Volume II
2015

ENERGY INSIGHT

A Yearly Publication of PEEDA

PEEDA

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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 progress. The northern countries and international agencies consider NGOs as alternate institutional mechanisms for the transfer of resources to 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 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 two institutions e.g. -Hydro Lab P. Ltd. established for hydraulic modeling and Hydro Consult Engg. Ltd. established for providing quality engineering consultancy services. 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 greatly hope that this publication would assist in increasing awareness on the sector. I would greatly like to acknowledge the efforts of PEEDA management team in bringing out this annual publication. Lastly, I would also like to extend my sincere 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

From the Chief Executive Officer

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. In accordance with the fact that there is sharp increase in oil and natural gas prices, renewable source of energy can be used as a substitute for fossil fuels and may reduce the dependence on imports and/or the greenhouse gas emissions. Nevertheless, different forms of renewable energy other than hydro-power are not yet commercially successful in Nepal because of various limitations and discrepancies.

PEEDA has been conducting various energy and environment related activities and projects over the last 16 years. PEEDA has been exploring and executing concepts and technologies that could impact lives both on shorter and longer terms. PEEDA is currently executing four 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 second 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.

Thank you!!!

Prabhash Devkota
Chief Executive Officer, PEEDA

Table of Content

ENERGY SCENARIOS OF NEPAL 2010 -2030: A RENEWABLE AND SUSTAINABLE APPROACH

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Abstract

The two major challenges of energy poverty are lack of access to electricity and reliance on biomass sources of energy for cooking. Nepal has the highest energy poverty in the South Asia with just 120 kWh of electricity and 15 GJ of primary energy consumptions per capita in a year. Nepal, because of its poor economic performance compared to other South Asian countries and its total dependence on imports of oil products, has to seriously take certain policy/strategy steps for its energy security and sustainability. Against this backdrop, an end-use approach modelling framework on the basis of Model for Analysis of Energy Demand (MAED) was developed from 2010 to 2030. Useful demand projection for each sector of the economy at 4.5%, 5.5% and 7% growth rates of GDP were obtained. Consequently, Nepal – MARKAL energy modelling framework was developed and inputs of the useful energy demands from the MAED model were exogenously incorporated in. Nepal consumed 410,000 TJ of final energy in 2010 with 85% of traditional biomass, 12% of fossil fuels, 2% of electricity and 1% of modern renewable energy. The final energy consumption in 2030 scenarios at the three different cases of GDP growth rates 4.5%, 5.5% and 7% are 685,000 TJ, 719,000 TJ and 783,000 TJ respectively. With the policy of promoting renewable energy and energy efficiency in the household sector the final energy scenario at the reference case of GDP growth rate 5.5% indicates energy consumption of 464,000 TJ in 2030 with 23% of energy supplied by indigenous renewable energy resources.

Keywords: Energy Poverty, Cooking, Renewable Energy, Sustainability, Energy Security.

Introduction

Geographically, Nepal is a mountainous country located in the South Asia. It is an agrarian economy country situated between two giant emerging economies- India and China with more than 76 percent of its people engaged in agriculture. In recent years this situation has changed significantly. According to the economic survey (1) and statistics on Nepal by Asian Development Bank (2), the contribution of the agricultural sector has declined to 35 percent and that of the non-agricultural sector has increased to 65 percent. The Gross Value Added (GVA) at 2001 constant prices in 2010 was NR 588 billion (US$ 7 billion). The GDP growth rates were around 5 to 6 percent during 1990s but it declined due to continued insurgency in the beginning of the decade in the new millennium. With the expected stabilization of the political situation in the country, Interim plan of the Government of Nepal (GON) projects economic growth at 5.5 percent during the period 2010 to 2013 (3).

The paper tries to portray the current energy situation in Nepal, the growing trend of unsustainable consumption of imported fossil fuels and the traditional fuel-wood especially for cooking purposes. It also try to show how a modelling framework developed to analyze the energy systems of the country can provide ample insights to develop energy policies for the sustainable energy development and energy security in the country. Such kind of modelling framework would be beneficial for other developing countries as well to analyze their energy systems and develop sound energy policies, strategies and plans.

Nepal's Energy Resources

Traditional biomass energy resources are the mainstay in the energy sector of Nepal. Only solid biomass fuels derived from plants, agriculture products and animals in the form of excreta (cattle dung) are used in Nepal. The fuel-wood consumption in 2010 was 313,000 TJ, whereas the sustainable supply from the shrubs and tree branches was around 273,000 TJ (4) (5). The forest resources are being denuded day by day due to unsustainable consumption of fire-wood and their inefficient burning is causing premature deaths in the rural areas of Nepal due to high indoor pollution (6).

Hydroelectricity, petroleum and natural gas and coal are the major commercial energy sources in use in the country. Among all commercial energy sources for power generation, hydroelectricity has the major share and also this is the most important in the context of the country considering the potential for hydroelectricity generation. The major rivers flowing through Northern Himalayas to the Southern plains have potential of 83,000 MW of hydropower, out of which 42,000 MW are economically viable. Regarding oil, Nepal has not found any known resources yet even though the Southern Mid -Siwalik range has been divided into 10 blocks for exploration. Only a couple of oil drilling firms such as Cairn Energy PLC have obtained the licence but drilling activities are yet to be commenced. Nepal has some sporadic deposits of low-grade lignite coal. A very small amount of the total coal supply is extracted in Dang district, Western Part of Nepal, for the consumption in brick industries. For the major supply, coal is imported from India and abroad.

Among the different renewable energy options in Nepal, solar energy, biogas energy, micro-hydropower and wind energy have gained popularity in recent times. Nepal, located in a favourable latitude range, receives ample solar radiation. The average solar radiation varies from 3.6–6.2 kWh/m2/day, and the sun shines for about 300 days a year. The development of solar energy technology is thus reasonably favourable in most parts of the country. As per Kawajiri et al. (7), Himalayan range has good performance of Photovoltaic System (PVS) due to its high altitude.

In Nepal, animal waste is mainly used for biogas production. The Biogas Support Program (BSP) under the Alternative Energy Promotion Centre (AEPC) and with the cooperation from various donors is promoting the installation of biogas plant in various part of the country. BSP-Nepal (8) has estimated the biogas production potential based upon the number of cattle/buffalo in the country in 1997/98, which comes out to be 4,356 m3 of biogas per day. As per AEPC (8) (9), bio-gas plants have reached 69 districts and have a total number of 262,000 units.

Current Energy Consumption

Energy resources are regarded as the key strategic natural resources and are considered as the major catalyst for all round development and economic growth of the country. Unless the energy sector is geared up for the efficient, judicious harnessing and sustainable development of the indigenous energy resources the economy cannot move forward on a higher growth path.

Table 1: Energy Balance in 2010 in '000 TJ

Commercial	Trad. biomass	petro. products	coal	Grid elect.	Renew.	Total
Household	345,519	4,687	35	4,194	2,794	357,228
Transport	-	24,019	-	-	10	24,029
Industrial	1,949	1,651	11,940	4,285	296	20,121
Commercial	1,794	3,002	-	733	14	5,543
Agriculture	-	2,872	-	177	7	3,056
Total	349,262	36,230	11,975	9,389	3,121	409,977

As per International Energy Agency (IEA) (10) per capita primary energy consumption in Nepal was 15 GJ and per capita electricity consumption 96 kWh which are the lowest compared to other South Asian countries. Both these low energy indicators denote that Nepal has the highest energy poverty in the South Asia. Table 1 indicates the energy balance in 2010 (1) (5). Residential sector consumes the most of the energy 87%, whereas transport 6%, industry 5% and commercial (services) and agriculture just 1% each.

Current Energy Systems Analysis

Nepal has been facing increasing constraints in importing oil to meet the needs due to soaring global oil prices. Nepal is totally dependent for imports of petroleum products for its energy requirement. Among South Asian countries in the period of 1995 to 2000, the oil imports in

Bangladesh increased by 6.17% annually, in India by 6%, in Pakistan by 43%, and in Nepal by 15%, respectively (11). As per Nepal Oil Corporation (NOC) in 2010, the growth was 18 % from its figures in 2009 (13). The expenditure on import of petroleum has increased from 27% of the export earnings in 2000/2001 to approximately 126 % (petroleum imports account for NR 94 billion: US$ 1.12 billion) in 2011/2012 which shows that total commodity exports from Nepal are not even sufficient to meet the rising demand of petroleum products (1). In the rural areas biomass continues to be the main source of energy while in the urban areas it is essentially kerosene and LPG meeting the energy needs. With the price of kerosene made equal to that of diesel use of LPG has increased tremendously among the urban dwellers. Nepal's installed electricity generating capacity in 2011 was 719 MW (13), of which around 92 percent was of hydropower generation which is mostly run-of-the-river (ROR)types and the rest was of thermal generation. The electricity demand reaches its peak in the dry season while the generating capability of run-of-the-river (ROR) plant is at the minimum level during this period. On the contrary, the generation capacity is highest in summer when demand is low. Fig. 1 indicates the peak demand of power against the installed capacity of power plants till 2010.

The peak load in January 2012 was 1,026 MW (13) while the supply was only 40%. This gap leads to a situation of power outages in managing the distribution- almost 18 hours a day in the dry season and 7 hours a day in the wet season. This has led to a tremendous anomaly in the electricity generation by the domestic as well as commercial and industrial entities.

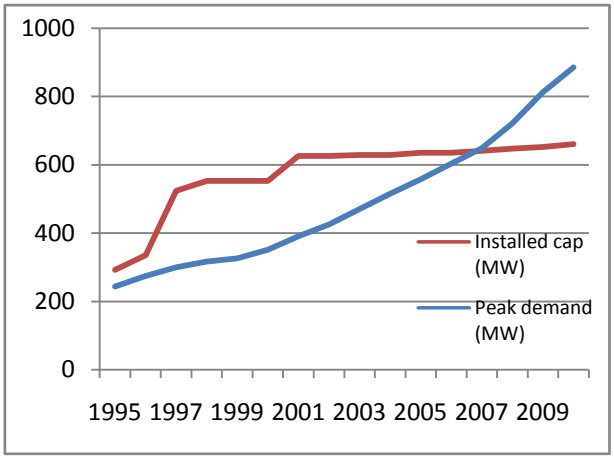

Fig.1. Difference between Peak Demand and Installed Capacity of Power Plants (MW)

As per NOC, a new trend has surfaced since 2008. A sizable quantity of petroleum products such as diesel, gasoline and kerosene are used in the isolated generation of electricity by households, service sector and manufacturing industries (12). Around 1,000 GWh of electricity is being produced by these captive generating sets which are neither accounted for in the energy balance of the country nor its adverse impact in the economy of the country is realized by the government policy-makers. The consumption of diesel has doubled from 2008 to 2010, whereas consumption of heating oil such as kerosene has plummeted since 2003, as NOC made the domestic prices of diesel and kerosene equalized for controlling rampant adulteration. Due to this reason, consumption of LPG are growing at double digits as it is the mostly available and cheaper energy carrier for cooking and other household purposes.

Household Fuel Economics

Due to use of inefficient traditional mud stoves, rural households consume around 60% of total household energy consumption whereas urban households consume 5% only. In India, 78% of the rural households still uses fire-wood for cooking, while only 9% uses LPG, 7% animal dung and 1% kerosene (14). As per the monthly life cycle costs (MLCC) of cooking in an urban household in Nepal as per D'sa and Narasimha Murthy (15), in 1997, the cheapest source of fuel for cooking was kerosene and the most expensive was electricity. But in 2012, the most expensive cooking fuel has become kerosene with NR 1,476 (US$18.00) per month and the cheapest has become electricity with NR 790 (US$9.40) per month. But, paradoxically, electricity generation in Nepal is dismally poor and is not even sufficient for lighting purposes. The actual access to electricity is around 53% in Nepal. Similarly, urban areas in Nepal have 27% access to clean energy facilities in cooking whereas rural areas have access even below 1% in 2010. In such a scenario, it seems Nepal has to go a long way in achieving the MDGs adopted by United Nations and universal access to sustainable energy by 2030.

Scenario Development

The current energy consumption pattern with growing dependence on imported fossil fuels, denudation of forest resources and soaring oil prices in the global markets indicates a dangerous economic ramifications if proper policies and strategies are not undertaken in the right time. Hence, a development of an energy systems modelling framework would be an appropriate tool for the policy analysis in the energy sector. This kind of modelling framework provides ample insights for the development of policies and strategies for the planners, researchers, and policy-makers in the concerned governmental agencies. The scenarios developed in this paper are based on MAED and ANSWER- MARKAL modelling framework.

The International Atomic Energy Agency (IAEA)'s energy planning tool – Model for Analysis of Energy Demand (MAED) has been used for modelling future demand in this case. MAED uses a bottom-up approach to project future energy demand based on medium- to long-term scenarios of socio-economic, technological and demographic development. Energy demand is disaggregated into a large number of end-use categories corresponding to different goods and services (16)(17)(18)(19). Similarly, for the supply side analysis, MARKAL (MARketALlocation) is used in this paper for the various scenario development.

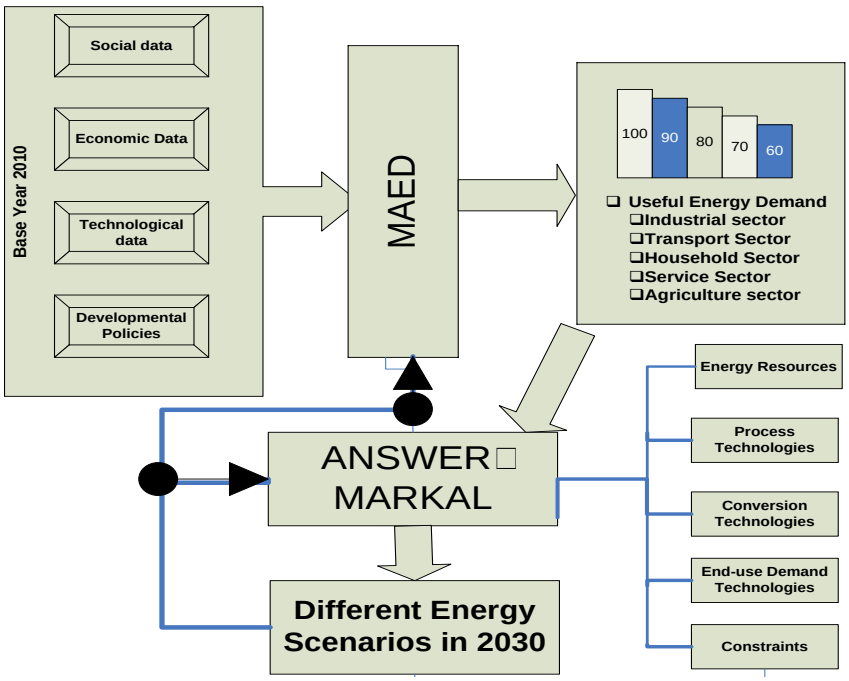

Fig.2. MAED- MARKAL Modelling Framework

MARKAL was developed in a cooperative multinational project over a period of almost two decades by the Energy Technology Systems Analysis Program (ETSAP) of the International Energy Agency (IEA). MARKAL is a generic model tailored by the input data to represent the evolution over a period of usually 40 to 50 years of a specific energy system at the national, regional, state or province, or community level (20). Fig. 2 shows the data requirements and the process flows in the MAED- MARKAL modelling framework for Nepal.

Results and Analysis: Energy Scenarios

Scenarios are widely used for policy analysis. Scenarios are images of alternative futures. Energy scenarios provide a framework for exploring future energy perspectives and strategies, including various combinations of technology options and their implications. A number of global studies have used scenarios as a tool to assess future paths of energy system development over the past 30 years. In more recent studies, sustainable energy development scenarios are usually carried out in many developed as well as developing countries. Scenario analysis differs from forecasting, which typically attempts to extrapolate past trends into future paths, given current information and a hypothetical causal relationship (21). However, forecasting is accurate only when underlying dynamics are thoroughly understood. For the energy sector, the case differs due to the instability of markets and the critical importance of scarcity. Hence, scenario analysis can provide insight into future energy trends that may be beyond the scope of existing forecasting techniques (22).

In developing the scenarios, three different sets of possible future energy demands have been considered – each corresponding to a future economic growth scenario. These are:

- Business As Usual (BAU) case with an average GDP growth rate of 4.5%
- Reference case with an average GDP growth rate of 5.5%
- Accelerated growth case with an average GDP growth rate of 7%

For policy analysis, reference case or the interim plan scenario of 5.5% GDP growth rate is observed in detail. During the period 2001 -2005, South Asia's overall economy was growing at an average growth rate of 5% (23). Hence, it seemed appropriate to analyze the energy systems at the GDP growth rate of 5.5% as it is quite near to the IMF analysis for the South Asia. Furthermore, the National Planning Commission of Nepal has projected GDP at 5.5% growth rate during the interim plan period of 2010 -2013 (24). As per the Advisory Committee on Energy and Climate Change (AGECC) of the United Nations (25), the two major goals are universal access to electricity and clean energy for cooking by 2030. In the scenario development these two goals are taken as the policy options. The Policy Options are (a) access to electricity to 100% and lighting by electricity by 2030, (b) replacement of cooking in urban areas on electricity by 2030, and (c) combined case with all the above policy options taken together.

