW Syangja mini hydro plant in Lamjung district developed by the Syangja Bidyut Company Ltd. (SBCL) with electricity generation from 2001 was the first project developed by private sector on commercial basis[4]. Other mini hydro systems such as Salleri Chialsa and Namche were fully grant based projects operational for over 20 years as public-donor-community model and success has resulted from years of capacity development at the local level and a professional management system aiming for profitability. Recent addition supported by the AEPC and RERL include the 400kW system in Haluwa Khola. Others such as 200kW Juddi (I and II) in Bajura and with 116kW Paropakar in Gulmi are classified as micro hydro by AEPC, but generating sufficient to be mini-hydro systems.

Looking forward, the sustainability of decentralised mini hydro systems for local consumption will depend highly on a business model that encourages local level investors and members to hold stakes in the ownership and/or management of the plant. Evidences of hydro systems that were leased out by the NEA over the last two decades have shown that lessees (often local community/cooperative or entrepreneurs) have continued to operationalize it to the best of their ability but the absence of contractual assent to invest further in the system has de-incentivised them to upgrade and maintain systems except for provision of basic services, particularly lighting (RERL and PAC, 2017). There is an appetite in Nepal's local level to build and manage their own systems but this would need closer engagement with professional private companies and commercial financing institutions.

[4] http://ledco.com.np/Page/index.php?PageID=6 (accessed 14 September 2017)

One of the current barriers is that there is no clarity on the exact market of mini hydro (or even micro) according to the potentiality of the type of business models that would fit. If communities in rural pockets will need to remain un-electrified by the national grid in the foreseeable future, these markets must be determined now. A combination of public-private-community business model/s would then need to be encouraged. Most of the mini hydro projects developed by the private sector for profitability are designed to be solely grid-connected. In fact, if one looks at the data of existing independent power producers, albeit a few, hydro systems developed for grid connection are small hydro ranging between 1-10MW. The profit-oriented private sector will not enter a risk-ridden territory of providing decentralised services to pockets of rural consumers without some form of incentives. Although the government subsidy policy of 2016 has opened up provision for private stakeholders, a thriving sector is not foreseen. There remains much to be known on the real time financial profitability of such systems as data remains largely loose and further detailed monitoring and analysis would help drive the design of a more profit oriented business model. With over 600 technical experts in micro-hydro alone, there is no dearth of skilled capacity in the country (Rai, 2016). However, there is an urgent need to build up a capable financial and managerial workforce to work at the local level for such systems. Once some of these barriers are lifted, it may soon be that Nepal will have decentralised concessionaires and local privatised electricity systems that are as successful as compared to the grid.

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An Assessment of Mini Grid Development in Nepal

Jagadish Kumar Khoju

Introduction

Micro hydro has been serving the rural communities for more than two decades in Nepal. Within few decades, lighting the house with the micro hydroelectricity has led to increase the load demand as people used more electrical utilities. The energy demand of people increased with increase in economic activities in the later days. Though the connection of multiple end uses seem to be possible and increase the utilization factor, it is somehow impossible to achieve the target due to some constraints left with a single plant. Similarly, the installed isolated micro hydro power plants are going to be influenced by the national grid extension. Now time has come to think of increasing the reliability of the systems as well as to increase the possibility of transferring spare power from one area to the other for more productive uses to increase the overall utilization factor of the generated energy and interconnect to the national grid. Mini Grid (also known as "Local Grid") is an innovative and cost effective solution to deliver the reliable electricity supplies to the beneficiary and an assessment is always must for the sustainable operation of the micro hydro power and the mini grid itself from the perspective of sustainable livelihoods and climate change mitigation.

Possible Mini Grid Clusters

Although there are 55 potential districts from the perspective of micro hydro power development in Nepal, Alternative Energy Promotion Centre (AEPC) has identified 25 possible mini grid clusters in more than 20 districts out of which Taplejung, Panchthar, Sankhuwasabha, Solukhumbu, Okhaldhunga, Sindhupalchok, Kavrepalanchok, Dhading, Gorkha, Baglung, Gulmi, Rukum, Doti, Achham, Bajura, and Bajhang are most potential districts for the mini grid development in the country.

