

# **Renewable Energy Development Strategies and Solid Biomass Fuels in Nepal**

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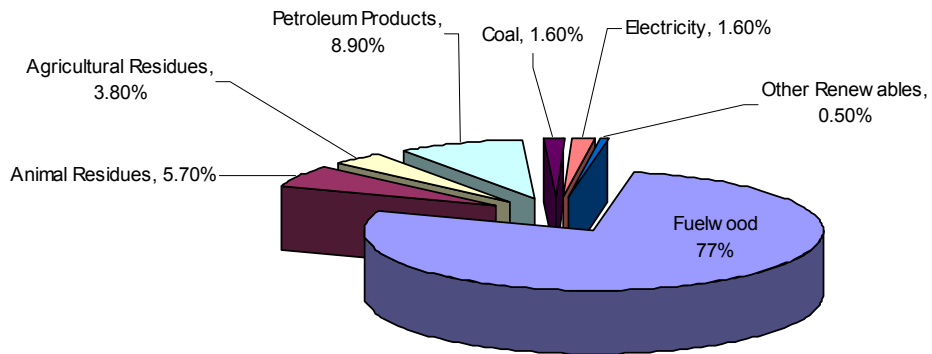
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## **Introduction**

Energy is essential to economic and social development and to improve the quality of life of the Nepalese people. Energy consumption in fiscal year 2002/03 increased by 0.9 percent to make it about 8.2 million TOE. Three sources, namely traditional energy, commercial energy and alternative (or renewable) energy, contributed about 87.4%, 12% and 0.4%, respectively in total primary energy consumption in Nepal. The estimated consumption growth rate for the next fiscal year (2003/04) was 2.9 percent (about 8.5 million TOE). In this amount the share of traditional energy was expected to reduce slightly at about 86.8 percent and that of commercial and renewable energy would increase slightly and make them 12.6 percent and 0.5 percent respectively. Although hydropower is a renewable source, it is classified under commercial energy sources together with petroleum products and coal. Except electricity generated through large and medium sized hydropower plants, all other renewable energy sources (i.e. biogas, micro hydropower, solar and wind) have been put under a new classification “Alternative Energy”. At times it miss leads the people by giving a false notion that electricity generated through large and medium sized hydropower plants could not be considered as renewable energy.

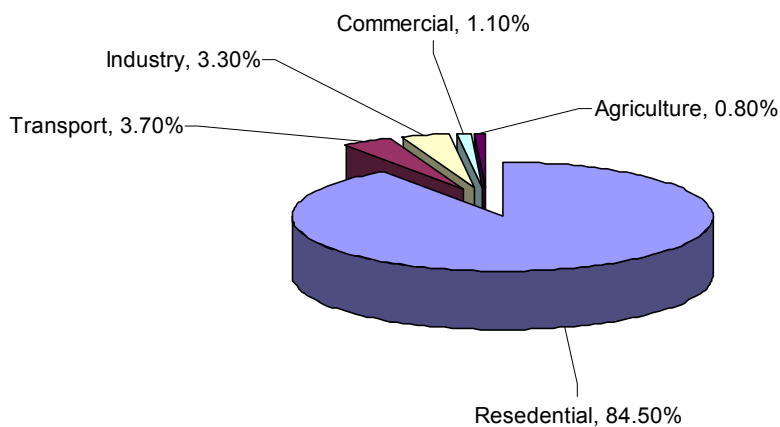
Of the total traditional energy consumption in 2002/03, the share of fuel wood alone was as much as 77.9 %, animal excreta (mostly cattle dung) 5.7% and agricultural residues (derived during crop harvest and agro-processing) 3.8%. In the coming financial year, the share of fuel wood is expected to reduce slightly in percentage term (to 77.3%), but it would be questionable whether consumption would degrease in absolute term. Similarly, of the total commercial energy consumption, the share of petroleum products, electricity and coal was 8.9%, 1.6% and 1.6% respectively. In the next financial year the share of petroleum fuels and coal is expected to rise slightly (to 9% and 2.0%, respectively), but the share of electricity would remain constant at 1.6%. Energy consumption in 2002/03 by fuel type and sectors are provided in **Figure 1** and **Figure 2** respectively.