BAU Case (Baseline Scenario)

Under the baseline case scenario with GDP growth rate taken as 4.5% and other assumptions taken as business as usual, the total final energy consumption will be 685,000 TJ in 2030. The share of petroleum products will be 23% in the total final energy consumption in 2030. Traditional biomass fuels will occupy 66 %, petroleum products 21%, grid electricity 7%, coal 5% and modern renewables 1% respectively.

In this scenario, residential sector will be still consuming 65% of the total final energy consumption in 2030 - a decline of 20% from its share in 2010. The energy demand in the transport sector will be reaching 13%, industrial sector 13%, commercial and services sector 7% each, and agriculture still at 2% respectively.

Reference Case

In this scenario, the GDP is expected to grow at the rate of 5.5% with other assumptions remaining as usual. The total final energy consumption will attain 719,000 TJ in 2030. Fig.3 indicates fuel mix in 2030. The share of the fossil fuels will be almost double of their share in 2010. Grid electricity and modern renewables will be increased by three folds in this scenario.

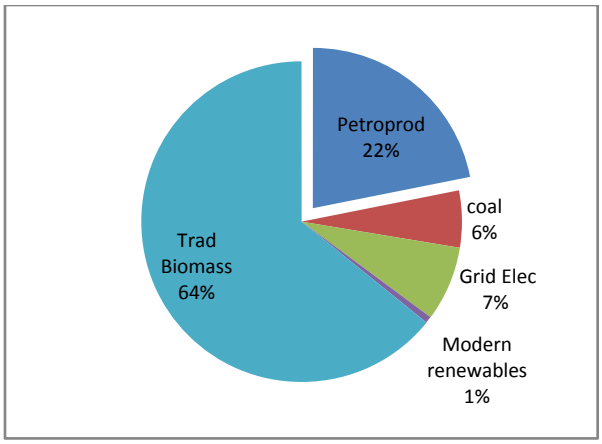

Figure 3: Fuel mix at Reference case with GDP growth rate 5.5 %

The share of the residential sector in the final energy consumption will decline to 62 % in 2030. Industrial and transport sectors will be gaining 15% and 13% respectively - a growth of more than 2 and a half times. Commercial and agriculture sectors will be having share of 8% and 2% respectively.

Accelerated Growth Case

This is an optimistic scenario with the expectation that the political situations in the country will be normalized and economic growth will be accelerated. The GDP growth rate is assumed to be increasing on average at 7%. The total energy consumption is expected to reach 783,000 TJ in 2030.

The sectoral energy consumption pattern in 2030 will be slightly changed from that of the reference case with the decline in consumption in the residential sector to 57%, whereas industrial and transport sectors will have consumption of 18% and 13% respectively. The demand in the commercial and services sector will also attain a share of 10% in 2030 and the agriculture will have only 2%.

Policy Scenarios

As per IEA and AGECC (6) (25), access to electricity and clean energy for household cooking in the developing countries are dismally poor and as a consequence, the Millennium Development Goals (MDGs) as envisaged by the United Nations (UN) are difficult to be achieved and around 4,000 premature deaths in a day are occurring due to poor indoor pollution in the rural areas of the developing world. Therefore, in order to achieve the targets as set by the AGECC, it is essential to observe what will be possible scenario by 2030 in the context of Nepal. Here, two policy cases are looked into, as stated above, (a) 100% lighting in all the sectors, and (b) clean energy for cooking by 2030.

Policy Case (100 % Access to Electricity)

Based on the Nepal Living Standards Survey (NLSS) (26) and the energy balance (6), the fuel mix of lighting services in the rural population in 2010 is kerosene 31%, incandescent lamps 36%, fluorescent lamps (FL) 1%, and electricity generated by domestic biogas plants and solar home systems (SHS) 31%. Similarly, in the urban areas, the fuel mix for the lighting services in 2010 was 2% kerosene, 52% incandescent, 44% FT and 3% CFL respectively.

It is assumed that by 2030 the lighting services will be much more fuel efficient and mostly incandescent lamps will be replaced by CFL both in the rural and urban areas. The policy assumptions are based on 90% lighting on CFLs and remaining still 10% on FL (as a remnant) in rural areas. Similarly, in the urban areas, lighting services will be based on 90% CFL and remaining still on 10% FL.

The energy consumption in 2030 would be 713,000 TJ which hardly differs compared to the consumption in the reference case. This is because the lighting services are not so energy intensive as compared to other end-use services such as cooking in developing countries.

Policy Case (100% Clean Energy Cooking)

One of the major energy consuming services is cooking and especially energy consumption in the rural areas are higher than in the urban areas in the developing countries as the villagers have to make cattle feed and to carry out space heating. In the case of Nepal, the final energy for consumption in the rural cooking comes around 60 percent of the total energy, whereas it is just 5 percent for the urban areas.

Table 2: Fuel mix in cooking for Households

Household subsectors	% in 2010	% in 2030
Rural cooking	Fuel-wood:92%; animal dung:8%;	Fuel-wood:63%; Electric:37%; biogas:14%; LPG:6%
Urban cooking	fuel-wood:68%; LPG:18%; biogas:5%; animal dung:5%; electric:2%; kerosene:2%	Electric:78%; biogas:22%

Table 2 shows the fuel mix in cooking in both the rural and urban areas in 2010. It also indicates the policy option taken in fuel mix in cooking in 2030. In 2030, the fuel-wood even indicates a higher share but cooking will be done all in the improved cook stoves (ICS) rather than in the traditional mud-stoves. This policy case indicates a drastic reduction in the total fuel consumption by 34% to 471,000 TJ and the share of the grid and isolated electricity jumps to 20% and modern renewables to 3%. In totality, renewable energy will have a share of 24 % almost as equal to the petroleum products. In absolute terms, fossil fuels declines to 161,000 TJ - a decline

more than 19% in the imports of fossil fuels in the reference case. The installed capacity of the power needed will be 14,000 MW which is almost three folds from the reference case. All the power will be generated by hydropower and the micro-hydro power plants.

Combined Policy Case

Household sector consumes more energy than other sectors in developing countries. In Nepal, household sector consumes 87% of the total final energy consumption. In this case, the scenario is developed for 2030 when both the above policy options are undertaken. Table 3 highlights the differences among the energy consumptions in the households in the policy cases with that of the reference case.

Table 3: Energy consumptions in Households at different scenarios in TJ

Scenarios	Consumption in 2010	Consumption in 2030
Reference case	357,000	446,000
Policy case with efficient lighting	357,000	443,000
Policy case with clean energy cooking	357,000	224,000
Combined Policy case	357,000	220,000

In this scenario, traditional biomass fuels are sizably replaced by the renewable energy sources such as electricity generated by large as well as microhydro plants, biogas plants, and use of 100% improved cook stoves in 2030. Though petroleum products and coal will be used for the transport and industry, their uses in the household sector are replaced by the indigenous renewable energy resources. The total final energy consumption in 2030 will be 464,000 TJ. The installed capacity of hydropower needed will be around 13,000 MW which is lower than the policy case of clean energy cooking because of the efficient lighting using FLs and CFLs. This will greatly benefit the national economy since the case shows the utilization of hydropower resources around 30 % of the economically viable capacity available in the country. The undiscounted annual supply investment in 2030 will be around NR 46 billion (at 2001 constant prices) which will be surpassed by the incremental savings in the domestic consumptions of fuel wood and import of fossil fuels in the range of NR 160 billion compared to the reference case. Similarly, the greenhouse gas (GHG) emission reduction in carbon equivalent will be around 5 million MT compared to emission in the reference case.

Conclusion

The paper shows that the modelling framework developed on the MAED and ANSWER-MARKAL systems can provide meaningful insights and can be instrumental in the development of sound policies in Nepal for the planners, researchers and policy -makers in the concerned governmental agencies. The scenario developed in the combined case with the GDP growth rate at 5.5% indicates that Nepal can have a lot of benefits such as a reduction of total energy consumption by 35% to 464,000 TJ, the share of indigenous renewable energy increased to 23% in the total energy consumption, a greenhouse gas reduction in carbon- equivalent of 5 million T, and a benefit of NR 114 million compared to the reference case. Despite all these benefits, Nepal can achieve the universal access to electricity and clean cooking for the overall population of Nepal by 2030 and hence, can also attain the MDGs eventually. The energy systems modelling framework thus developed can also be useful in other countries where such kind of frameworks are yet to be established in the analysis of energy systems and development of energy scenarios.

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Scope of Biofuel Potential of Nepal for Sustainable Energy Supply

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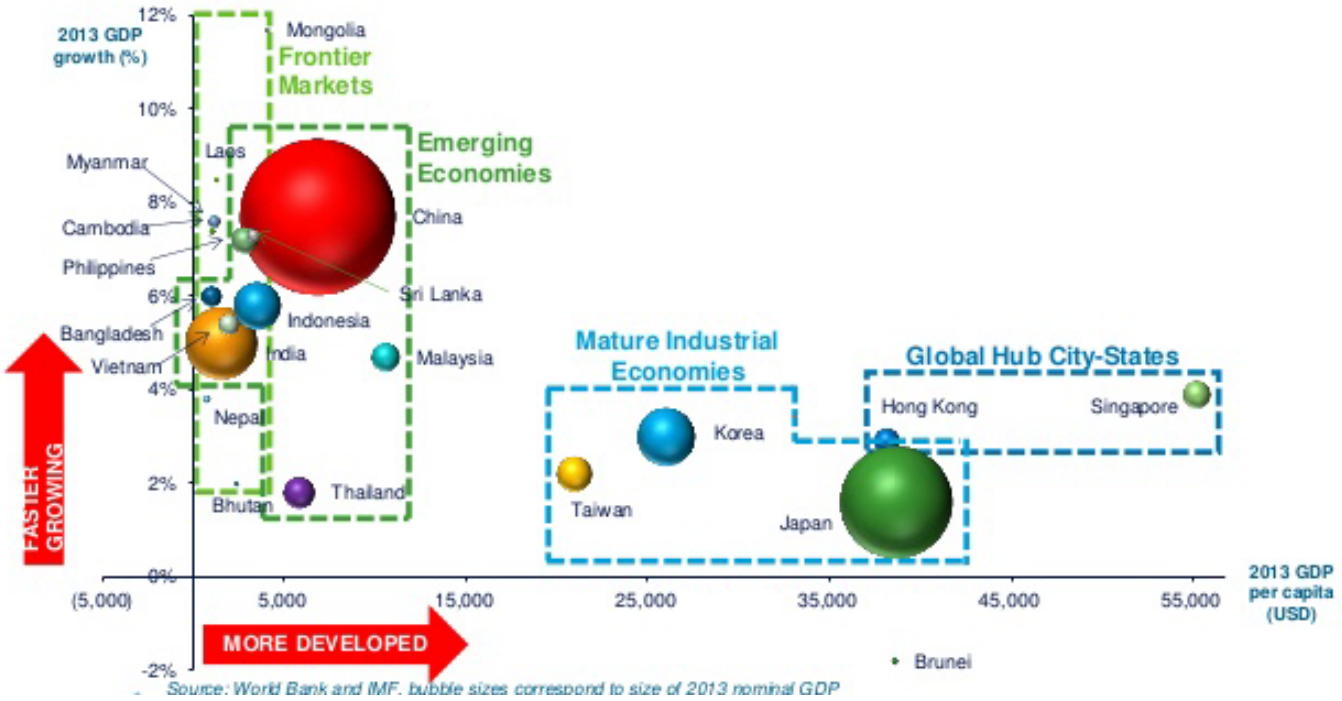
Nepal is situated between the two giant nations in terms of population, market and economy. Not only that, when we see the compatibility, we observed our ethnicities, food and cultures are a kind of blends of these two nations which is obvious. If we compare these three nations, we found us as dwarf varieties of similar crop. We are struggling on graduation on bottom; India is struggling on graduation on middle and china on top of every sectors. The distance between Nepal and India is similar between India and china except population size. In fact, Nepal is among the poorest and least developed countries in the world, with about one-quarter of its population living below the poverty line. Agriculture is the mainstay of the economy, providing a livelihood for more than 70% of the population and accounting for a little over one-third of GDP. Industrial activity mainly involves the processing of agricultural products, including pulses, jute, sugarcane, tobacco, and grain. Industrial development of the country is severely behind to the even Asian par due to political uncertainty and a difficult business climate. Additional challenges to Nepal's growth include its landlocked geographic location, persistent power shortages, underdeveloped transportation infrastructure, civil strife and labor unrest, and its susceptibility to natural disaster.

On all these backlashes, Nepal has proposed its graduation from **Least Developed Country** to **Developing Country**. For graduation, we need to work in all sectors together with economic reforms, focusing on productivities, improve our quality of life and explore new avenues of investment and development.



The youth has been moved to other second tier countries to up lift the wellbeing of their family. However, their tremendous struggles to make them escaping from the vicious circle of their poverty has either ruined their social stigma that inspire rest of the family to live with consuming behavior in their society or ended with next round of vicious circle to entrap forever. Hence, we have to address this issue timely for the nation rebuilding and successful graduation of the nation. For this purpose, we need to focus on energy, Infrastructure, productions (agricultural and Industrial) and consumption expenditure that may drive every other sectors to achieving the graduation goal. The Picture of Asian economy reveals that Asia is diverse in economy and well-being of its citizen[1]. If we see the position of Nepal in Asia, we are in corner of neither developed state nor fast growing states, suggesting we will not change our position for another couple of year had we work in business as usual scenario. However, this article is not divulges on all pertinent issues, but would like to focus on energy issues focusing its biofuel potential underneath.

Energy

Every nation needs energy to drive their economy in the right track. One of the easiest and high demanded forms of energy is fossil fuels. It is being highly used in industrial, agricultural, automobiles, commercial, and household usage. The total global consumption of fossil fuels is 10 million tons per day[2] whilst Nepal consumes fossil fuels is ca. 1,000,000 tons per anum[3], which is continuously on rise especially after peace agreement in the country when economic activities took shape, however is being spent mainly on service sectors. Due to high consumption of fossil fuels, it is expected that human society will face an extreme possibility of an energy supply collapsing in nearby future as a result of the exhaustion of fossil energy sources. In few decades, the deposition of fossil fuels will be depleted in such alarming rate that it will impact on the majority use of this energy resources.

The use of fossil fuels as energy resource is seen as having major environmental impacts. The major impacts of fossil fuels occur due to their consumption which produces different toxic gases like CO_2, SO_x, CO, NO_x (known as Green House Gases, i.e., GHGs) and other harmful gases as well as some organic and inorganic compounds like aldehydes, monocyclic aromatic hydrocarbon (MAHs), polycyclic aromatic hydrocarbons (PAHs), and some other particulates[4]. These harmful compounds deteriorate the greenhouse system of environment, cause global warming, pollution, acid rain and so on. In this note, it is very necessary to find out other energy source, which can be obtained from bio sources.

To this effect, the biofuel use would be the real solution for the nation like Nepal to mobilize it's all possible resources including human and natural resources. In fact, the Fuel produced from renewable resources, especially plant biomasses, and treated municipal and industrial wastes are biofuels. Biofuels are considered carbon neutral because the carbon dioxide given off by burning them is balanced by the carbon dioxide absorbed by the plants that are grown to produce them. The use of biofuels as an additive to petroleum-based fuels can also result following advantages:

- As it is originated from biomass, it is biodegradable, non-toxic, economically sound, renewable and ecologically feasible.
- It produces low GHGs and thus reduces environmental impacts.

- Due to closed carbon cycle, the carbon produced from biodiesel will up take by the plant so, the quantity of carbon is balanced and thus reduces the global warming.

On the basis of forms, biofuels can be classified as

- Solid biofuels: wood, charcoal
- Liquid biofuels: Bioethanol, biodiesel
- Gaseous biofuels: biogas, bio hydrogen, bio methane, bio propane

Hence, it is very clear that liquid biofuels are the best alternative of the petroleum fuel for transportation and can also be used in the stationary engines to generate electricity, water pump, mills as well as choking and lighting.

Biodiesel

Biodiesel is currently the most important alternative source of energy as it contributes in reducing the external dependence on fossil fuels. Similarly, it reduces the environmental impacts as it emits substantially lower quantities of most of the regulated pollutants than mineral diesel[4]. So, the biodiesel has been gaining worldwide popularity as an alternative energy source due to its high efficiency which can overcome the petroleum crisis and increasing cost of petroleum diesel[5].Biodiesel is one of the best alternative fuels as it has many advantages such as:

- It encourages the market of excess production of oils to enhance the rural economy.
- It has high efficiency in engine performance so can be used in diesel engine without any modification of engine[6].