Mini Grid Developed Districts

Baglung is the first mini grid developed district and Gulmi is the second one in Nepal. AEPC in the support of UNDP through REDP completed Baglung mini grid in 2010 interconnecting 6 micro hydro power plants having total power output of 107 kW. Similarly, the second mini grid installed in Gulmi district in 2014 in the support of Fraunhafer, Germany by interconnecting two micro hydro plants having total power of 180 kW. Likewise, AEPC is going to install the third mini grid in Taplejung district in the support of the World Bank and Government of Nepal by interconnecting 8 micro/ mini hydro power plants having total output of 901 kW.

Assessment of Mini Grid

Based on the mini grid operation and management experience, AEPC has conducted an assessment of the mini grid and its findings can be categorized into technical, social, economical and management.

Technical Assessment

After the Mini Grid interconnection, there are a lot of technical up gradation in the control system, protection, safety, measurement, instrumentation in all micro hydro power plants. This technology and equipment has resulted stable voltage & frequency, reliable service due to effective relaying. Further, fault detection process is made easier and faster by using indicators, alarming facility & relays based protection system in the control system. Better quality of the electricity, reliability of electricity supply, introduction to energy based tariff structure from power based tariff system, better operating condition of generator, the provision of large scale end use application expanded (power for telephone tower, stone crusher), becoming a research place, interconnection of Mini Grid into National Grid are the major technical benefits of the mini grid. Although there are many technical advantages of Mini Grid, there are some technical difficulties or issues which obstruct the smooth operation of Mini Grid. Some of the current technical issues that were felt in this system are - lack of central control and monitoring unit, lack of convenient communication mechanism, issues on the active and reactive power sharing, lack of operating and maintenance guideline, lack of synchronization check, lack of spare parts, difficulties in dry season load management, lack of data recording devices and older structures of the plants.

Management Assessment

Management system of mini-grid is more complicated than the existing standalone operation. The working modality for mini-grid under rural circumstances is specifically dealt with three options: Option A- the whole system, including generation and distribution, is managed by one entity, Option B- the "business as usual" situation, where the Mini Grid operator will be receiving surplus power only but it coordinates among the other MHPs, and Option C- the Independent Producer (IPP) model where each MHP is responsible for the generation only and load management and dispatching is controlled by the Mini-grid operator Power. In case of Baglung mini grid, Urja Upatyaka Mini-Grid Cooperative was formed from the representatives of each Micro Hydro that are connected to the Mini Grid. The Cooperative is responsible for operating and maintaining the Mini Grid, distribution and consumer services, and individual Micro Hydro Functional Group (MHFG) were restricted to independent power producers (IPP). Gap creation between Micro Hydro Functional Groups and the Co-Operative, delay in problem solving, high financial burden over the Mini Grid are the major management issues of the mini grid.

Social Assessment

The social benefits of the mini grid are: motivation of the local people towards the income generating activities, changed concept of electricity diversification, better understanding on the electricity saving, confidence of the community on bigger project management, unification of the different communities socially which protects the micro hydro powers from vanishing, even if the grid has already covered the area. However, difficulty in community mobilization, still lack of ownership, local political interference and individual biasness of local people, lack of unity of different community are the major social issues of the mini grid.

Economic Assessment

After the mini grid connection, there are a lot of economic benefits in the rural areas which are - increased income, new local jobs creation, many possibilities of financial strengthening of the micro hydro and Mini Grid. However, still low electricity consumption rate of domestic consumer, higher repair/maintenance cost due to older structures of the plants, lack of deposit fund with the Mini Grid and power plants, high and lack of human resource cost and difficulties for end use promotion are the major economic issues of the mini grid.

Recommendations

Despite of large number of benefits of Mini Grid to the both users and plants, there are many challenges on the way, including technical, managerial, social, economical and other regulatory issues. In order to address the issues of the mini grid, the following recommendations are must.