**Figure 1: Energy Consumption by Fuel Type in Nepal 2002/03**



Currently, the major energy-consuming sectors in the country are residential, transport, industry, commercial, and agriculture sectors. The residential sector consumed as much as 84.5% of the total primary energy in the fiscal year 2002/03, followed by the transport sector, which consumed 3.7%, the industry sector 3.0%, the commercial sector 1.1%, and the agriculture sector 0.8%. In next financial year, the share of industry sector is expected to increase only slightly (to 3.4%), but the share of other sectors is expected to reduce a little bit from their current level of contributions (HMG-MOF, 2004).

**Figure 2: Energy Consumption by Sector in Nepal, 2002/03**

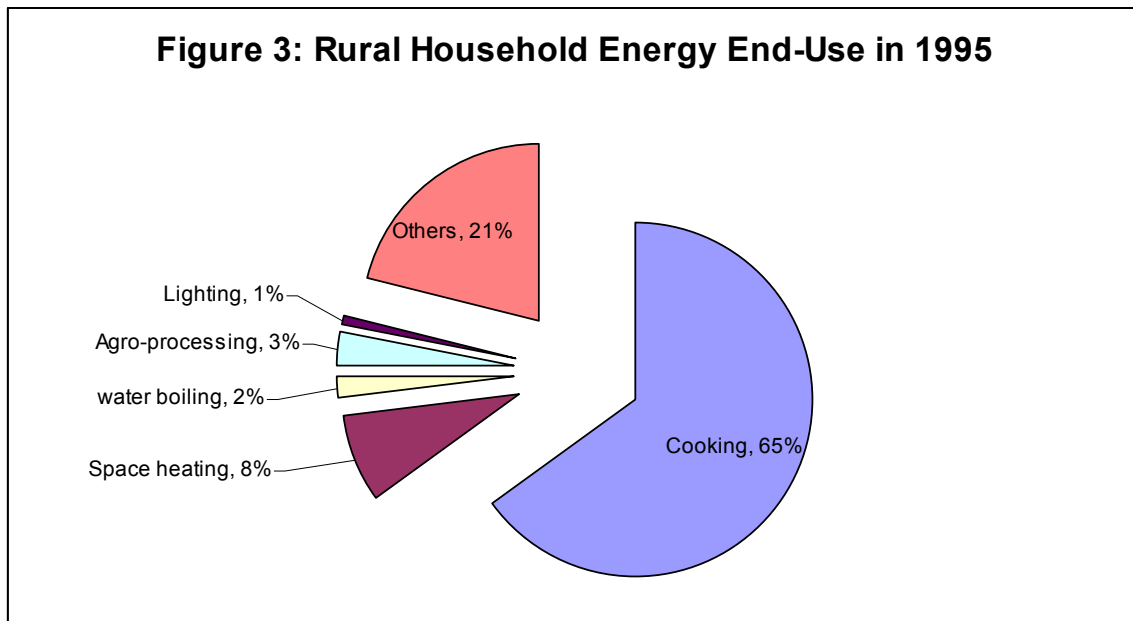


One study (RWEDP, 1997) tried to convert the total amount of traditional fuel (mostly wood fuel) consumed in Nepal into its economic value using the average wood fuel

prices in 1990 and it was calculated worth US \$ 469 million, or equivalent to 40% of Nepal's export earnings in 1990.

The Nepal Living Standard Survey Report 1996 of CBS-NPC (2002) categorically suggested that there was a heavy reliance on wood as a source of energy. It was the main source of energy for cooking in most part of the country for over 65% of the households. The second most common fuel used for cooking was other biomass in the form of animal dung, leaf litters, grasses, straw, stalks etc.), which was used by another 25% of the households. And only 5% of the households used kerosene and less than 1% households used LPG for cooking. The use of other energy sources such as electricity, coal, charcoal, and bio-gas was very low. Electricity was used mostly for lighting purposes wherever supply existed in rural Nepal. However in rural areas of the country more than 70% of households used firewood. Kerosene ranked first in urban Kathmandu valley followed by LPG where the use of firewood was only nominal.