The natural resources like vegetable oil (edible and non-edible) and animal fats are good sources as alternative fuels for diesel engine but due to high viscosity, acid compositions and free fatty acids of oil create problems in diesel engines. So, various methods such as dilution, microemulsions, pyrolysis, catalytic cracking, and transesterification have been considered to overcome the problem associated with direct use of oil. Out of these, all alternatives, transesterification process has been proved to be the best option.

Ethanol for Fuel

Ethanol mostly from renewable sources has been popularized during the value addition of several agrobusiness, mostly sugarcane and corn. Most advanced countries in ethanol production are Brazil and USA from sugarcane and corn, respectevily, in which the economy of ethanol production is high sounding than USA's corn ethanol i;e 22 cents per liter in Brazil from sugar cane against 30 cents in US from corn. Going back its history, E5 blend was started first time in brazil by 1931 and still a leading ethanol producer of the world producing 24.9% of the world. While going through domestic status, the annual report of MOAD has suggested that 200,000 farmers are involved in this business whereby 2.94 million tons of sugarcane was produced in 2069/70 and 165,000 ton of sugar was produced while sugar demand is 170,000 ton[7]. The study has suggestedthat ca. 7% ethanol has been produced in the country from secondary sources without invading direct food production[8], which strongly suggests that at least E5 can be achieved by now and also commercializing scope of the business of biofueling in the country.

National Energy Scenario

The source of our energy are mostly traditional such as firewood, animal dung and agri residue that occupy nearly 86% of our overall energy source, whereas the commerical resource like petroleum product occupy only 8.24% as suggested by the WECS report, 2010[9]. When it goes to consumption, transport sector consume mostly the petroleum product, occupy nearly 5% where we believe we could contribute more on this sector by increasing domestic production of such fuel by substituting the imported fuel. The other important sector and consumer of such products are industries, which need to consume more energy for the national prosperity. According to NOC, the current level of consumption of petroleum product is around 1 million ton per anum which has been recently increased as economic activities are offing after the truce on political unrest. Eventhough there is low level of industrial activities in this country and many remained shut, which need to be addressed as early as possible. There are two option floating on us, inspire the industrialist to have processing plants on both sector and motivate and convince the farmers and other agro entrepreuners to have commercial farming of the feedstocks. Many sugar industries are not in operation recently, which might have been consuming sugarcane but at the same time could have produced molasses as the by product which could be used for the ethanol production. Both situation would be as happy and healthy for ethanol producing firms in terms of sustainability. At the same time jatropha farming practices is not well established, however, its practices is decade old which suggests the easier acceptabiltiy to the farmers, but need to have increased level of motivation for commercial level of farming. The technological know how on fermer`s level is there, but we have to create the scietific know to be be disseminated to the industrial people which could be possible only through stringent research activities hovering on multi faceted research on biofuel activities. There are some scattered form of bioethanol research activities, which should be streamlined and research on biodiesel sector confined in one academy needs to beexpanded.

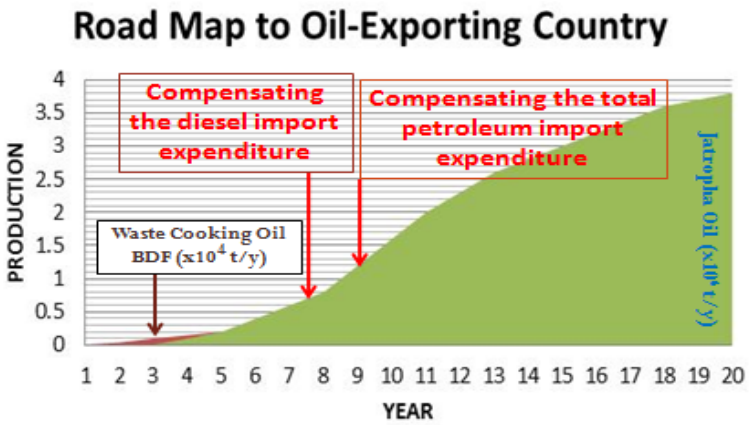
Current Status and Scope of Ethanol Production

With Brazil and the USA as global leaders in the production of biofuels from corn, sugarcane, and lignocellulosic crops, countries in Asia are also emerging as players in the biofuel market. Among them, China produces an enormous amount of agricultural residues suitable for biofuel production, with ethanol blended fossil fuel comprising 20% of total Chinese petroleum consumption. In India, first generation biofuel technology is more mature than second generation technologies, with India supporting its bioethanol production with sugarcane molasses. Hence, Nepal cannot keep away itself from this scenario since there are no proven fossil fuel deposits available in the country and total petroleum products are imported.

But because of rapid fluctuations of fossil fuel prices in the world market and the political instability in the country, shortage of petroleum products has become very common experience. If implemented, bioethanol blending to petrol in Nepal could reduce Nepal's fuel import which could save substantial money and could also minimize the environmental pollution. When the total potential ethanol production is taken into account, the surplus could be incredibly large.

Current Status and Scope of Biodiesel Production

At the moment, there is almost no production of biodiesel in this country, even though there are few processing plants of biodiesel but are not functioning properly. Some academic endeavors have taken its sole accomplishment of activities indicating the poor economic drive in this sector. Due to lack of favorable policy and will power of the policy makers, production of biofuel raw materials is severly low. It is clearly understood that the energy crops should be commercially farmed using the waste land as much as possible as FAO suggested that suffice the land available for jatropha, castor and other suitable oil seed crops. Farming such oil bearing crops that could generate huge amount of oil and hence, could be converted into biodiesel. In addition to that, the service sectors, industries and household has huge potential of generating the waste cooking oil once we generate the public awareness of possible harmful effect of used cooking oil. The business should be initiated using waste cooking oil in the beginning while national plantations scheme drive off. Once the production level seeds of such oil bearing plants increased and streamlined to industrial development, we could turn this country as oil exporting country.



According to GIS calculation and FAO report, there could be availability of 1.9 million hectars land for energy crop like jatropha and castors, which could possibly produce 3.8 Million Ton oil which could be converted into biodiesel. This theoretical calculation may not come in practice in real sense, however, the possible surplus could lead to producing exporting commodities in long run, had we agressively intervene the sector. Once we start using the waste land in optimal level as suggested, it could compensate the current level of diesel consumption by 8 years time and total petroleum consumption by 10 years.

Conclusion

Energy crisis faced by this country could be resolved through producing biofuels (bioethanol and biodiesel) complementing the fuel demand of the country. Doing normal business of producing such biofuels, Nepal could easily suffice its fuel demand to blend as thereotically accepted level, however, aggressive intervention on such novel causes may not only fulfil its fuel demand, but could drive the nation into **more energy sustainable, economic expansion and generating huge employment offer** inside the country.

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Mainstreaming Women and Girl: A Scenario of Biofuel Community Project from the Perspective of Rights Based Approach

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CEO, PEEDA

"Ratifying CEDAW remains among the unfinished business
of the Civil Rights movement." - Dorothy I. Height
April 13, 2010

Background

Foreign aid as a global good has been playing crucial role in carrying out developmental and other activities around the world. Foreign aid, the transfer of money, goods, and services is believed to have started after World War II, when United States provided aid to rebuild the economies of affected countries in Western Europe and to contain the Soviet expansion. Foreign aid took a much larger scope after International Monetary Fund (IMF) and World Bank was established in 1945 to help debt relief and economic expansion of underdeveloped nations. Today, foreign aid has been a crucial component in every developing nation's arsenal.

In a report of CEDAW, articulated in 2010 as – The Convention on the Elimination of All Forms of Discrimination against Women – is a landmark international agreement that affirms principles of fundamental human rights and equality for women around the world. CEDAW is a practical blueprint for each country to achieve progress for women and girls. When Women in Development was assumed as the weapon to fight with the inequalities that women are facing, WID came in to existence to fight against all kinds of discrimination. In 1970, when Ester Boserup challenged the implicit assumption that modernization naturally benefits both men and women, the concept of women in development (WID) was born (Boserup 1970).

The international development community then identified a prominent role for itself: to intervene in women's lives in order to remedy the unequal state of affairs. An initial focus on welfare, particularly on women's health and education, gave way by the late 1970s and early 1980s to economic support for women, in recognition of women's productive role in the household economy, the significance of which had by that time been realized. But still it has been a far cry and bitter reality that millions of women and girls are under suppression and violence of this or that forms of their rights abused in to the world. And Nepal is no exception on it. Local governance issues have been constantly challenging the national efforts.

The government and non-government sectors have made realizations of weak implementation of the programs; constant efforts are ongoing to address the issues of good governance; local democracy, transparency, aid effectiveness, meaningful participation, impact group's engagement in decision making, equity, rights and justice, however, we are being unable to achieve the sustained improvement in the life of women and children. The WID approach itself, in both its social welfare and its economic productivity modes, has more recently given way to a focus less on "women" and more on "gender". This latest shift in priorities is based on the view that

women do not, in fact, stand in societal isolation, rather they are embedded in social structures of subordination created and maintained by specific legal, economic, cultural and political arrangements.

Nepal in Two Decades

The historic political, social and cultural movements of during two decades and people's overwhelming participation and recent promulgation of the new constitution and the meaningful participation of women, Dalit, Ethnic, marginalized and deprived have proved that people in this country are politically sensitive. The spontaneous overflow of the participation is the reflection of the combined forces of dominations, discrimination and injustice that was sustained by the feudal systems, and feudal mindsets in the country.

However, the complete transformation in the systems and minds of the people is still a challenge for us. We have to go long way to democratize our systems, our practices and our attitudes that are largely influenced by the century long ill socio-political practices. Again, the issue is self-representation; leadership and social responsibility are the crux of any people's democratic practices. Thus the challenge for us now is to address these issues at individual levels, at community levels and at the bottom of the social structures. Accordingly, the issue of democratization of knowledge is also another significant issue in terms of developing the leadership from the margin. Even within the margin, the issues of dominations exist at different levels: thus still a complete transformation in our practices has been a challenge even today.

Implementation of Rights Based Approach and Transformative Learning

Rights Based Approach and Transformative Learning process aims to create such a dynamic political space for different sections of society to participate in a forum, develop a combined learning practice, share knowledge, and feel of combined sense of responsibility. The larger democratic scene of course is a strong base to democratize our practices, but at the mean time it is important for us to acknowledge the issues within the periphery and the complexities around it. We have to minutely address these issues at the bottom of social structure, if we want to establish popular democracy that is sustained from the bottom.

Till date, most of the local governance programs are being scattered approaches and the dire need is of addressing it comprehensively. Inclusion as one of the deep rooted issue in the country is getting momentum as the high-flying debate around development sector today in Nepal. Realizations are made that large number of women, children, Dalits, marginalized have been excluded from the mainstream national life.

In the limelight of this concept, this paper tries to explore the reality check of "Biofuel Consolidation Project-Okhaldhunga" which has been implemented for 9 years in three different phases (2007-2009, 2010-2012 and 2013-2015). One of the major objectives of the project is to empower the women of the project areas. PEEDA is a pioneer organization for the promotion and implementation of Jatropha bio fuel project in coordination with the local communities in the Okhaldhunga district. Lately PEEDA has been involved in a range of research activities aiming to support the production and marketing of bio fuel-based products in the hilly regions of Nepal including Okhaldhunga. PEEDA's interventions can be noted in the line of transdisciplinary

in nature, ranging across the concerns of the disciplines of Pure Science and Social science concentrating on history, sociology, anthropology, and philosophy. However PEEDA is taking pure science and social science together.

History of the Project

Okhaldhunga District, a part of Sagarmatha Zone, is one of the seventy-five districts of Nepal, a landlocked country of South Asia. The district, with Okhaldhunga as its district headquarters, covers an area of 1,074.5 km² and had a population of 156,702 in 2001 and 147,984 in 2011. Okhaldhunga is part of area traditionally called WalloKirat (near Kirat), home to indigenous ethnic groups Rai and Sunuwar . Apart from these indigenous ethnic groups, other ethnics and hill castes live in the district. Therefore the primary recipients of the project are people in margin and extreme poverty. Hence, this analysis is made on that backdrop.

In order to achieve the subsistence earning from the spare time of a daily schedule by producing Jathropa as an alternative means of livelihood in barren, isolated and neglected field the project has been instrumental. As the major right holders of the program are people in margin whose voice has not been heard by mainstream development discourse this program has amplified the voice in margin, organized them, transformed the knowledge of participatory culture, raised their issues in VDC level, made access over services and opportunities being provided by state and non-state development partners, ensured their rights and proportion on such opportunities and services.

As the Pilot Project the project was developed in Okhaldhunga's 7 VDCs named as Rural Jatropha Biofuel Development. First Phase: 2007-2009 and major activities of the periods are organizing the farmers, awareness building, training, plantation and agricultural research. Second Phase started in 2010 to 2012 and the major activities carried were intensifying plantation methods, processing of the oil, R & D, marketing and technology development, lobbying & advocacy on national & international level. While the third phase was 2013 to 2015 this is exit phase. The major activities carried in this time frame are demonstration and use of end use technology based on Jatropha, Sharing of learning and lobbying & advocacy on national and international level.

Setting the Context

On the foundation of it; PEEDA launched this pilot action research. In the core of the intervention there is the tie up of Right Based Approach and Transformative Learnings. Governance teaches both the aspects of getting rights and remembering the responsibilities too. It clarifies that who is in the core of power structure having decision making role. PEEDA focuses its intervention in poor, vulnerable and socially excluded-who are the most discriminated and marginalized section of the society. Based on it; from 2007 PEEDA has been identifying its impact groups through the participatory approach of rights based approach and transformative learning. Now, organizing such women in groups PEEDA intervenes its programs.

Ignorance, lack of education, no access to information has become the major sources of these social ills in Okhaldhunga district. Based on the available resources, information, different

research findings, and by analyzing the existing scenario, government and non-government attempt to address the issues, this paper has tried to present a comparative scenario of more than 9 years of the timeframe.

Sensitization to Awareness Raising

During the long run of more than nine years, PEEDA realized that it is a must to organize people in broader framework first in real sense for that each field staff has to be a catalyst, a change agent only then it could be possible to transform the women who are in hardest hit of ignorance, lack of information and without in the access of services and structures. Unless they are not organized then the vocal cannot be heard, if the vocal is not heard then the process of amplifying the vocals become failure. If we fail in it then certainly the desired outcomes of `empowered women and girls' would be a mere dream. But it was not that much easy, door to door approach, convincing the rightholders, being catalyst our field staffs devotion made it a success. Informally, they launched Reflect learning methodology. BasantaBista, Community officer of PEEDA reflects those primitive years and becomes nostalgic, "Really, it was tough time. To work with the women in Nepal is a hard thing and even more it is harder to the projects whose outcomes can be realized after a continuous and a long run. Working with Jatropha had become of no interest to them in first few years as the products bearing span of time comes to be more than 3-4 years and even more it was a pilot project."

Orientation, Induction and Information Dissemination

When PEEDA started implementing the project first of all it realized to have extensive orientation practice to the rightholders about the project, it's objective, it's impacts and outcomes. Moreover, PEEDA in parallel launched many sessions on it. It brought the fruits as slowly people started showing interest up on it but they were not being ready to plant jathropha and even it was a challenge to get incorporated efforts of women in project cycle. We made the road by walking galvanizing local governance issue with the project activities. We initiated the initiation of information dissemination on why we are poor? What makes so? Who is responsible for that? What is right and wrong? We analyzed the context they are living with minutely and massively. Our mobilizers and field staffs were trained in Right Based Approach and Transformative learning in theory and in practices. They trained the both sides of the project i.e. technical aspect of how to farm jathropa in uncultivated and barren land, how to plant, when to plant? How to look after? How to collect seeds? From where to get seeds to why women are restricted? Is it justified? Who is responsible? We brought hot discussion in within their selves and within the communities. It worked. They become able to analyze the contexts, their conditions.

Paradigm Shift to Mainstreaming and Empowerment

Surprisingly during second phase we had organized groups of women, even Dalit women groups as our rightholders. They were united for common cause. They had started to ask to the local authorities about their proportion, they started asking questions to their man counterparts. Together they had started to go to school meetings, VDC meetings, User groups' meetings, police stations etc. They had been able to identify their need, their demand. From second phase they started to collect the fruits of Jatropha and get money (though very nominal). It

worked as the income source to sum up the subsistence economy. More than that now a few among them were in the limelight of leadership.