- Technically, it is a new technology for Nepal, so the equipment and human resources for installation, testing and commissioning need to be imported at present. Since the cost and the time associated with the installation, operation and maintenance of imported equipment and technology is high, the technology should be developed at domestic level. As the new technological issues like power sharing, metering, protection, central control and monitoring with appropriate communication mechanism between plant operators and grid operator must be adopted, upgraded and enhanced for better effectiveness of Mini Grid.
- Managerially, the choice of the particular management modality depends upon the various factors like arrangement of network formation, overall plant factor of the system, system size (total capacity of integrated system), geological condition of the system, capacity of community to manage, etc.

- At the moment, the economic profile of the mini grid is not attractive enough. To improve this, energy sell must be increased through the establishment of more and more end use to operate during day time and night time if possible. Connection with National grid will resolve the financial problems.
- In order to eliminate the social issues and to enhance the ownership of Mini grid comprehensive meeting/workshop must be organized at site, including major stakeholders.
- Suitable guideline and framework needs to be developed, which would reflect the entire context and directs the way forward.

Conclusion

Mini Grid development by interconnection of nearby isolated Micro Hydro Plants can be the best method of solving the various issues of standalone Micro Hydro Power. Affordable and reliable supply to the rural communities of Nepal can be delivered through the construction of such local grids. Implementation of the Mini grid opens the new avenues for the construction of such community managed projects in other possible clusters in the country. In the current context, such projects require suitable choice of technologies and implementation strategies right from the design stage. Mini Grid project has provided much positive impact regarding technical, management, economic and social aspects to the localities in the short period of implementation. There are number of technical, management, economic and social rationale for system interconnections, which should be analyzed in the different stages of the project management.

(Mr. Khoju is associated with Alternative Energy Promotion Center, Nepal as Programme Coordinator of Kabeli Transmission Project/Rural Enhanced Energy Services Programme)

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A Recipe for Local Economic Development: Hydroger

Mr Onkar Nath* & Mr Manoj Mahata**

* & ** Technical Expert, GIZ (New Delhi, India)

We often talk about extending grid or installing hydro power plants in hills when it comes to meeting energy needs. Extending grid more often found to be economically un-viable and installing hydro power plants face lot of issue in terms of harming local ecology and rehabilitation of local people. Therefore, it is imperative to explore technological options which are small but are capable of meeting energy demands while maintaining harmony with the local people and ecology.

Hydroger is one such technology developed by a local agency The Nagaland Empowerment of People by Energy Development (NEPeD) based in the state of Nagaland, India. The core design of the hydroger is built around the design of a turbine, which has been primed to act as either as a 'reaction' turbine or an 'impulse' turbine. The hydroger was first designed as a 1 kW Reaction turbine which has now been supplemented by a larger 3 kW turbines of both reaction and impulse versions. The operating principle of the hydroger is very simple. A 3 kW hydroger generates power at 750 rpm, and requires water flow at roughly 10 – 40 litres per second. An electronic load controller is paired to the output for a better load management. Currently hydrogers are connected to single-phase (230V, 50Hz) electricity distribution networks, but three phase electricity can also be paired to power output. The hydroger's significant strengths lie in the fact that it is a significantly lower-cost unit to build; and also largely maintenance-free. These conditions allow it to be easily implemented in remote locations especially in hills.

Technical Details:

Technical Specifications		
	Parameters	Specification
1	Volume of Flow Needed	: Between 10 and 40 litres per second (LPS)
2	Penstock diameter	: 65 mm to 150 mm depending upon site specific conditions
3	Turbine design	: Turbo-impulse as well as reaction. Other variations are also possible depending upon site conditions
4	Alternator design	: Alternator design is permanent magnet type
5	Power Output	: 3 kW at 230 V AC, 50 Hz
6	Cost	: A 3 kW unit costs approximately INR 150,000 excluding local site development costs