Shrestha (2003) cites the 1995 survey of the Water and Energy Commission Secretariat (WECS) to explain the energy end-use perspective in Nepal. It states that about 85 percent of the population lived in rural areas and residential cooking comprised of the single most energy end-use, which accounted for about 65 percent of the total energy consumption in the country. Among other end-uses in the residential sector, space heating accounted for 8%, agro-processing for 3%, water boiling for 2%, lighting for 1% and other uses (including animal feed cooking, special cooking during social, cultural and religious occasions, etc.) for 21% **Figure 3**.



Bajgain (2003) presents a unique case, 91% primary energy consumption in the residential sector of Nepal, Out of which 80% used for cooking. Besides, many activities in the commercial and industrial sectors depended on traditional sources for meeting their energy needs. The only sector that relies solely on imported petroleum fuel is the

transport sector in the country. The present energy scenario in Nepal is unique for a country which is supposed to be endowed with enormous hydropower generation potential by the nature.

### **Renewable Energy in Nepal**

NPC (1995) separates the energy used in Nepal into two types: traditional energy and commercial energy. This classification tries to distinguish the sources as per their supply mechanisms in the Perspective Energy Plan for Nepal (PEPN) 1995. Other energy planners might classify them into traditional and non-traditional energy, some others into commercial and non-commercial energy, etc. Whatever terms might have been used for distinguishing different energy sources, the logic behind seemed very much motivated to separating these sources based on whether these were purchased in commercial markets or self grown/collected from accessible public sources without any cash payment.

But such a classification might also lead to confusion, as fuelwood consumed by urban households, traditional industries and commercial establishments is often purchased at going prices in local markets. So, on this ground, all market purchased fuelwood could very well be commercial energy.

Ambiguity remains also with the definition of renewable energy sources in Nepal. As solid biomass fuels, although these are renewable, have not been included in the list of renewable or alternative energy. The definitions of “new and renewable energy” as well as “alternative energy” seem to include only new renewable energy based technologies but not the new technologies commercially available for modern application of traditional biomass fuels. Similarly, development and promotion of biomass energy in liquid and gaseous forms, even if renewable, have not been included under the alternative energy development programme in Nepal.

The most important energy source in the country from the point of view of total consumption is the traditional energy (i.e. solid biomass fuels, primarily fuel wood and to some extent also crop and animal residues). These biomass fuels, if produced and used sustainably, would be both renewable and environmentally benign. Commercial energy, the second important source, includes all traded energy sources such as coal/coke, petroleum fuels and electricity. Except hydropower, all commercial energy sources consumed in Nepal are non-renewable. And the electricity generated through large hydro-power generation plants, although renewable, has not been grouped with other renewable sources of energy. Its production and consumption statistics are shown together with other commercial energy, but under a separate heading, hydropower.

Currently, production of energy from alternative sources in the form of solar-thermal, solar-power, wind-power etc, has become possible with development of new technologies. Development of new and renewable sources of energy has, therefore, been promoted globally in which Nepal is no exception.

The important components of alternative energy development in Nepal include biogas, micro-hydropower, solar thermal, solar power, and wind power, or the newly emerging

renewable energy technologies (RET). In 1996, a separate agency known as Alternative Energy Promotion Center (AEPC) has been established with the aim of serving as a national nodal agency for coordination and monitoring of all alternative energy development programmes in Nepal.

But in the solid biomass fuel sub-sector, the current priority has been limited to improving the heat efficiency of wood burning cook stoves, with or without chimney. The current narrow territory of alternative energy in Nepal covers only the new and renewable sources and technologies for. Therefore, the important renewable energy technologies (RET) that are being promoted recently include micro-hydropower, solar thermal and solar photovoltaic, wind power, biogas etc.