Talents Have No Bounds

"Really, I have made my road by walking. A conservative village woman who was just an ignorant and illiterate without the access in any information of the surroundings and outer world now is an outspoken representative voice of the common women of my village." Remembering the past and playing with the cell phone in her hands takes a long breath of satisfaction and articulates, "This all happened because of the change agent and that change agent is PEEDA/SAHAS who encroached and guided me each steps towards organizing, participation, rights, democracy, gender issues and moreover to achieve the political space for women and women issues in community, VDC level and even in district level. How to ensure women issues in all development activities of all the interventions being in the village has become my major agenda to fight against injustice and poverty. Sarki Maya Shrestha-42

Social inclusion and exclusion has become a global development jargon and according to the change contexts the definitions and modality of it's interventions are different. Where the issues of margins are interlinked with it then this issue becomes even more serious. It has been realized during the project period in its intervention at different places of Okhaldhunga namely and mainly to the 4 concentrated VDCs. The issue of Dalits (Untouchable) the extreme and vicious cycle of poverty and undergone injustices in their life were rampant at Madhabpur VDC.

"As a young girl I used to have dreams that one day I will be fully educated, dependent on my own and have my own way of life and it's coping up strategies and mechanisms. After giving the School Level Examination in the family slowly I started listening the issues and agendas of my marriage, roaring voices that I am grown up now and should be married. One day I was notified and made alert as well too that soon after a few months I am going to be married to a person to whom I have never seen and meet before. It touched and shaked me from inside, with the courage I shared my feelings with my mother but she was mentally prepared and counseled me this and that of the patriarchy society. I was numb that my future was being crucified soon after a few months. Inside me a rebel was born but not that much pro-active to come out and challenge this patriarchy of my system. I evaluated a girl and boy's life comparatively. I started doing calculations over the practices being treated on me and my younger brother who was just one year junior to me. I noted similar practices in within all the prevailing system of my community. I was poor enough equipped with nothing an immature girl by age and education. I obeyed the family decision and married. Certainly, inside me there was a rebel who was unnoticed till this project had come in my community. For the first time, independently as a woman farmer I was being organized in a community of Jathropha farmer, slowly the rebel inside me tried to seek place of political space of women issues in the community, I started Nursery of Jathropa and as the woman farmer leader I tried to search the answers of marginalization, exclusion, poverty, injustice etc. The massive discussions on such issues on the Farmer's group made me to internalize main things hidden inside the vicious cycle of poverty. In the meantime, I realized that the Dalits who are isolated and excluded from mainstream development should be organized as this program was for them specially. It was a challenge but where there is will there is the way I met one pro-active Dalit women for the purpose and she

was convinced slowly I organized them, empowered them, by our own efforts we are seeking the opportunities and services being given in community and VDC level. Certainly, the project has empowered us as today we are able and capable of seeking any rights issues if we realized that we are cheated or violated. Significantly, we have realized that women and gender violence and child abuse has been decreased in the VDC. In economic term it has started showing delivering the sustainable tangible benefits to the Dalits.

Moreover, now I am teaching my daughter how to come out from the romanticization of male, see, it is male who decides what you were and what you are restricted for? Muna Basnet-39-Madhabpur

As the historical domination, patriarchy society, feudal mindset women have been dominated and marginalized from previous history. The patriarchal politics has been one of the major discriminating factors in the life of women. Women are dominated within their house, society, culture, economy, politics etc. Either in a developed or in a developing country the socio-political status of women is constructed more or less in a same level or they are considered as the second-class citizens. In such vicious circle of domination one can imagine the situation of Nepali women (even a remote woman of a remote district-the layers of discrimination-folds of discrimination) who have been facing different forms of sociopolitical and economic exclusion. The situation of Nepali women in the Nepalese context is even worst.

No access to resources, participation of women in different user groups and in committees is also poor; Dalit representation is also weaker in the different kinds of committees and user groups. Decision making process has been highly dominated by the male members in different service providing institutions, being as a girl, discrimination within the family is prevalent, this discrimination has made limited access to girls in to the schools and in higher education too. Dalit women and men are excluded in public places to have access in social functions.

Realizing the gravity of the issue, PEEDA implemented this project in the research area towards sensitizing, empowering and inspiring excludeds towards claiming their rights. PEEDA believes in a just democratic world and for this it intervenes from the perspective of Right Based Approach to the development. Governance as the pillar of holistic transformation of the excluded societies PEEDA gives special focus on governance. PEEDA thinks and believes that knowledge initiatives should be generated through different approaches from the field intervention and among the approaches rights based approach and transformative learning are the special tool for awareness raising and empowerment of poors, vulnerable, socially excludeds and marginalized through social mobilization, certainly it works if people are organized.

From the facts and figures above it can be analyzed and prescribed that though the project was a pilot initiative but it has got the potentialities of being viable politically, socially and economically. The project has been instrumental in awareness raising and empowering of women, Dalits and the marginalized. However, it has to be noted that ditto-replication may not be sufficient enough to address rural poverty so other cross-cutting themes like food security, governance, inclusion and sustainable development with integrated approach will be stronger enough to address this context in the post-earthquake context in Nepal.

Further R&D, Optimization of Jatropha Pressure Jet Stove and Guideline Development for Local Level Transesterification Mechanism.

Prabhash Devkota & Shalabh Poudyal*, Sulav Shrestha & Rakesh Sahukhal**, Prakash Chandra Jha***

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Executive Summary

Biofuel based cooking technology is a new concept in our energy sector and one based on Jatropha is an even obscure idea considering the minimal amount of materials available on cooking technologies that employs crude Jatropha. This research work was undertaken to further our previous work in developing Jatropha based cooking stove while extending our interest area into R&D of transesterification technique replicable at indigenous level. Coming on to the end of this project we have attained majority of our aforementioned goals while introducing the techniques we developed to local community at Okhaldhunga as a part of our capacity building endeavour.

The project conducted in close co-ordination amongst the collaborators has been successful in delivering its primary objective of further modification on our previous prototype, transesterification mechanism adoption and dissemination of the technology to targeted communities. The results of tests on modified kerosene stove shows improvement in efficiency from previous 30.6% to 33.1%. There are also slight improvements in terms of emission with PM concentration reducing from 675 to 672 (ug/m3) and average PM concentration reducing from 227 to 224 (ug/m3). The WBT tests on normal kerosene stove showed an efficiency of 38.4% while use of transesterifiedJatropha in same stove resulted in efficiency of 30.6%.

In terms of findings from the project, the mechanism finalized for transesterification is replicable with the biodiesel so derived practically usable in existing cooking means in rural communities. The improvement made in the stove design from this project has also transformed the prototype into a product that can be commercialized and launched as Jatropha fuelled stove across different regions of the country with more confidence in its performance than before.

Introduction

Fuel crisis is a perennially recurring theme in the context of Nepal with the imported fossil fuel unable to meet high demands of the people. Add to that recent political blockades and price fluctuations, the issue becomes even more grieving. Depending upon economy level people have replaced traditional kerosene stove by other commercial source of energy like LPG gases, Solar energy etc. while people with poor economic background are still bound to use the same method for burning/cooking, even though they are aware its negative effect towards the environment. In rural areas traditional biomass energy such as wood and dung are still the main

source of household energy. Increasing wood consumption for cooking is resulting in deforestation creating severe ecological, economic and social problems. Moreover, open fire cooking is frequently practiced in poorly ventilated rooms, which leads to serious health hazards.

PEEDA, under the support of Renewable Nepal has been working on development of pressure jet cooking stoves suitable for rural households in Nepal for the past few years. Previous RENP-supported project "Further R&D, optimization and prototype development of Jatropha based sustainable cooking technology for rural Nepal by enabling environment for technology dissemination and commercial development" (Project ID 1087) oversaw developments of two cooking stoves based on crude Jatropha, one operating on traditional wicks while the other operating a pressurized dual tank and dual burner system. This project was marked as the first step in a continuous series of research development and design works that will lead to attainment of optimum cooking technologies suitable for rural areas. This current concept was a continuation of those research efforts as the previous outputs could still be worked upon and the findings could be refined. Further modifications have been done in terms of stove design and fuel customization.

The goal of this R&D project was to develop measures for adoption of transesterification of crude Jatropha on a local level while further optimizing the Jatropha pressure jet stove developed in our earlier project. The specific objectives of this project were research & adoption of partial transesterification techniques at community level and testing of the transesterified fuel in Jatropha pressure stove and customization of stove accordingly. This project details the research on crude Jatropha cooking stoves as well as tests of transesterifiedJatropha in normal kerosene stoves. So it is referable for anyone seeking the advents of biofuel cooking technology in Nepalese context, be it academicians, students, researchers or scientists.

Inputs and Methods

The project was carried out in terms of these two sets of activities:

Activity Set I: R&D of Local Level Transesterification Technique

Transesterification refers to the alkaline catalyzed or non-catalyzed technique of eliminating fatty acid triesters of glycerol present in biofuels like Jatropha to produce biodiesel. This can be done in many ways using alkaline catalysts or non-alkaline supercritical alcohol like methanol. In this case, a feasibility study was conducted on the research of these techniques in collaboration with NAST and finally a technique employing methanol in a heterogeneous system using sodium hydro-oxide as a catalyst was finalized.
Amount of methanol was taken as a reference based on which the other chemical components of the process were taken. The proportion of mixture includes methanol (CH3OH), sodium hydroxide (NaOH) & crude Jatropha in 100:1-1.5:600 ratio.

Activity Set II: Optimization of Jatropha Vapor Jet Stove

Earlier there were modifications on a normal kerosene stove with addition of a separate fuel tank and a customized Jatropha burner. The customization of Jatropha fuel pipe involved

coiling of readymade copper pipes into a certain number of turns and welding it to the outer circle of the guiding plate. The open end of the fuel was then adjusted with a burner nipple to concentrate the ejection of Jatropha vapour. This resulted in ejection of Jatropha vapour fuel as expected with slight issue of pressure drop in the Jatropha tank the only concern. This time around the Jatropha fuel pipe was reduced in diameter from 5 mm to 3 mm with addition of a smaller nipple which saw noticeable improvement on the previous issues of fast pressure drop and timely spray of un-atomized Jatropha fuel. The prototypes were then user tested in a field visit to Okhaldhunga and positive feedback was received. The performance test, efficiency test, safety evaluation etc. were done at Regional Cook stoves Testing and Knowledge Centre (RTKC) department of CRT/N.

Refinement of Manufacturing Methodology for Earlier Designed Dual Tank Pressure Jet Stove

Initially the components such as fuel flow pipes, square frame, frame supports and fuel tank were joined together by arc welding to form stove which is then tested for the leakages in the water full of bucket. After this an additional tank was added to house crude Jatropha on the opposite side to the regular kerosene tank which was simply attached to the frame supports. Once the burner was added, the Jatropha tank was retrofitted with an additional copper fuel pipe. These copper pipes were readily available in market; however these copper tubes were bended manually as per necessity. Once the fuel pipe took its shape, the nipple of a standard burner was welded onto its tip so as to concentrate the spraying of Jatropha vapor on the underside of the heating plate of standard burner.

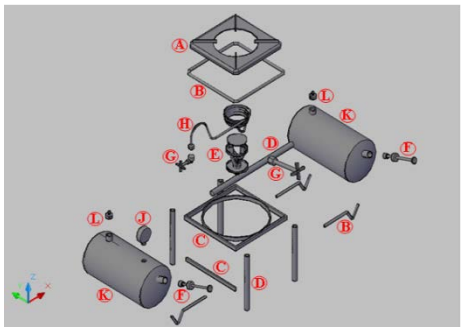

Fig 1:Exploded view of the of the pressure jet stove

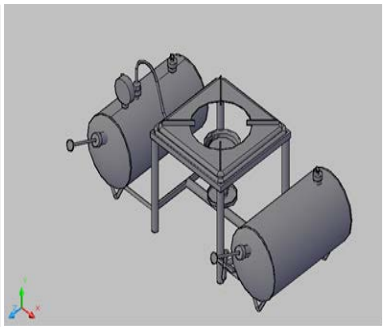

Fig 2:CAD representation fuel pipe

Fig 3:Customized Jatropha pressure jet stove

Efficiency Test Using Kerosene, Crude Oil & Transesterified Oil

The water boiling test (WBT) is generally used in stoves to check its thermal efficiency. It gives the efficiency of the stove rather than the efficiency of the fuel. Firstly the stove is made ready to work as it is done normally; the fuel is measured and kept in the fuel tank. The weight of the fuel used is measured in kg. After the stove has started, the pot is placed upon the flame with amount of water in it. The amount of water used is also measured. The temperature of water before boiling is measured and the stove is operated till the water reaches the boiling point which is then stopped. The remaining amount of fuel as well as water is measured and the boiling temperature at that particular condition is also measured. After the data are measured the thermal efficiency can be calculated by using a simple formula as shown below:

$$h = \frac{4.186 * (P_i - P) * (T_f - T_i) + 2260 * w}{f * LHV}$$

Where,

P = Mass of the pot

P_i = Mass of the pot with water before test

P_f = Mass of the pot with water after test

T_i = Water temperature before test

T_f=Water temperature after test

f = Fuel used

LHV = Lower calorific/heating value of oil

w = Water vaporized

Results

It was found that thermal efficiency of normal kerosene stove with kerosene and transesterified Jatropha as fuel was 38.4% and 30.6% respectively. In addition to thermal efficiency test, emission test and PM test were executed for each of three experimental setups namely local pressure valve stove with kerosene, local pressure valve stove with transesterified Jatropha and hybrid (dual tank) stove with both kerosene and crude Jatropha. The emission from the stoves was tracked through the dome outlet. The amount of the CO_2 present in the emission was measured through the help of gas analyser. The amount of CO_2emitted from the purified biofuel was less in comparison to the commercial kerosene and thus this amount of CO_2 can contribute towards the Clean Development Mechanism. The PM test was measured via performance test and the results of tests are highlighted in the following table:

IWA Performance Metrics	Units	Average Values	
Operational Fuel Modality		Kerosene only	Dual mode
High Power Thermal Efficiency	%	36	33.1
High Power CO	g/MJd	4.31	5.48
High Power PM	mg/MJd	303.3	261.9
Average PM Concentration	ug/m^3	229	224
Average CO Concentration	ug/m^3	2.6	2.1
Highest PM concentration	ug/m^3	685	672
Highest CO concentration	ppm	3.9	3.1
	Standard Performance Measures		
Fuel Consumption Rate	g/s	0.96	0.914
Jatropha Fuel Consumption Rate	g/s	-	0.116
Kerosene Fuel Consumption Rate	g/s	0.96	0.87
Burning Rate	g/min	5.102	6.805
Specific Fuel Consumption	g/litre	32.89	21.475
Temperature Corrected Specific Fuel Consumption	g/litre	33.8	22.85
Firepower	watts	3222	3327
Equivalent Dry Fuel Consumed	g	109	105
		Overall Tier	
High Power Thermal Efficiency		2	4
High Power CO		4	4
High Power PM		2	2
Safety[1]		3	3

The above table shows the comparative test result of the dual tank stove. One is fueled by kerosene only and the other is when fueled by both kerosene and crude Jatropha oil. The efficiency of the stove decreases from 36 % to 33.1 % while adding the Jatropha fuel in the operation; this could be due to some amount of heat lost to preheat the Jatropha fuel which consequently resulted in to the temperature decrement. From the fuel consumption table we can see that we were able to reduce the consumption of kerosene by 0.116 gm/s. The amount replaced has significant change in the emission rate as well. The amount CO and PM has been reduced to some extent due to the use of the plant oil which replaces certain amount of fossil fuel during the procedure.

Furthermore, the PM and CO concentration in both dual tank mode and kerosene only mode are shown in figure 4 and 5 respectively.

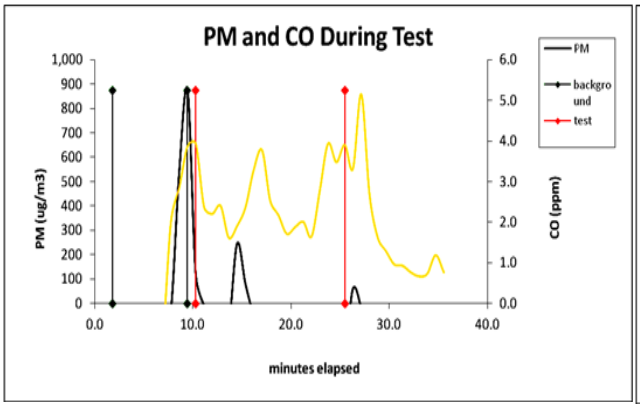

Fig 4: PM and CO concentration in dual tank mode

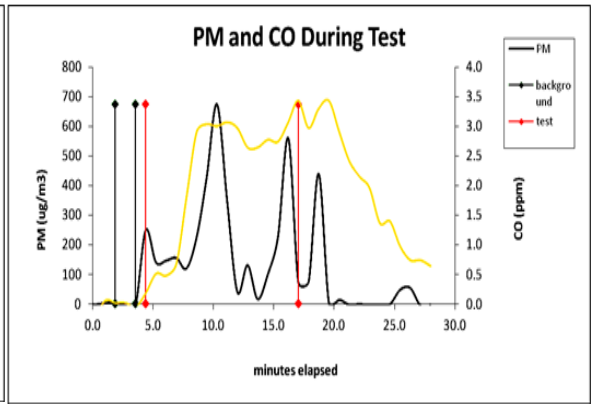

Fig 5: PM and CO concentration in kerosene only mode

It was found that during the dual tank operation, the PM concentration reaches a peak point during the 8-9 minutes time period. This is the time at which the Jatropha is released and a higher burning rate of kerosene is seen during that period. Apart from this the PM concentration remains controlled throughout the operation. In case of the kerosene fueling many peaks were seen throughout the test period. The average value of PM concentration was higher compared to the dual fuel operation tests. The same case can be seen in case of CO concentration as well. The peaks were at steady point during the use of kerosene only hence averaging higher than the value when used with dual fuels.