Operation and maintenance

As a 3 kW capacity of Hydroger, roughly takes two months for the installation purpose. The estimated duration may further go up if the project sites are located in a remote location with poor road access. Further, installation requires technically skilled inputs, along with unskilled labour. While civil works and laying of the penstock (which is usually a non-metal pipe as provided by NEPeD) can be carried out by local people, installation of the hydroger and connecting the tailrace etc. are carried out by skilled engineers. There are some examples of Hydroger installed by NEPeD which are running since last 10 years without any major problems. Other than issues of damage to the intake line (penstock) and / or disruptions in the distribution network, the hydroger has very low maintenance costs. However, it is also a fact that no provisions are made for skilled O&M personnel to be present at site post installation. Any O&M issues with the hydroger (such as inlet pipe damage) require intervention of skilled personnel. Thus, owing to these reasons downtime of hydroger is higher in case technical issues crop up.

Usefulness of the technology in local context

The technology is useful in meeting energy needs of local people especially in hills where other alternatives like main grid extension is not economically viable. Areas where availability of water is not an issue, the use of Hydroger seems to be useful. The technology not only is capable of lighting households but the electricity produced can also be used for local commercial applications such as carpentry work, running local shops, mobile charging station, operating small flour mills and oil expellers etc. Local people can start a small business based in their villages and earn enough to sustain themselves without migrating to large cities. Although the initial capital expenditure is high for the installation of the technology but availability of subsidy and other incentives would bring down the cost of the technology. Access to low cost finance is another area where potential local entrepreneurs can take advantage of. Training on the operation and maintenance of the technology along with promotion of productive uses of energy is imperative to popularise the technology.

Use of photos

3 kW Impulse Turbine

1 kW Reaction

Electronic Load Controller (ELC)

Productive uses of energy

Potential Impact

- Use of fire-wood for the purpose of lighting will decrease thus preserving large scale deforestation
- Use of candles & kerosene will decrease in villages
- Hydroger tail race water is used for wet terrace cultivation & fisheries
- Women have more time at night to work at home
- Children get more time to study during the night
- Community street lights prevents wild animals to enter into villages during night time
- Use of TV further creates awareness among people about government schemes and programmes.

Disclaimer:

- The views, opinions, findings, and conclusions or recommendations expressed in this paper are strictly those of the author. They do not necessarily reflect the views of any organisation. For more information, readers are encouraged to directly contact the authors of this article.
- Photos must be duly credited to Nagaland Empowerment of People through Energy Development (NEPeD).

Clean Power to Empower – Using Hydro Potential to Break Poverty Trap in Nepal

Durga Prasad Upadhyay
Environment and Climate Change Advisor, United Mission to Nepal (UMN)
MSc in Climate Change, Brunel University London, UK

Nepal makes one of the frontline countries in terms of having possessed inland water sources with more than 45,000 MW electricity generation at technical viability. Similarly, with 300 days of sun shine comprising an average solar radiation reception from 3.6–6.2 kWh/m2/day leads the country, as the AEPC report 2008 claims, to be the commercial potential of solar power at 2,100 MW. Besides, the same report reveals that the specific mountain wind pockets of Nepal are endowed with 3,000 MW of wind power at commercial scale. The different studies demonstrate that considering only 50% of the 15 million ton of daily cattle dung production capacity of the country more than 1 million biogas plants having technical capacity of at least 4 cubic meter could be one of the reliable sources of clean energy for cooking in the rural Nepal. The increasing municipal solid waste could be yet another source of clean energy as it contains almost 66% as the bio-degradable organic waste.

In acknowledgement to such huge renewables potential, hydro power development policy and rural energy policy of Nepal attempt to give a policy clearance to attract investment from the private sector. The investment in this sector has proven to be profitable as the well managed hydro power companies have been able to distribute good amount of dividends to their shareholders. Hence, these days investing in the hydro power seems to be one of the secure investment sectors for people in Nepal. However, if we see the total invested amount so far in the hydro sector and the share of the people living in the ultra-poverty whose cash income is less than a dollar per day is virtually nil. Further, their financial inability has completely excluded them benefiting from the every growing and lucrative energy sector. To date, there is no framework or guideline in place to make the energy sector inclusive so that the ultra-poor people could also be the owner of the local hydro power company thereby breaking the poverty trap they have been with for generations. Nevertheless, there is an approach called 'Pro-poor hydro' –a sort of breakthrough in approach with a potential in paving a sustainable pathway to fight rural poverty at scale in Nepal.