Optimizations and Validations of TransesterifiedJatropha Oil

Transesterification process was verified by the bioenergy laboratory of NAST (National Academy of Science and Technology). The Fuel thus obtained were tested in normal kerosene stove for its efficiency and emission. The emissions are characterized following the specifications of the ISO IWA. Two sets of measures are reported, one for outdoor pollution, and one for indoor pollution.

Results on Viscosity Test

Kinematic Viscosity of both transesterified and crude Jatropha oil was tested, the results of which are shown in the following graph,

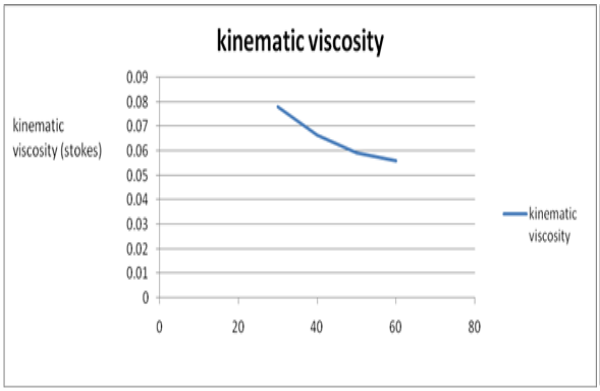

Fig 6: Graph of Viscosity vs. Temperature (Crude Oil)

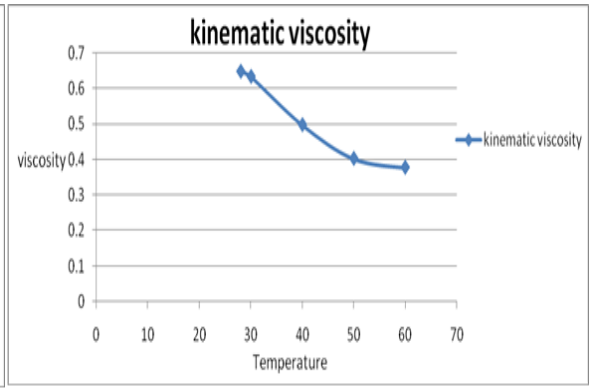

Fig 7: Graph of Viscosity vs. Temperature (Transesterified Oil)

The results show that transesterified Jatropha has less viscosity than that of the crude one. Since transesterified fuel can be used directly in the stove, the comparison show by how much temperature the crude oil has to be heated to make it suitable enough for its performance in a normal kerosene stove. By observing the two graphs it can be seen that about 110°C of variation for temperature was needed to make the viscosity of crude oil close enough to that of the transesterified one.

Conclusion

Previous issue in pressure jet included pressure drop in Jatropha tank. This time around modifications were made in the Jatropha fuel pipe to eradicate the issue and the final prototype was then tested and judged under different circumstances. Furthermore, the current modified stove is significantly less erratic in vapour ejection compared to the previous model through simple replacement of fuel pipe with smaller diameter. In terms of ease of usage, the stove is same as previous design. Preliminary feedback from field demonstrations has been positive. A local transesterification mechanism was also developed and subsequent fuel tested in normal kerosene stove, which worked without any complications. No mixing with the kerosene was required for the transesterified Jatropha oil. Moreover, transesterification at local level has provided a further option highly encouraged by the local communities. Setup of a local minimalistic laboratory for transesterification which can provide for continuous supply of biodiesel is another derivative from field level dissemination.

The major contribution from this project has been demonstration of the ease of usage of biodiesel in normal stoves that received an enthusiastic reaction from the community. The method for transesterification is replicable with the biodiesel so derived practically usable in existing cooking means in rural communities. The improvement made in the stove design from this project has transformed the prototype in to a product that can be commercialized and launched as Jatropha fuelled stove across different regions of the country with more confidence in its performance than before. The end product of this project has broadened the uses of Jatropha crude oil as cooking fuel; this has helped to establish Jatropha crude fuel as biomass and petroleum substitute.

Since the simplicity of biodiesel production is clearly evident, it becomes imperative to develop a systematic chain from plantation to expelling to treatment for biodiesel production. The next logical step becomes commercialization of this concept to an extent possible. The modified stove could be worked upon in terms of ease of usage. However current lack of manufacturing expertise in modifying stove has been a slight issue.

Recommendation

These biofuel projects have been handy in development of local technologies to elevate the livelihoods of local communities. The next logical step would be commercialization and extension of the developed technologies. In terms of our project a treatment facility near plantation areas could be pursued and stove manufacturing facilities with proper expertise for further changes in current design could be highly useful. In case of the trans-esterified Jatropha

oil a fixed cost has not yet been given for comparison with the readily available fuels. However provided that it can be produced at a reasonable price, trans-esterified Jatropha is a much better prospect and needs to encouraged via both policy and technical backstopping.

METHANE LEAKAGE CALCULATION FROM BIOGAS PLANT AND CARBON TRADING

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Introduction

International developments with respect to climate change have resulted in binding greenhouse gas emission reduction targets for countries in the developed world and those making a transition to a market economy, the so called Annex - 1 country. For non-Annex countries like Nepal, only the Clean Development Mechanism (CDM) is of relevance. Given the large sustainable development impacts biogas digesters, micro-hydro, improved cooking stove have for rural households, emission reduction credits generated by household of renewable energy technologies are potential source for the niche market for sustainable development credits.

Clean Development Mechanism

Clean Development Mechanism was established by article 12 of the protocol and refers to climate change mitigation projects undertaken between Annex 1 countries and non-annex 1 countries. Biogas programme is developed as a first CDM project in Nepal. This not only opens a window of opportunity for AEPC to be able to work towards financial sustainability but also brings in new challenges due to higher standards required under the CDM regime.

Methane leakage occurs in biogas plants especially from slurry reserve tank and pipelines. The possible loss of methane which is dissolved in the slurry, escapes once the slurry comes in the slurry reserve tank and is a continuous loss of methane from the slurry and pipe line. Similarly, the bubbles originating from lower section of the Dome pass upwards in the slurry tank and finally escape to the environment. During summer, from April to July, temperature increases and gas production also increases considerably.

Emissions and their Calculations

Baselines Emissions

In order to develop a standard baseline on small-scale biogas digester, there are some major components in biogas baseline analysis. Since cow/buffalo dung is used in biogas digester, what would have happened with the dung if it was not fed in the digester and how much methane would it have emitted? If there is no biogas, other alternatives could be used but what are the greenhouse gas emissions from these alternatives? The questions are answered in the baseline emission calculations.

Given the specific nature of a household technology project in rural areas (small size of each plant, large quantity of plants, wide dispersion), the use of a field survey of a sample of

households is necessary to collect appropriate information on baseline and project emission sources. This makes the use of a standardized baseline approach necessary in two ways:

1. The baseline and project emissions established upon a limited number of households (randomly selected) will be applied to all biogas plants, which meet the same specification;
2. The standardized baseline is not an estimate of the baseline emissions but of the net emission reductions of a biogas plant (baseline minus project emissions). In a field survey data is collected on both baseline and project emissions by interviewing households. This makes the data more useful to estimate the net emission reductions rather than on a baseline or project emissions alone.

CO2 Emission from Kerosene and Firewood

CO_2 emission from kerosene is 2.41 kg CO_2/ liter kerosene and from firewood is 1.83 kg CO_2/kg of firewood (IPCC, 1996).

Average consumption of kerosene per day before and after biogas installation is to be calculated. Calculation formula for each plant size per region in tCO_2 eq. / year is calculated as follows:
Kerosene consumption in lit. per day x 365 x 2.41 kg CO_2 / lit/1000.

Average consumption of firewood per day before and after biogas installation is calculated. Calculation formula for each plant size per region in tCO_2 eq. / year is calculated as follows:

Firewood consumption in kg. per day x 365 x 1.83 kg CO_2 / kg of fuel wood/1000.

Emission Calculations

One of the studies carried out by the consultant for the Winrock International in August 2003 showed that the average biogas leakage calculation in Chitwan (Terai) for 6 cum plant was found 0.165m^3/day from both methods of drum volume calculation as well as water heating method. Likewise, the daily average biogas leakage calculation in Kavre (hills) for 4 cum, 6 cum and 8 cum plants were found 0.11m^3 /day, 0.165 m^3 /day and 0.17 cum/day from both methods of drum volume calculation and water heating method.

However, the leakage from the slurry is comparatively less due to low temperature in winter. For these figures and photos, I would like to acknowledge

Winrock International.

For this calculation;
CO_2 emission factor for fuel wood = 1.83 kg CO_2/kg of fuel wood
CO_2 emission factor for kerosene = 2.41 kg of CO_2/lit. of kerosene
Average vol = 0.08 m3/day= 29.2 m^3 per year
Density of methane= 0.71kg/m3/1000= .00071.
D= M/V or M = Vx D = 20.73 kg

Methane emission calculation per plant per year for 6 cum plant:
M^3 of biogas production percentage of methane 0.71kg/m3 x 12.5% x 21 tons of CO_2 equivalents. i.e. 1.8 x 0.52 x .00071 x .125 x 21 = 6.73 tons of CO_2 equivalent
Net CO_2 emission saving from kerosene for cooking (0.07) + firewood for cooking (7.17) + net methane emission saving from firewood (0.32) = 7.56 tons.
Project emission (0.58) tons
Net saving = 6.98 tons of CO_2 equivalent per plant per year.

Carbon Trading

The present value of CO_2 trading is about US$ 10 per ton and we can earn about US$ 70 per plant per year. We have already installed about 300, 000 biogas plants and we can claim about

US $ 21,000,000 per year only from biogas plants. Government of Nepal is getting money from CDM after the validation of the project from 2005. This money could be used for the subsidy as well as research and development of biogas technology in the country.

Conclusions

- It is concluded from the study that there is excess leakage of methane from the slurry in the biogas plants both in Terai and Hills.
- The excess leakage of methane from the slurry in biogas plants both in Terai and Hills were measured by drum volume calculation and water heating method and found more or less equal from both methods. This was also checked with stove running time and was found almost equal.
- The average daily methane emission was found 8.2 percent, 8.5 percent and 7.9 percent from 4 cum, 6 cum and 8 cum plants respectively installed in the Hills. Similarly, the average daily methane emission was found 8.5 percent from 6 cum plants installed in Terai.
- CO_2 emission reduction from a 6 cum plant was found 6.98 tons of CO_2 equivalent
- The emission reduction from a biogas plant can be trade at the rate of about US$ 10 per tons of CO_2 reduction and can generate money for the subsidy or for the research and development of the biogas plants and their accessories.

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Decentralized Renewable Energy Systems, Rural Economy, Rural Economic Zone (REZ)

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Abstract

The extension of the national grid is, technically and financially, very challenging in Nepal where off-grid renewable energy seems to be the only viable solution. Over the last 30 years, Nepal has installed over 2,500 off-grid micro hydro plants benefitting over 300,000 rural households. The electricity produced is primarily used for lighting purposes and powering some low capacity equipment. Most such systems have issues of financial sustainability due to heavy under-utilization of available power. In this context, the concept of REZ has been developed with valuable experiences from similar activities in rural India. REZ is an entrepreneurship model which pivots around an assured power supply and creating rural enterprises. Around these, economic activities are encouraged based on traditional skills and value addition. REZ is owned and managed by private promoters under the public private partnership model. REZs overcome the twin barriers of promoting renewable energy and demonstrating sustainable growth.

Background

Nepal is a land locked country located in South Asia between India and China. It contains 8 of the 10 highest mountains peaks in the world, although some of its low lying areas are near mean sea level. Thus there is an extreme spatial climate variation in Nepal, from tropical to arctic within a span of only 200 kms. Despite its natural beauty, Nepal is one of the poorest countries in the world with 25.16% of the population living below the poverty line[2].

As compared to other under developed countries, "Energy Poverty" remains a major source of concern for development in Nepal. Over 80% of the people in Nepal live in rural areas with overwhelming dependence on traditional biomass for fuel. Despite huge hydropower potential, Nepal has one of the lowest per capita electricity consumptions in the world. Still about 40% of the population does not have access to electricity. Considering the difficult terrain, subsequent cost involved and institutional barriers, extension of the national grid is very difficult to the remote rural areas. Off-grid renewable energy (RE) systems are essential to reach these areas still lacking electricity. Only about 15% of the rural population of Nepal has access to electricity from off-grid RE systems. In this pursuit, Nepal has installed over 2,550 micro hydro plants (MHPs) over the past 30 years with a gross installed capacity of 36.8 MW utilizing variety of development aid and local matching funds benefitting over 300,000 households of rural Nepal. However, electricity produced is primarily used for lighting purposes and powering low capacity equipment. According to very rough estimates by Alternative Energy Promotion Centre (AEPC), the national nodal agency for promotion of rural and renewable systems in Nepal, around 30% of the systems

[2] The Nepal Living Standard Survey (NLSS) measures poverty considering 2,200 calories per person per day consumption and access to basic non-food items as the threshold in Nepal

are no longer in operation for variety of reasons – technical, social, institutional, etc. Off-grid RE systems have issues of financial sustainability lacking enough revenues for operation and maintenance (O&M) and repair. The utilization of these systems is very low. Although some rural enterprises mainly agro-processing has come up in the vicinity of MHPs, it is estimated that the load factor of MHPs in Nepal is only about 19%. Productive energy use, through the establishment of rural enterprises, to make productive use of the power generated for income generating purposes is a way to increase utilization.

In the other hand, the cities in the country are growing at the rate of 7% per annum while more than 10% of total country's population live in the foreign countries for jobs. Majority of these people come from the rural settings. Such an outflow of economically active population from rural areas makes the living more difficult. The challenges coupled with climate change, extreme weather and other natural disaster jeopardize the rural stay. Thus there is a dire need of doing something that creates local job, uses local resources and brings more economic activities in the countryside.

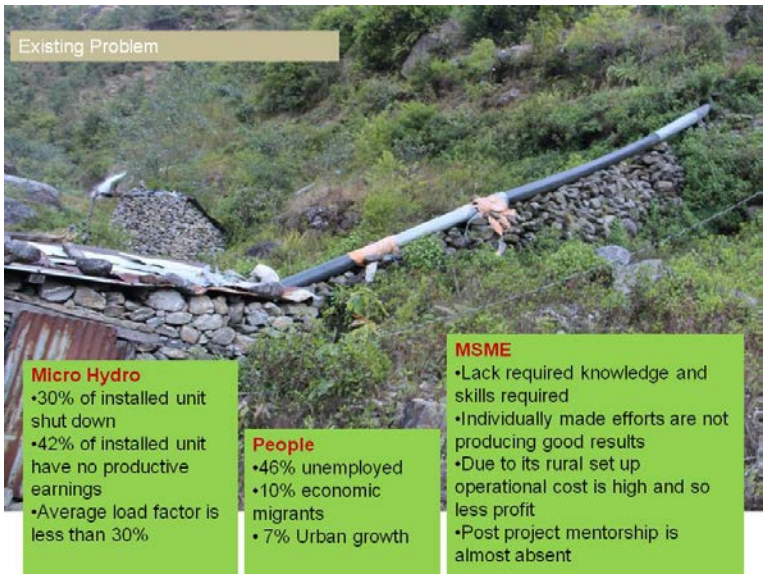

Figure 1: Key Existing Problem of Rural Nepal

Nepal faces numerous challenges both similar and different to other developing countries. Its unique geography and culture provide a base for solutions for these challenges. Energy consumption in Nepal is increasing and is critical component for development. A variety of rural renewable energy technologies are commonly being utilized and promoted in Nepal such as biogas, biomass, solar and micro hydro power (MHP). The promotion of these technologies has focused on rural Nepal where other source of modern energy is absent. Lighting has been primary use of the energy source and there has been a dire need to balance the use of the energy produced from these system and to generate income to ensure long term financial sustainability.

It is well established that Micro and Small Enterprises (MSEs) forms the backbone of any economy be it rural or urban. However, the notion of promoting rural enterprises is very challenging in Nepal considering that MSE sector is also at a very nascent stage. Considering that off-grid RE systems are based in remote rural areas of this mountainous country, the operational cost of setting up such enterprises as well as the operational cost is very high; thus, directly hampering the profitability of such an establishment. There is, then, a distinct lack of knowledge and skills required for establishing and operating such enterprises at the local level. Compounding the whole process is the fact that most previous individual efforts have resulted in poor quality products thereby restricting the market and profits, which directly acts as deterring factor for any potential investors and enthusiasts. Although many external actors have been playing an

important part in developing the capacity in these aspects, there seems to be lack of post-project mentoring necessary to support the rural enterprises at the difficult initial stages of establishment and operation.

It is assumed that rural electrification in Nepal will generally serve for social and economic development of the beneficiaries with electricity access as the entry point. The past efforts in off-grid RE system promotion, to a large extent, have been able to impact positively on this development front. It was thought that increasing electricity access would inevitably boost economic development. However, past experiences have shown that although electricity is a pre-requisite condition for increased income and employment generation at the rural areas, it is not the only pre-condition. A well supported mechanism for promotion of productive use of electricity is necessary to foster the development. This generally helps to encourage private sector to participate in the productive use of electricity thereby increasing income and employment generation opportunities, reduction of drudgery, quality production at the comparatively lower prices that can be marketed at the local market, etc. This ultimately helps in positively impacting on the social and economic development of rural areas.

Rural Economic Zone- A Concept

The present concept aims to overcome the twin barriers by promoting green power and clean technologies and demonstrate sustainable growth through the concept of "Rural Economic Zones (REZ)." The concept of REZ revolves around renewable energy generation and distribution systems. In a REZ, a reliable RE source will allow energy-reliant businesses to flourish, and vice-versa, the businesses will provide the needed fees to pay for and maintain the energy operation, be it a business or cooperative.They are set up in energy starved areas or existing stand alone systems with potential for clustered industries. Around these assured power supply zones, economic activities are encouraged based on traditional skills, value addition and waste utilization.

The focus of the project is on stimulating viable economic activity based on local resources, local entrepreneurs, and local stakeholders with the addition of some outside knowledge, skills and examples. The MSEs consist of connected businesses that create a unique value proposition for the customer and provide assured services and green power to enterprises. Uninterrupted power supply to value adding enterprises is provided by RE generation systems at scales ranging from 10 kW to 1000 kW. The REZ thus acquire a brand value for quality products for various products and skills.

The proposed project envisages strong self-sufficiency and "Equal Opportunity Partnerships" between investors, users and management. Enabling policy and financial support is also sought for overall development. Land for setting up REZ is identified and transferred through Local Governments. Capital cost of the RE based power generation and distribution system is partially financed through financial institutions (FIs) and equity and incentives from government agencies. Commercial banks or apex body FIs is engaged in this process to leverage risk free loans.

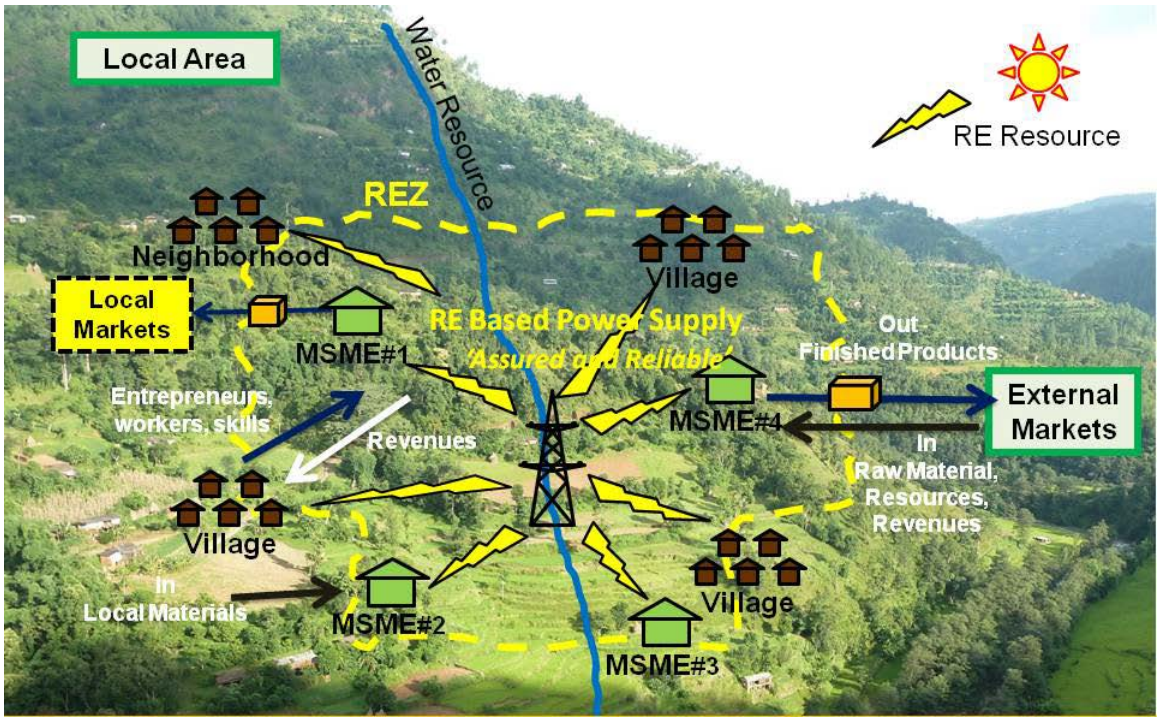

Figure 2: Rural Economic Zone Concept

The successful demonstration of REZ considers the facts that include the MSE development and growth are driven by both exogenous and endogenous factors, which together form the basis of an enabling condition. While some of the enabling attributes already exist prior to MSE development, others need to be nurtured and helped to grow in the local environment. At the same time, the drivers of an enterprise cluster are seen to be influenced by factors such as entrepreneurship development, business development support, assessing products and factor markets, technology, branding, etc. While the enabling conditions are more exogenous to any local cluster, the drivers are more endogenous and hence are influenced by local conditions.

Expected Impacts

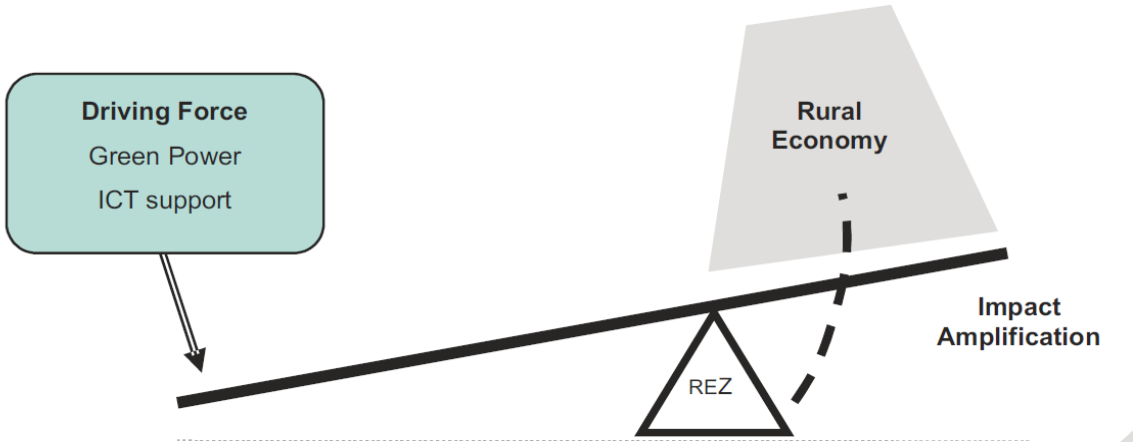

Figure 3: Impact illustration of REZ

The demonstration of successful operation of REZs will result in the sustainable economic growth of enterprise clusters in selected rural and semi-urban areas of Nepal. The REZ along with green power utilities will be managed to ensure growth of the enterprises and the economic viability of the energy provider. The revenues and cash flows will be substantially enhanced through the realization of carbon revenues. Value addition to products and clustered production will enhance market visibility and brand of the REZs. The project will focus on transforming the federation/cooperative into credible "energy service providers" managed with local participation.

The project will setup an example of facilitation of renewable energy based power generation and distribution systems reducing the dependency on fossil fuel energy. Coupled with service approach for supporting enterprises towards uptake of the power being generated, it will bring in an economic independency in rural areas. It will also significantly reduce emissions and promote economic independencies. Successful demonstration will create interest amongst Government agencies and policy makers to adopt and implement the systems thereby reducing energy demands.

Successful demonstrations of project objectives are expected to realize the following impacts in the regional and national scenario of the energy scenario of the country.

- Energy access and security
- Economic opportunities and benefits
- Environmental impacts
- Policy impacts
- Maintenance of cultural heritage

Conclusion

The development of entrepreneurship can be a major means of fighting economic inertia in rural areas that are located far from the main industrial center of a country. The notion of "rural entrepreneurship" is not limited to agriculture and related activities such as food processing, but rather it covers industrial development in general. In addition, the concept is not restricted to the villages but also is relevant to small towns and semi-urban areas. The concept aims at representing the strategies for spurring economic activity in underdeveloped areas. In this regard, access to modern forms of energy access is a major constraint to such a development initiative due to remoteness of the areas. Facilitating the provision of assured energy access with rural entrepreneurship, rural economy can positively be enhanced.

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Technoeconomic and Life Cycle Analysis of Camelina Jet Fuel

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Biofuels can be an income source for rural communities, while also addressing concerns of energy sustainability, environment, and petroleum demand. Ethanol, typically produced from corn starch or sugarcane, is a commercially-proven biofuel replacement for gasoline. FAME (fatty acid methyl ester) biodiesel, typically produced from soybean or other vegetable oils and animal fats, is a commercially-proven biofuel replacement for diesel. Numerous processes have been explored as biofuel replacements for jet fuel. Three processes have received ASTM approval since 2009. Fischer-Tropsch Hydroprocessed Synthesized Paraffinic Kerosene (FTH-SPK) can be produced from any biomass, such as municipal solid waste, corn stover, or lignocellulosic energy grasses. Hydroprocessed Esters and Fatty acids Synthesized Paraffinic Kerosene (HEFA-SPK) requires triglyceride feedstocks such as plant oils or animal fats. Fermented sugars hydroprocessed Synthesized Iso-Paraffins (SIP) require sugars. Of the three certified processes, HEFA-SPK has proven the most commercially possible as of 2015. Neste Oil has two HEFA-SPK refineries in Finland as well as one each in Singapore and the Netherlands. Renewable Energy Group and Diamond Green Diesel each also have a HEFA-SPK refinery in the USA.

Presently HEFA-SPK refineries use the same feedstocks as FAME biodiesel refineries. However, the economics can be enhanced if new feedstocks are developed. Camelina is an annual herbaceous crop in the mustard family which has received much attention in the biofuels community in the last decade, due to its low input requirements for water and fertilizer, fast growing rate, tolerance to abiotic and biotic stresses, high oil content, meal co-product, conduciveness to conventional agricultural equipment, and conduciveness to many soil types. There are field trial reports of high yields, but yield is one of the most important factors for lifecycle biofuel technoeconomics, and yield stability has yet to be commercially proven. Camelina is conducive to genetic transformation. The potential for genetic engineering and breeding and also improvements in farm management practices can improve the yield stability.

Previously we have evaluated the technoeconomics of camelina jet fuel (Natelson et al., 2015). If the yield is 2,250 kg/ha, then the jet fuel break-even selling price is $0.80/kg (in U.S. dollars), under the baseline conditions assumed. In this paper, we explore the life cycle analysis (LCA) of camelina jet fuel under the yields assumed in the previous paper.

The LCA was conducted using GREET v1.2.0.11425, a software packaged developed by Argonne National Laboratory. We deduce that the camelina yield assumption used in the GREET model is 1123 kg/ha. This is because the GREET model assumes 16.8 g Nitrogen / dry lbcamelina for camelina farming (Elgowainy et al., 2012). This equates to an assumption used in a previous camelina jet fuel LCA paper (Shonnard et al., 2010) which assumed that the given N rate would yield 1123 kg/ha. Here, we assume the yield is doubled, through efforts in genetic engineering, breeding, and best farm management practices. We have modified the Farming emissions, Table 1, by halving all the emissions, assuming half the land would be required. Table 1 also

shows the other emissions, including extracting camelina oil from camelina, transporting camelina oil to the renewable jet fuel plant, converting camelina oil to jet fuel, and transporting jet fuel to the end-user. The numbers in Table 1 are for a refinery with capacity of 20 million U.S. gallons hydrocarbon products per year. More details can be found in the previous paper. Some numbers are reduced between the second and third column, due to allocation of different resources and coproducts as simulated in GREET.

For modeling the combustion emissions of camelina jet fuel, we refer to a flight test study (Rahmes et al., 2009). A jet fuel from 42% camelina, 8% jatropha and algae, 50% petroleum was tested in a Pratt and Whitney engine in a Boeing 747-300 by Japan Airlines. Emission results suggested that, when flying the camelina jet fuel, there was a ~1-5% reduction in NOx, 5-9% increase in CO, and 20-45% increase in hydrocarbons, compared to petroleum jet fuel. However, the hydrocarbons emissions increase was fairly negligible because the absolute values were not significant.

The CO_2 produced during the lifecycle of camelina jet fuel is biogenic because of the camelina production. As camelina yields are increased, the LCA of camelina jet fuel is improved.

Table 1: Results from GREET LCA analysis of camelina jet fuel production.

Annual Emissions	Farming 191,204,800 kg Camelina @ 2,250 kg/ha	Farming 191,204,800 kg Camelina @ 2,250 kg/ha, Extracting 66,424,560 kg Camelina Oil from Camelina, Transporting 66,424,560 kg Camelina Oil to Renewable Jet Fuel Plant, Converting Camelina Oil to 46,980,273 kg Jet Fuel, and Transporting 46,980,273 kg Jet Fuel
VOC (kg)	37,731	136,196
CO (kg)	76,518	94,166
NOx (kg)	190,641	220,740
PM10 (kg)	16,455	20,511
PM2.5 (kg)	13,795	17,682
SOx (kg)	176,667	165,052
CH4 (kg)	67,116	178,302
N2O (kg)	81,010	68,161
CO2 (kg)	30,898,166	74,563,066
PM10_TBW (g)	0	0
PM2.5_TBW (g)	0	0
VOC_evap (g)	0	0
CO2C (g)	0	0
CO2Biogenic (kg)	-27,941	-57,894
CO2LandUseChange (g)	0	0
CO2Fertilizer (g)	0	0
Black carbon (kg)	4,125	4,067
Primary organic carbon (kg)	2,911	3,270

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Integrating District Climate and Energy Plan into Decentralized District Development Planning in Nepal

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Introduction

Nepal has a long experience in systematic periodic development planning and during the period of the 8th five year plan (1992-1997), National Planning Commission (NPC)formulated first Perspective Energy Plan (1991-2017) in the form of an indicative planand Alternative Energy Promotion Centre (AEPC) formulated Renewable Energy Perspective Plan of Nepal (2000-2020) in line with national development objectives.

Similar to the national level, local governmental bodies have an extensive role in local level development planning in general and decentralized energy development planning in particular in the districts. The local self-governance act (LGSA),1999 and the LGSA regulation, 2000 state that the District Development Committees (DDCs) should prepare District Periodic Plans (DPPs) for development of the district by comprehensively taking into consideration the situation, needs and potential of the district, and aspirations of the local people.The District Periodic Plan covers a period of at least five years. On the basis of this plan, the district is to prepare annual plans for development investment (there are sets of government guidelines for helping the local authorities undertake these planning exercises). In addition to the annual plans and district periodic plan, the districts are also encouraged to prepare a sectoral perspective plan of the concerned district in a participatory manner. This sectoral perspective plan defines long term development goals in different sectors for the district. The Rural Energy Policy, 2006 promulgated by the Government of Nepal for the first time in the country further emphasized that government, non-government and donor agencies are encouraged to collaborate in the capacity building of the DDCs for implementation of rural energy programmes prioritized in the periodic plan of the DDCs and activities related to district energy perspective plan. However, rapid development of renewable energy systems and addressing the climate change issues can only be achieved through careful planning. Thus, a systematic approach needs to be developed towards district climate and energy planning at all levels but particularly at the district levels where large section of the population reside.

Efforts towards District Climate and Energy Plan

'Sustainable Development', 'Sustainable Livelihood, 'Sustainability', 'Global Warming', 'Climate Change', are most popular development agendas not only in global arena but in national, regional and local levels. The importance of sustainable energy development cannot be ignored to achieve all development goals as energy is always central for the sustainable development which is correlated to economic, social and environmental development as recognized, the three pillars of sustainable development. Energy has a correlation with climate change issues in terms of energy production and high dependence on natural resources.

However, poor people often have limited access to modern energy services and limited choice of technologies which transform modern energy to enhance the livelihoods of the poor people. Energy provision is being implemented at district level through a wide variety of stakeholders including governmental and non-governmental organizations, private companies, and microfinance institutions. The District Development Committees (DDCs) are taking initiatives and consolidating to establish District Energy Environment and Climate Change Section and to form District Energy and Environment Committees (DEECC) in order to coordinate and operationalize Renewable Energy Technologies (RETs) in the districts.