An ideal set-up to the pro-poor hydro power approach includes several core elements such as a profitable hydro-power project; a local hydro power company; the poor; a local community group; a commercial hydro-power developer, financing agencies; local non poor; and may be NGOs.

One of the most important elements is that the hydropower must likely to be profitable, otherwise the approach will fail. Because, the poor as the share ownership will benefit primarily through receipt of dividend payouts from the profit earned by the hydro power company that develops the project. Similarly, there should be a local hydropower company formed to develop and operate the profitable local hydropower company.

Since pro-poor hydro power approach is about giving the ultra-poor the opportunity to choose to invest in a local hydro-power company, the poor need to be motivated to invest. Because, given the economic status of the poor they do have nothing but their labor to invest. The local poor who make contribution during the construction phase of the project are paid in cash for at least 49% of their labor for their daily substance, and the other 51% becomes their share investment. Moreover, their investment may be in the form of their own labor as 'sweat equity' in the local hydropower company or through share equity through the access to finance on favorable terms. The poor will own more than 50% of the local hydropower company thus.

The commercial hydropower is vital in the system; but the poor peoples' share-holding should be more than the shares from financial institutions and non-poor locally. Further, the role of financing agencies are important in pro-poor hydropower company as their investment is required to finance the investment of the poor, and supporting infrastructure—particularly the connection to the national electricity grid, and road access construction. Nepal Rastra Bank should encourage the commercial banks to invest in this line. More importantly, another element is the local non-poor who wish to invest in the local hydropower company. Their investment need to be encouraged, provided that the poor still represent more than 50% of the shareholding in the company.

There should be a formally registered local community group to actively facilitate the empowerment of the poor. The local community group will be responsible for managing the whole process of the poor investing in the local hydropower company from awareness raising and mobilization to distribution of dividends and support in investment in those dividends. The local community group may need external support to carry out such complex and critical task, and probably NGOs can play an important role here. Further, an NGO is important in the early stages of the project design and implementation, where trust between the different stakeholders is likely to be low. NGO can partner with local community group in order for its capacity building. As well, it can facilitate the project in collaboration with commercial hydropower developer, and work with financial agency to help secure finance on favorable terms. Further, NGO can facilitate the investment through financial institutions to the poor so they could receive concessional or non-interest loan to allow them to purchase company shares, independent of their labor contribution. It is very important that all those core elements work very closely in tandem. And as time goes on, the project debts will start to be paid off, local people will be receiving dividends.

At a time when Ministry of Energy in coordination with Ministry of Population and Environment is leading 'Water and Energy thematic working group' in the current process of formulating National Adaptation Plan (NAP) it is a right time that they consider pro-poor hydropower approach as one of the sustainable poverty reduction pathways in the national initiative of climate change adaptations and mitigation.

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Geothermal as an Alternative Source of Energy

Tapendra Chand
Project Officer, PEEDA
E-mail: tapendra@peeda.net

Introduction

Geothermal energy is the heat obtained from the Earth which is clean and sustainable. Resources of geothermal energy range from the shallow ground or upper 10 feet of the earth's surface maintaining a constant temperature of 10°C to 16°C to hot water and hot rock found a few miles beneath the Earth's surface and down even deeper to the extremely high temperatures of molten rock called magma. [1] Geothermal power is extracted from heat stored in the earth and originates from radioactive decay of minerals, and from solar energy absorbed at the surface. It has been used for space heating and bathing since ancient times, but is now better known for generating electricity. [2]

Identified locations in Nepal

It is one of the resources of renewable energy in Nepal and it is recorded that more than 39 hot springs are available containing temperature ranging from 16.5°C to 73 °C and flow of 0.05 to 6.0 liters per second. [3], [4] These hot water springs are currently being used for the therapeutic purposes. However, hot water of this temperature in combination with other secondary fuel can be used for electricity generation via steam turbine. Furthermore, end product like less saturated steam via heat exchangers can be used for thermal applications like space heating, heating biogas digester etc. It has been found that geothermal energy provides roughly 2.1 MW of energy with further development and investigation of the resource ongoing. [5] Geothermal Mapping is shown in figure 1 whereas Table 1 indicates the surface and discharge enthalpy at different locations denoted by alphabets like A, B, C etc.