There have been a number of efforts by different organizations to create energy plans at district and village levels that have attempted to map the supply and demand of renewable energy through development of District Energy Situation Reports (DESRs), District/Village Energy plans, District Energy Perspective Plans (DEPPs) and District Energy Master Plans (DEMPs), which attempt to further map RET supply and potential demand in districts. However, there is still a need to have concrete district climate and energy planning for renewable energy in the majority of districts, where there is no long term visionary plan for energy to guide and direct development.

District climate and energy planning should cover more than just mapping RETs. They should also be set within a broader framework that encapsulates national energy plans for coordination and consistency. AEPC is ideally positioned to provide an integrated approach for clean energy and climate change by developing local, on-the-ground adaptation and mitigation practices that can be linked to wider climate change frameworks including National Adaptation Programme of Action (NAPA) and Local Adaptation Plans of Actions (LAPA).

AEPC with the technical assistance of Netherlands Development Organization (SNV) Nepal and financial support from the UK's Department for International Development (DFID) supported Ilam, Makwanpur and Mustang DDCs for the development of District Climate and Energy Plans (DCEPs) as a pilot project first time in Nepal. This have improved the implementation of district energy plans and develop methods for coordinating plans with integrating national and local climate mitigation and adaptation activities as well as assuring that the planning process addresses gender and social inclusion issues. After successful formulation of the DCEP in three pilot districts, AEPC under the National Rural and Renewable Energy Programme (NRREP) has supported to replicate the DCEP formulation process in more than 25 Districts by June, 2015 as follows in which the plans have been endorsed by the DDC council of the respective districts.

Table 1. DCEP Formulated Districts in Nepal

Development Regions	DCEP Formulated Districts
Far- Western Development Region	Achham, Bajhang, Bajura, Kailali
Mid-Western Development Region	Dailekh, Pyuthan, Dang, Jajarkot, Jumla, Bardiya
Western Development Region	Nawalparasi, Gulmi, Tanahu, Lamjung, Myagdi
Central Development Region	Ramechhap, Dolakha, Mahottatri, Chitwan, Nuwakot
Eastern Development Region	Morang, Sunsari, Udayapur, Khotang, Solukhumbu

Source: AEPC Climate and Carbon Unit

Conclusions and Way Forward

DCEP as the key document shows how the District Development Committees (DDCs) should address district climate issues in relation to energy development at district level whilst incorporating the mainstreaming of gender and social inclusion issues. This plan provides an inventory of district energy resources to identify the most appropriate actions, opportunities and interventions for increasing access to RETs and therefore promoting low carbon development as well as RET's contributionto climate change adaptation measures. As DDC's DEECCS and DEECC play the main coordinating role within the district for energy promotion, they should be strengthened in all aspects. As the capacity building of DDC/DEECCS and its DEECC is the key issue for proper implementation and sustainability of the energy promotion activities, DDCs should be provided with more budgets to conduct suchactivities on its own as part of technical capacity building. Thought should be given to develop innovative ways to finance RET projects within the district for greater accessibility to energy services for the common people especially women, vulnerable communities and low income groups. The DCEP should be revised every two years based on the ever changing energy scenario and the progresses made till that time.

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Renewable Energy Technologies Benefit Rural Villages to Build Adaptive Capacity to Climate Change

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Nepal is vulnerable to climate change. The majority of rural Nepalese depend on rain-fed agriculture. The dramatic topography of the rugged Himalayas in the North and the flat land in the south makes the country prone to flooding, drought and landslide. The question then is, can these vulnerable communities increase their adaptive capacity by using small scale renewable energy technologies to climate change?

I carried out research following the above mentioned question to evaluate the socio-economic impacts of small scale renewable energy technologies on enhancing climate change adaptive capacity of rural communities in Nepal. The small scale renewable energy technologies investigated in the study area are solar home systems, improved cooking stoves and gravity goods ropeways.

The study was based primarily upon the quantitative data obtained from the villages of Bhumlichok village development committee (VDC) in Gorkha district of Nepal. The study used a 'With and without' approach to compare the results obtained from the household survey. As a case study, it covered 14 villages in the area to conduct household surveys where 200 households were interviewed. In a random household interview, 154 households were found engaging in the project and hence named as "project participant households" and 46 households who were not engaged in the project named as "non-participant households".

The study result show that in the villages improved access to clean and renewable sources of lighting and cooking energy have positive health impacts on communities and reduced expenditure on fossil fuels. It is found that on an average, a project participant household annually saves 44 liters of kerosene for the household lighting, which means annually the household members, especially mothers and children are less exposed to carbon dioxide emission by 110 kgCO_2, as compared to the non-participant households. In terms of money, annually a project participant household saves an average amount of NPR 4,111 by reducing the consumption of 44 liters of kerosene, 187 numbers of wax candle and 16 numbers of dry cell batteries. The sum of average saving amounts to nearly the equivalent of a monthly salary of a primary teacher in Nepal, or that the amount saved can buy a new set of solar TUKI lamps for his/her household lighting purpose.

The survey result revealed that the non-participant household members have higher cases of indoor air pollution related diseases such as respiratory problems by 22.2%, eye problem by 7.4%, chest pain by 5.6% and tuberculosis by 3.7%. That means, the non-participant households have higher expenditure on health problems related to indoor air pollution and higher day loss of patient and his/her carer, than the project participant households.

In the Bhumlichok VDC, the majority of project participant households (71%) use improved cooking stoves while the majority of the non-participant households (74%) use traditional cooking stoves to prepare their daily meals. The children from the non-participant household annually spend 7 days more on collecting firewood as compared to the children from the project participant households. Similarly, adults from non-participant households spend annually 5 more days collecting firewood as compared to adults form the project participant households. In addition, the results indicate that 89% of the non-participant households depend on physical labor to transport their vegetables and daily consumables while 42.9% of the project participant households have access to gravity goods ropeways for the same purpose. That means, improved access to renewable energy technologies helped the project participant households to reduce labor burden and increase the availability of free time to engage in household and agricultural activities.

As per the survey results, the largest income share (30%) of the project participant households is from selling vegetables. The project participant households have on average 5% more goats and sheep, 3% more fowl, 8% more buffalo and 14 % more oxen than the non-participant households. It can be said that project participant household have more time to engage in agricultural activities and on rearing livestock. Conversely, the non-participant households are losing the productive time in cultivating high value agricultural products and self-employment in the village and instead are depending on daily wages and foreign employment.

In the areas, availability of solar DC-charging facilities in the project participant households highly increases the usage of mobile phones. The use of mobile phones helps them to communicate with the retailers about the market price of their agricultural products as well as decrease the frequency of traveling to the retailers for their receivables. Most of the participant households use radio to listen for news, political events, weather forecast, market price of agricultural products and most of the time songs. It is noted that the project does not have any influence over the listening behavior, attitude and beliefs of the people; however it encourages the increasing use of it.

In the research area, children below 11 years of age from the project participated households have higher literacy rates compared to the non-participant households. The higher literacy rate of children reflects the motivation on their studies due to the presence of clean source of light and stove in their homes. The similarity in result on children's average hours of evening study in both project participant and non-participant household implies that the renewable energy technology implemented does not have impact on the study duration of children.

The project participant households have an average 38% higher annual income for expenditure on things (other than food and shelter) as compared to the non-participant households. In the study area 86% of the project participant households are living above the global poverty line which is 12% higher than the non-participant household figures. The higher level of income and reduced poverty level of the project participant household is due to the increasing access to renewable energy technologies, as it helps them to reduce their annual expenditure on fossil fuels, reduce health expenditure and increase income from selling vegetable products. It is noted that none of the project participant households in the area use electrical appliances for household commercial activities.

According to the survey results, around 62% of the project participant households increased the safety of their crops and livestock's from wild animals due to the presence of light and 86% the non-participant household do not feel safe due to the absence of light. In the households electrical lights are playing an important role in keeping wild animals away from crops and livestock.

An assessment on the perception of renewable energy and climate change in the project participant households indicates that nearly half of the households (42.2%) in the research area agree that increasing use of renewable energy technologies helps them improve their children's education, reduce health risk by using clean sources of lighting and cooking, improve income and reduce physical labor due to the increased use of gravity goods ropeways and consequently also increase their capacity to adapt better to the negative consequences of climate change, such as flood, drought, landslides etc.

Summarizing the above results it can be concluded that renewable energy technologies such as solar electricity, improved cooking stoves and gravity goods ropeways play a strong role in increasing community adaptive capacity to climate change as it contributes to improve the rural households' health, education, information, transportation, income and better use of natural resources. The increased adaptive capacity of community households means that they are less vulnerable to climate events.

Without RETs	With RETs
	
Image1:Kid study under smoky kerosene lamp	Image2:Study under clean solar powered LED lamp
	
Image3:Preparing lunch on traditional cooking stove	Image4: Use of improved cooking stove
	
Image5:Children labor burden on carrying vegetable	Image6: Usage of gravity goods ropeway

Sustainable Improved Watermills Program in the State of Uttarakhand:A Case Study

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Abstract

This case study briefly presents the work carried out under the Indo-German Energy Program: Renewable Energy Component (IGEN-RE)[3] of GIZ to create a sustainable Improved Watermills Program in the state of Uttarakhand. The case study briefly traces the history of watermills, challenges faced by watermillers, government effort to address those challenges, low uptake of government scheme, IGEN-RE approach of demand driven cluster based up-gradation of watermills, implementation of a pilot project based on the approach, outcomes of the pilot and further steps.

Background

In Uttarakhand, watermills (also known as 'Gharats') have been traditionally used to generate mechanical power to grind food grains. It has also provided a source of livelihood for members of the community in villages. Furthermore, watermills also played an important social role, since they provided a common meeting point for the community, given that individual households were dispersed in hills. However, with time, as access to these regions improved through better infrastructure (road as well as penetration of the electricity grid), the traditional watermills were gradually displaced by diesel and electric mills, primarily on account of comfortable accessibility and lower processing time. The electric/diesel based mills' grinding rate was higher than that of the watermills which consequently led to overall decline in the usage of watermills in Uttarakhand. To revive the use of watermills, Uttarakhand Renewable Energy Development Agency (UREDA) has been carrying out their upgradation to enhance their efficiency and expand their sphere of usage from mechanical to electro-mechanical applications. Upgraded watermills can produce up to 5 kW of electricity which is sufficient to electrify 10 to 15 households. UREDA also gets support from Ministry of New and Renewable Energy (MNRE) in the form of capital subsidy to upgrade the watermills. As per the survey (in 2005- 06) conducted by UREDA, there are 15,449 watermills in the state, of which 55.14% (8,519) are not functional.

Despite the subsidy available under this scheme, the demand for such upgradation of watermills has not been very high, primarily because the demand side issues have not been adequately addressed which have consequently resulted in underutilization of installed capacity and also insufficient income generation for the watermillers. A preliminary study, including a sample survey of 100 watermillers was undertaken by GIZ in order to assess the current status of the improved watermills programme in Uttarakhand. The key learning from the study was the fact that the improved watermill has a significantly higher processing capacity that surpasses the

[3]Renewable Energy component of Indo-German Energy Program is a predecessor of the current IGEN-ACCESS program of GIZ. The objective of IGEN-RE program was to promote renewable energy in rural areas through the participation of private players. The intervention on watermills was an activity under the IGEN-RE program jointly executed with UREDA/MNRE in order to strengthen Improved Watermills Program in Uttarakhand

local demand. However, given the lack of appropriate forward and backward linkages to service potential demand beyond the local market, the watermills do not generate adequate revenues for the watermillers.

With an aim to develop the business case for watermills, GIZ developed and implemented a pilot project based on an innovative and holistic approach, where a cluster of improved watermills addressed a specific energy demand for different livelihood activities (processing, packaging and marketing ground flour and spices) that were owned and operated by self-help groups within the local communities.

Pilot Project in Uttarkashi

a. Activities

GIZ implemented the pilot project in Uttarkashi in partnership with UREDA. The key activities under the pilot project included –

- Identification of demand that can utilize the energy available from improved watermills
- Assessment of the feasibility of a cluster of improved watermills addressing such demand
- Development of a detailed project report for the proposed pilot based on the feasibility study
- Implementation of the pilot project, which included
    - Formation of the watermill cluster/ group that managed the enterprise
    - Up gradation of watermills
    - Capacity building (technical & commercial) of the group members
    - Establishing forward (market) and backward (raw material) linkages
    - Improving quality and market related issues (packaging, labelling, etc.)

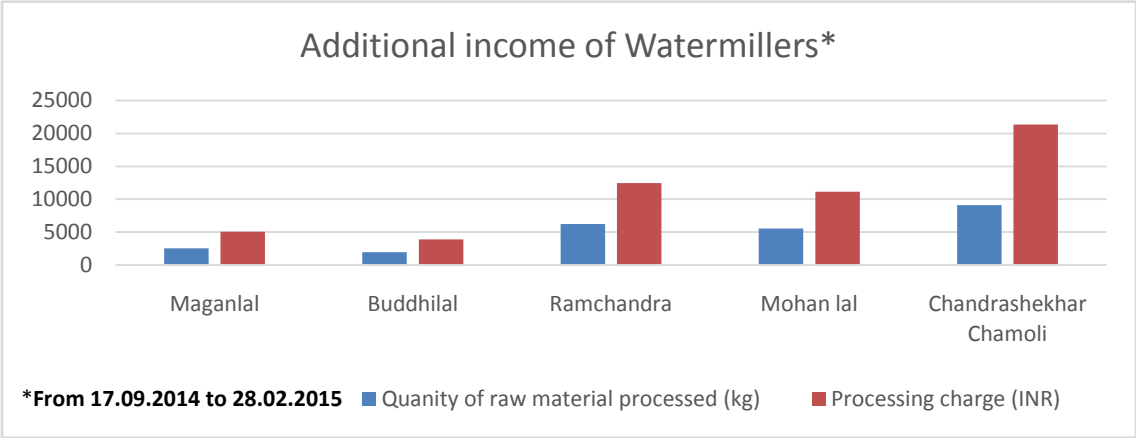
b. Achievements to Date

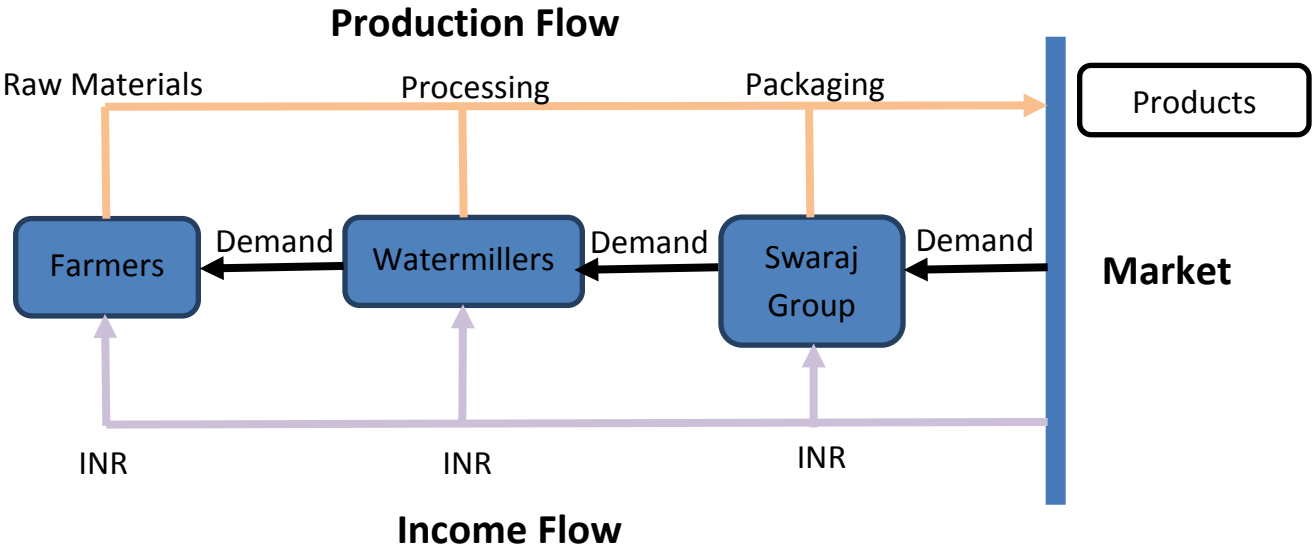
Within a short time span since the initiation of activities on the ground (April 2014), the project has achieved several important milestones -

- A cluster of 5 watermills have been identified and upgraded.
- The associated group (Swaraj group) has been established and has started functioning as an enterprise with products such as cattle feed (Pinda), cold flours, oil and spices.
- The group has obtained certification (Regn. No. 050011100350) as a Micro Enterprise with the Directorate of Industries, Uttarakhand.
- The group has successfully established forward linkages for its products in local markets and ashrams as well as agencies such as the Azim Premji Foundation.
- The group has also participated in regional trade fairs and events, including the recently held International Conference on Hydro Power, and has received significant appreciation from district/government officials.
- Based on the technical training obtained, the group is also generating additional revenues through installation of other watermills in the region.