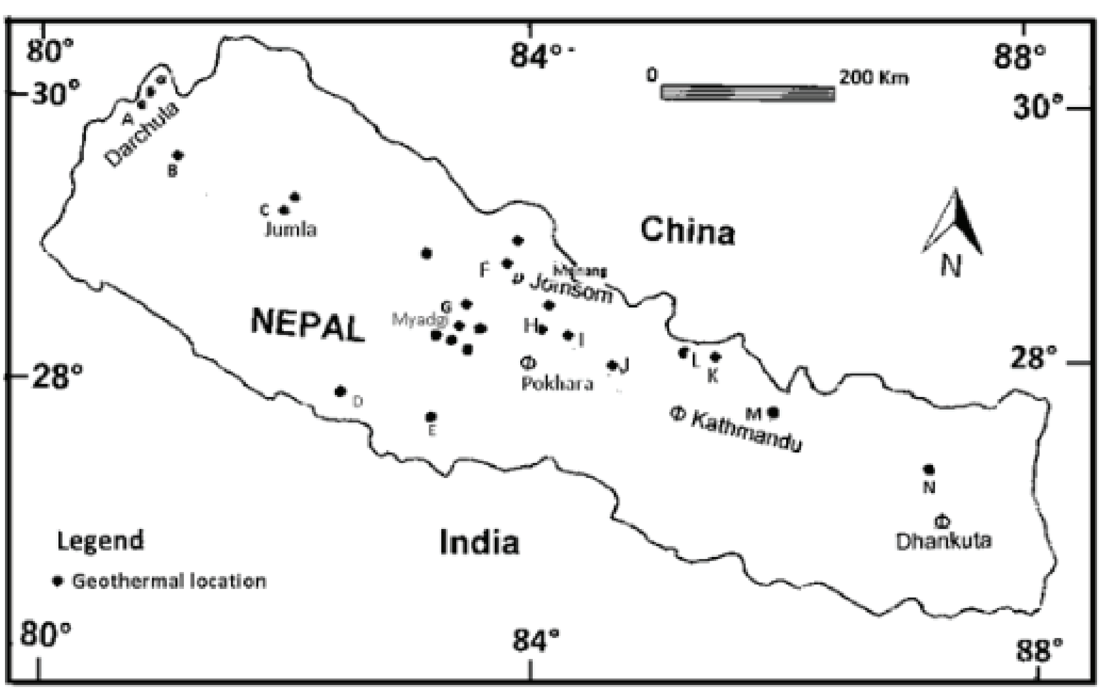

Figure 1: Map of Thermal locations in Nepal [4]

Table 1: Geothermal localities and general information [4]

Locality	Symbol	Flow rate (l/s)	Surface Temperature (°C)	Discharge Enthalpy (KJ/kg)
Darchula	A			
Sribagar		0.9	73	380
Sina Tatopani		0.8	30	255
Chamaliya		0.3	30	158
Tapoban	B	0.3	31	126
Jumla	C			
Dhanchauri-Luma		0.8	24	448
Tilanadi		1.3	42	464
Riar	D	1.5	33	227
Surai khola	E	1.7	36	210
Mustang	F			
Muktinath		3	22	211
Jomsom		0.07	16.5	380
Dhima		n.a	n.a	n.a
Myagdi District	G			
Ghorepani Tatopani		n.a	n.a	n.a
Singa Tatopani		6	54	452
Dhadkharka		n.a	n.a	n.a
Chhumrung		n.a	n.a	n.a
Darmija		n.a	n.a	n.a
Dana Bhurung		1.8	72	484
Mirsa – Seti Khola area		n.a	n.a	332
Jamile		0.05	30.6	n.a
Kharpani	H	0.4	49	n.a
Machhapuchhre base camp		2.2	64	1020
Mayangdi	I	2	40	376
Down Batase		0.1	44.3	420
Up Batase		0.2	21.5	n.a
Bhulbhulekhar	J	1.2	34	n.a
Rasuwa	K			
Chilime		0.9	48	386
Syabri Besi		0.4	34	365
La Ta Manang	L	n.a	n.a	n.a
Pargang		3.8	49	390
Kodari	M	5.5	42	17
Hatiya- Sankhuwasabha	N	n.a	n.a	n.a