Initial evidence from the operations from September 2014 to February 2015 shows an increased usage of the watermills resulting in increased income of the watermillers. The pilot project has thus had a direct positive impact on sixty people (family members of watermillers, assuming a

family size of 5) and an indirect impact on several more people involved in the forward and backward ends of the supply chain.





The above diagram explain the entire value chain starting from sourcing of raw materials from farmers to processing of raw materials by watermillers, packaging and marketing of products into markets by members of the Group. Here, it is important to highlight that in order to increase usage of watermills, one has to look at entire value chain and other actors involved in the value chain. In turn, the benefit not only gets accrued by watermillers but farmers and members of the group also benefits equally.

Next Steps

The initial evidence from the pilot project reflects the merit in the approach to linking the energy available from a cluster of watermills to a specific demand/livelihood intervention on the ground. Accordingly, GIZ is interested in supporting UREDA to help establish 3 – 5 similar clusters in each of the hilly districts of Uttarakhand. The key aspects proposed to be covered within the technical assistance from GIZ are -

- Developing and implementing a framework for engaging with local agencies that will own/implement the clusters
- Providing capacity building support to the agencies involved in the implementation
- Establishing appropriate forward and backward linkages and also analyze value chain of products processed by watermills for appropriate interventions
- Developing product quality control processes and required certifications
- Developing a suitable monitoring and evaluation framework

Green Industries in Nepal: Realizing a Dream!

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Nepal is a small landlocked country situated in South East Asia and sandwiched between two economic heavyweights, China and India. The country is currently on a transition phase as the citizens await a new constitution. According to the Central Bank of Nepal, GDP growth rate for the fiscal year 2013/14 has been a mere 3.56%. In addition to this, the industrial sector has been suffering for a long time due to lackluster business environment, energy crisis, political stalemate, and failure to raise internal and external capital. According to the Economic Survey published by Ministry of Finance, annual average growth rate of industrial sector for the fiscal year 2012/13 is a mere 1.7% that is hampering the economy by leaps and bounds. Furthermore, its contribution to the GDP is also a staggeringly low of 6.2%. The biggest contributors to the GDP are agriculture including forestry, and remittance with 34.3% and 22.4% contribution respectively.

Infrastructural development is also progressing at a very lethargic pace. Even in the capital city Kathmandu, people are compelled to face more than twelve hours of power cut-off every day during dry season due to insufficient electricity generation from existing hydro-powers. The situation is virtually the same throughout the country. It was reported that in 2011, around sixty industries in Birgunj-Pathlaiya industrial corridor had to be shut due to energy crisis. In addition to this, 9 cement factories, 6 plywood factories and twenty one crusher industries were badly affected by the acute energy crisis along the Chandrauta-Krishnanagar corridor of Kapilbastu district (Industries Effected by Energy Crisis, 2013). These are just some of the examples showcasing the dire situation of the industrial sector.

However, the situation is likely to improve in the coming years. After seven years, Nepal Electricity Authority has predicted that the country will witness enough electricity generation from under construction hydro-powers in order to power big industries. According to Department of Mines and Geology, Government of Nepal, the country possesses abundant raw materials for cement, agro-lime, marble, talc, dead burnt magnesite, zinc-lead etc. industries. Similarly, small-scale mines of coal, peat, clay, salt, talc, quartz crystals, semiprecious stones, precious stones and quite a few dimension/ paving stones, roofing slates, etc. can help boost the industrial production as such materials are used in variety of industries. Labor cost is also moderate in Nepal and market potential can be explored in the booming neighboring countries and throughout the world.

According to Environment Protection Act- 1997 of Nepal, Government of Nepal may, to encourage any industry, enterprise, technology or process which causes positive impacts on environment protection, by publishing a notification in the Nepal Gazette, provide additional concessions and facilities as prescribed. Such concessions are minimal and are unable to lure industrialists to really embark upon technology and innovation to facilitate resource efficiency. The government has promulgated New Industrial Policy, 2009 to develop industrial sector and to protect and facilitate the investors. Government is laying more emphasis on the establishment of industries but is showing apathy towards making the existing industries more resource friendly as

no such programs and targets were set in their much emphasized Three Year Plan: 2011-13. The biggest cause of concern at the moment is to avoid any industries from being shut permanently.

The biggest obstacle for increased resource efficiency in Nepal can be attributed to the lack of policies supporting green industry and resource efficiency. Awareness level among industry owners regarding the benefits of energy audit is minimum and their willingness to recycle and reuse is only limited up to the case when they do not need any subsequent investment to proceed. Owing to energy crisis coupled with competition from foreign products and lack of ability of businesses to take calculated risks, industrialists are reluctant to upscale their endeavor as they fear it might add up to their per unit cost. Industries are compelled to use diesel generators during power shortages that is tremendously increasing their cost and making their products unable to compete in the national as well as international market. This is also causing high inflation in the country followed by an increment in the air pollution.

The financial market of Nepal is flooded with commercial banks and financial institutions that have majority of their investments in unproductive sectors such as real estate. Government could use environment financing as an instrument for promoting resource efficiency and they themselves could lead by an example by adhering to green procurement. As government is not in a position to financially support the greening of industries, they could channelize Foreign Direct Investments (FDIs) to take a stake in the local industries that would deem the industry capable of enjoying economies of scale.

Trainings and capacity building programs on resource efficiency should be conducted jointly by government and private sector as this association holds the crux for sustained resource efficiency practices. Success stories of local industries that have been successful in lowering their cost by adhering to resource efficiency practices and clean production should be promoted so that others would be motivated to replicate the same. Production and use of bio-fuels should be prioritized and incentivized so that industries could use them as a substitute to diesel for better efficiency and lower emissions.

Furthermore, policy makers could be taken for exposure visits to make them understand different policies adhered by different countries and their subsequent implications. Furthermore, policy makers should bring in the representatives from the industrial sector, NGOs, INGOs, coupled with economists, engineers, etc. and form a heterogeneous team so that sound and sustained policies could be formed. Government needs to support R&D programs aimed at increasing resource efficiency and even if they are unable to do it financially, they could at least link such researchers to their compatriots in developed nations so that they could bring-about some value addition to the domestic industrial sector. Market Based Instruments (MBIs) such as taxes, subsidies, emission trading, etc. that help lower the compliance cost, provide incentives for innovation and internalize the external cost should be brought into practice. Flexible policies should be formed that does not hinder technological innovations.

Finally, as Nepal is currently heading towards the federal system of governance, the central government when formed should waste no time in institutionalizing the notion of resource friendly industries. The country would be embarking upon the road to industrialization in about half a decade's time from now, so a sense of urgency has to be instigated in order to

successfully build resource friendly industries. Opportunities galore for Nepal and it is only up to the government and private sector to grab the opportunity for sustained industrial development of the country. Hence, the government should waste no time in forming a task force comprising of all stakeholders and should set short term goals that would revitalize the existing industries and enable the soon to be constructed ones to be more resource friendly.

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What about Clean Energy Community House?

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The entire world is about to enter into another era of high tech technologies and infrastructure that will necessitate mammoth consumption of energy. One small component of that world is a country named 'Nepal' that too might require energy in four or five digits of MW. This is a prediction of future Nepal that is going to be exceedingly industrialized, motorized, modernized, and hybridized with Indian and Chinese market policies and many more. Hence, we need energy and the hunger for it will grow exponentially.

In the present context, Nepal is facing an energy crisis and to fulfill energy demand, our country is importing electricity and fossil fuel worth billions of Rupee, which consequently contributes to huge trade deficits of more than six hundred billion Nepali Rupees. Therefore, it's time for us to think about an alternative that could save our country from such a man-made disaster. Recently, this artificial disaster was accompanied by a natural disaster entitled 'earthquake.' The earthquake has destroyed the majority of privately owned and some state owned hydropower plants, which has resulted into disruption of electric power that nearly equals to 200 MW. This is a devastating scenario for Nepal as it is generating electricity below 1000 MW, mostly from hydro power plants. So, it's time for us to think about renewable energy that could positively offset the energy demand of our country. Our small effort and effective policies promoting green source of energy could save our country from such scarcity of Energy.

In order to tackle the energy crisis, I have an idea of "clean energy community house" that encompasses almost all sorts of renewable energy like solar, biogas, wind, bio-diesel and hydro-power. This house will be a business enterprise developed with the concept of public private partnership that includes a restaurant, a dairy farm, an organic farm, a library, and a training center.
There will be a dairy farm and the 'Gobar,' the wastes of those animals, will be used as raw material for the biogas plant. The biogas or 'Gobargas' thus generated will be used for cooking in a restaurant. Moreover, the milk from dairy farming can be sold in the local market. After a certain period of biogas generation, the cow or buffalo dung i.e. 'slurry' can be used as fertilizer for organic farming. The vegetables and fruits grown with the organic fertilizers can be consumed in the restaurant. This organic food will allure foreign as well as local tourists in the community.

The lighting and heating demand of this community house can be fulfilled via photovoltaic solar panels and solar thermals. Furthermore, small wind turbine can be placed on the rooftop that can be hybridized with solar panels. Both wind and solar can compensate each other at their respective odd time, i.e. when there will be no wind, solar will provide the electricity or when there will be no sunshine especially at night, a wind turbine will generate electricity.

A library can be operated that will benefit the local people and school children with a minimum charge for using books and the internet. This will create learning environment and will enhance the academic standard of local people. I have another thought of operating a training center on the same house that will train people about the construction of biogas plants and installation as well as maintenance of solar panels. Thus, semi-skilled manpower can be produced that will flourish not only these renewable technologies, but will also make them self-sustainable. The vehicle of this house will operate with the blended fuel which consists of diesel and unused cooking oil. Thus, the entire house will use renewable or clean form of energy for its heating, lighting and transportation demands.

Ecotourism can be promoted via development of small hydro-power of some Kilowatts. This will include a tank that will store rain water and small turbine, generator and all other necessary equipment's will be placed in an underground in order to create necessary head. The water flow can be controlled manually and whenever a demo is essential for tourists, it can be operated for certain period of time. I came up with the entire concept when I was thinking of a collective approach that would encompass not only renewable energy, but will also provide income, and employment to the local people.

Similarly, the government can generate revenue by 'Carbon Trading' via such 'Clean energy community house'. Major market of such trading could be developed countries that need to maintain their emission limits of greenhouse gases. Thus, they are ready to pay millions of dollars for such projects. So, I think it's time to construct such houses as tourist destinations of Nepal, which is beneficial both for the local communities as well as for the government to compensate the energy demand of the growing economy. This could boost our national economy, reduce unemployment, reduce overseas employment, reduce emission of greenhouse gases, promote culture and tradition, and solve the problem of energy crisis and many other intangible benefits.

Renewable Energy for Sustainable Livelihoods

Prem Bikram Karki

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The people in different parts of the world have been continuously using non – renewable energy in the forms of gasoline, diesel, natural gas and other forms. Everyone is aware that after some time, this energy will come to an end. Care for the proper usage of such energy resources is minimal as it benefits the people at the current time and thus doesn't care to think of the future. This has raised concerns among top environment friendly and conscious world leaders. Support for such global issues need to arise from the ground level individual.

People should start using alternative forms of energy which is renewable in nature. It could be use of biogas, solar energy, wind energy, geo-thermal energy, hydropower etc. The energy received from renewable sources can be stored and converted into daily activities. It can also turn up into creation of employment in rural areas of the world. Locally available renewable natural sources can be used to produce scalable environment friendly solutions which could consequently reduce the operation cost of the organization.

Organizations should really be looking forward to work on usage of renewable energy for sustainable livelihood creation. Scalable models can be replicated. Fostering livelihood creation can uplift the economic development of the community. Capacity development and training can enhance common people to raise awareness of the use of renewable energy thereby saving the amount of non-renewable energy. Environment conscious and friendly scalable energy projects will not only save the environment but also reduce operation cost of the project.

Sustainable renewable energy should be implemented in rural areas of the country especially where economic development is very low as compared to urban areas. Sustainable development can be promoted by the use of sustainable renewable energy. This initiative would bring the disadvantaged and marginalized group of the community in particular to get in access to energy services and modern technology. Renewable energy can be used in small household activities like cooking, heating, lighting and small scale enterprise development in the rural areas. Renewable energy in the form of solar panels and biodiesel can contribute to poverty alleviation through sustainable development. The per capita energy consumption of a country is one of the key economic development indicators. Utilization of renewable energy can reduce the emission of carbon dioxide as thereby reducing pollution and in turn improve friendly environment.

As per the millennium development goals of the UN regarding sustainable development, 17 goals were proposed as of March 2015 that included ending poverty and hunger, improving health and education, combating climate change, making areas more sustainable and protection of water resources and forests. The role of the government is vital, where it can provide subsidized prices for access to common people. Investment in infrastructure is important which cannot take place without the intervention of the government. The adverse impact on the environment by the use of non-renewable sources and the fluctuations in the prices of fuel

has led to concerns and in turn has created urgency for the generation of renewable energy production. Sustainable livelihood mainly focuses on reducing poverty and value creation of common people by generation of employment activities through the allocation of common local resources.

Alternative forms of energy can be very essential in daily human life. These energy forms are economic and environment friendly. The use of photo voltaic cells from photons emitted by sun can be used to generate electricity. Solar energy can reduce air pollution and CO_2 emissions. Wind turbines can be used to generate power via conversion of wind energy into electrical energy. Geo thermal energy can be used for industrial processes, desalination as well as agricultural applications.

The production of biogas from wastes and agricultural residues can contribute to the generation of electricity. Biogas utilization will save fuel costs, reduce deforestation, increase revenue generation, enhance employment and value creation.

Thus, use of renewable energy is very essential for the economic development of an individual, a community, a country and the world as a whole. All countries should take this global issue to the extent up to which it can save the world from energy crisis. Alternative forms of energy should be emphasized to be used for the betterment of the common people in the whole world.

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. Formation of Nepal Bioenergy Society (NBES)

   After almost 9 years of working experience in the field of Biofuel, PEEDA realized that the achievement achieved so far needs to be materialized and institutionalized for sustainable development of bioenergy. In the present context, Nepal is totally dependent upon fossil fuels and additionally suffers from scarcity of such fuels periodically. Thus, PEEDA in collaboration with various relevant stakeholders decided to support the formation of an organization namely Nepal Bioenergy Society (NBES), the objective of which is to promote renewable form of energy technologies derived from biomass. Furthermore, it aims to execute policy and people centric advocacy. The first Annual general meeting of NBES was held on November 6, 2015 at Indreni Complex, New Baneshwor, Kathmandu.

2. A Seminar on Bio-energy

People, Energy and Environment Development Association (PEEDA) in collaboration with Nepal Academy of Science and Technology (NAST) and Nepal Bioenergy Society (NBES) invited major stakeholders of Nepal's bio-energy sector along with ministers from concerned ministry, youth leaders of political parties, bureaucrats, professors, consultants, Journalists, etc. for joining the one day seminar on "Bio-energy as the Major Alternative Energy Source in the Changed Context of Nepal: Challenges & Possibilities", which was held on November 6, 2015 at Indreni Complex, New Baneshwor, Kathmandu.

About 110 individuals from government agencies, private sector, research institutions, universities, media, NGOs and INGOs acquired detailed overview about the bio-energy as well as its challenges and future plans during several presentations and panel discussion.

Fig 1: Panel discussion during Seminar on Bio-energy

3. Support to the Earthquake Affected Families of Nepal

PEEDA, in coordination with SAHAS- Nepal and support from Bread for the World-Germany distributed 600 Tarpaulins to the earthquake affected families at Thakle, Manebhanjyang, Toksel and Madhavpur VDCs of Okhaldhunga district on 30 May 2015. Tarpaulins were distributed at the request of DDC- Okhaldhunga and other stakeholders. A very special thanks goes to Nepal Army, Armed Police Force and Nepal Police for their management and support for this endeavor. Also, the efforts of VDC Secretaries are highly appreciated.

Fig 2: Tarpaulin Support at Okhaldhunga

PEEDA with donations collected from the families in UK distributed 32solar lanterns to the earthquake affected families of Ghyangphedi village (Nuwakot district) on 22nd May 2015.These solar lanterns were distributed to 22 families in Ghyangphedi and the remaining 10 were given to the families of neighboring village. Since, prior to its distribution, all of the recipients were relying on battery powered torches; they were delighted to have such solar powered lanterns. Accordingly, PEEDA gave a brief demonstration on how to use the light and explained that once fully charged, the lantern could provide light ranging from 4 to 8 hours depending upon its use on either higher or lower setting.

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