Global Scenario and Technology

As of the end of 2015, the world market reached up to 13.3 GW (Gigawatts) of geothermal power operating in 24 countries such as USA, Philippines, Indonesia, Mexico, New Zealand, Italy, Turkey, Iceland, Kenya, China, Germany, etc. It has been forecasted that the global market will most likely reach 18.4 GW by 2021 with the continuous effort of countries that already have geothermal plants and the countries that are new to this technology such as India, Australia, Argentina, Columbia, Armenia, Chile, etc. [6]

The types of conventional geothermal power technologies are: dry steam, flash and binary. In dry steam plants, naturally occurring, high-pressure steam shoots up from the dry steam reservoir and is used to run the turbines that power the generator. In flash plants, steam is separated from high-pressure and high temperature geothermal fluids (hot water and steam). The steam is delivered to a turbine that powers a generator. The liquid (condensed from the steam after passing through the turbine) and remaining geothermal water are injected back into the reservoir. In binary or ORC (i.e., Organic Rankine Cycle) plants, the heat is transferred from the hot water to an organic working fluid that has a boiling point lower than the boiling point of water. The working fluid is then vaporized to run the turbine provided that the liquid content is maintained below 15% in order to avoid the damage of the turbine blades. The geothermal water is never allowed to reach the atmosphere- 100% is injected back into the reservoir. In all systems, the injected fluid is never allowed to mix with the shallow groundwater system. [6]

Advantages

There are many advantages of geothermal energy listed as follows:

- It can be extracted without burning a fossil fuel such as coal, gas, or oil and such plants produces only about one-sixth of the carbon dioxide that a relatively clean natural-gas-fueled power plant produces.
- Unlike solar and wind energy, geothermal energy is always available throughout a year.

Disadvantages

It's also relatively inexpensive; savings from direct use can be as much as 80 percent over fossil fuels. But it has some environmental problems. The main concern is the release of hydrogen sulphide (H_2S), a gas that smells like rotten egg at low concentrations. Another concern is the disposal of some geothermal fluids, which may contain low levels of toxic materials. Although geothermal sites are capable of providing heat for many decades, eventually specific locations may cool down. [7]

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PEEDA AT A GLANCE

PEEDA is an NGO dedicated to improve livelihoods of communities, particularly the poor, by collective utilization of renewable energy resources, while ensuring due care for the environment. This is achieved by establishing institutions active in the renewable energy sector, promoting cooperation between relevant stakeholders to undertake development projects, advocating for policy and regulatory reforms and undertaking targeted research. The principle behind the activities of PEEDA is that the poor of Nepal, who live mainly in rural areas, should share in the benefits of Nepal's renewable energy resources, but this will not happen without dedicated and sustained effort. PEEDA is committed to the values of empowering individuals and communities to help themselves, non-discrimination, and maintaining good relationships.

News & Events

1. Selection of New Board Members

As per organization rules and regulations, new board members were selected after the unanimous decision made by the general members of the PEEDA during its 19th Annual general meeting held on 18th November 2016.

2. CEO of PEEDA Sharing Experience in SEforAll Forum

The sustainable energy for all (SEforAll) forum organized over three days (3-5 April, 2017) in New York was attended by Biraj Gautam, CEO of PEEDA representing civil society organization on behalf of ACCESS Coalition. He shared experience from work in Nepal to global community & media. The forum was highly successful in assessing the latest data towards progress on Sustainable Development Goal 7 and highlighted success stories from its Partners from across the globe.

3. Group Facilitation Training to Social Mobilizers of Dolakha District

The training was executed for the staffs of PEEDA on 5th and 6th May 2017 which was facilitated by Mrs. Himali Gurung of UMN. The training was focused on different aspects such as community group concept, group development stages, group formation/ emerging process, problem analysis, action plan and implementation, identification of resources and mobilization, community based livelihood, sustainability of farmers group, group conflict and solution, documentation, relationship and coordination with stakeholders and activities monitoring plan.

4. Exposure Visit

PEEDA successfully conducted exposure visits to Ashapuri Organic Farm and Sunkoshi Krishi Farm for the beneficiary farmers of targeted Rural Municipalities of Dolakha district.

5. Training for Apiculture

It was held from 27th August to 15th September 2017 to the beneficiaries for the project namely "Climate Resilient Communities and Sustainable livelihood initiatives for Pro-poor of Dolakha District of Nepal".

6. Awareness Program

PEEDA has successfully completed awareness program on chemical fertilizer and organic farming among the beneficiary farmers group. Moreover, awareness class on climate change and earthquake was executed among students of class 7, 8 & 9 in 10 schools of Thulopatal, Namdu, Mirge and Jungu VDC (Now, Ward No. 8 of Jiri Municipality, Ward No. 6 & 7 of Baiteshwor Rural Municipality, Ward No. 3 of Baiteshwor Rural Municipality and Ward No. 1 & 2 of Gaurishankar Rural Municipality).

During the awareness class at school, both essay and poem competition were executed and afterwards the best students were awarded. Among those poems, one of the poems written by Ms. Aarati Nepali (Grade 9) of Shree Kalika Secondary School of Thulopatal is below;

वातावरण स्वच्छ सफा हराभरा
जलवायु परिवर्तनमा ध्यान हामी सबैको अभिभारा

प्रकृतिले भरिपुर्ण कति राम्रो हाम्रो देश
प्रकृतिमै जन्म भयो प्रकृतिमै हुन्छ शेष
प्राकृतिक वातावरण बनेको छ , आज असुन्दर र कुरुप
वातावरण प्रदुषणले विगार्‍यो हाम्रो देशको स्वरुप

हरिया डाँडा पाखाहरु आज निर्वस्त्र र नाङ्गा बन्दैछन्
स्वच्छ शुद्ध पानीका मुहानहरु प्रदुषणले गर्दा सुक्दैछन्
हैजा, झाडापखाला जस्तो रोगले पिरोलीने छ जब
प्रश्न त्यही उठ्नेछ ,
किन आ नै खुट्टामा बच्चरो प्रहार गरिस् ??

हरियो वन नेपालको धन यर्थाथता बनेको छ दन्त्यकथा
कोही पनि भएनन् है बुझ्ने यो दुःख लाग्दो व्यथा
नराम्रो लाग्न थालेको छ आज आ नै सृष्टि
जलवायु परिवर्तनले निम्त्याँउदा अतिवृष्टि र अनावृष्टि

नगरौं वातावरण प्रदुषण र जलवायु परिवर्तन हुनेखालका
क्रियाकलाप यसले आफैलाई पुग्छ हानी
प्रकृतिको संरक्षण गरे बन्छ आ नै देश धनी
वातावरण हराभरा, स्वच्छ, सफा भाषणमा होइन
व्यवहारमा कापी घोटौं
स्वच्छ वातावरण को युग युग कल्पना गरौं

बन्द गरौ है अब अमानवीय
शस्त्रास्त्रका सबै प्रकारका परीक्षण
नभ लौ कहिल्यै पनि राख्नुपर्छ
वातावरणलाई स्वच्छ , सफा र हराभरा
जलवायु परिवर्तनमा ध्यान पुर्‍याउनु हो
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Devkota Marg, Mid-Baneshwor, Kathmandu-10
P.O.Box 8975, EPC 2157 ~ Telephone: +977-1-4469456,458
E-mail: mail@peeda.net~ URL: www.peeda.net