The important components included under New and Renewable Energy Technologies (NRET) in the PEPN are micro-hydropower, biogas, improved cook stoves (ICS), solar energy (including solar heaters and solar photovoltaic, wind power, and biomass briquetting. **Table 1** shows the cumulative achievement in the alternative energy sub-sector of Nepal up to mid 2003

**Table1: Cumulative achievement in the alternative energy sub-sector up to mid 2003, Nepal**

<b>Alternative Energy Component<sup>1</sup></b>	<b>Number of Installation</b>	<b>Total Capacity</b>
<b>Biogas (Gobargas)</b> (Capacity ranging between 4-20 m <sup>3</sup> , average 7 m <sup>3</sup> )	134,570 <sup>2</sup>	942000m <sup>3</sup>
<b>Solar Photovoltaic Power</b> (Mostly stand-alone systems comprising of over 44,600 SHS and 52 Pumps)	44,658	1,661.3 kW
<b>Micro-Hydropower<sup>3</sup></b>	2,065	14,110 kW
<b>Solar Thermal:</b> Solar Water Heaters Solar Dryers Solar Cookers	30,000 2,246 400	
<b>Wind Turbines<sup>4</sup></b>	6	1,900 Wp
<b>Geothermal Energy</b> (Number of hot water spring sites with water temperature up to 50° C)	32	
<b>Biomass Energy</b> Improved Cooking Stoves (ICS) Biomass Briquettes (Bee-hive charred and non-charred regular briquettes)	96,086	

<sup>1</sup> Does not include 552 MW renewable hydropower generation

<sup>2</sup> Includes total number of biogas plants installed up to December 2004

<sup>3</sup> Includes Peltric (1,504kW), Non-Peltric (5530kW) and Mechanical Schemes (7,071kW)

<sup>4</sup>Mostly 200-watt wind turbines installed at various locations

**Source:** Derived from Karki, a. et al (2005) and Shrestha, J.N. et al. (2003)

Most planners and policy makers in Nepal seem still reluctant to reclassify all renewable sources under one common “renewable energy” heading. Currently, the large hydropower sub-sector is very powerful in terms of lobbying for, and drawing investment from national and donor agencies for development. It is managed by a separate agency Known as Nepal Electricity Authority (NEA). The alternative energy sub-sector, on the other hand, is being developed totally under donors’ assistance. Therefore, continuous flow of required funds for component specific development could not be guaranteed for a long term. At present, AEPC acts as a nodal agency for promoting and mobilizing resources in this sub-sector. An “Interim Rural Energy Fund (IREF)” has also been established by the government to mobilize resources from various donor agencies and to coordinate with local banks for ensuring the availability of loans in this sub-sector. The IREF is now in operation. In the mean time, a process for transforming IREF into a “Rural Energy Fund” in the future has already been initiated according to MOF (2003).

### **Energy Supply Systems**

The energy resource in Nepal is still very much dominated by biomass, primarily fuel wood. And wood fuel, if produced and utilized under a harvest equals re-growth management regime would be a renewable source. At the same time, efficient combustion of available biomass through improved and efficient devices would reduce the emission of carbon dioxide into the atmosphere- a positive contribution to the environment. As live trees and plants absorb and store carbon in biomass, sustainable use of biomass for energy will also be carbon neutral and should be promoted. However, unsustainably produced fuel wood from illegal forest harvesting or deforestation, or from land use change (from forest to other uses) would not be a renewable source of energy. In most heavily populated rural areas where community participation in forest management is not still practiced, unsustainable harvesting of fuel wood for energy could be contributing to local level deforestation and affecting the local environment. Recently, increasing amount of animal excreta is being used for the generation of biogas, which is a clean energy and should be promoted further.

The traditional energy resources in Nepal (i.e. forests, farms and livestock) have been accessible freely to most people for free collection of fuel wood for own use, or managed by the owners themselves for producing biomass for energy, mostly for self consumption. Therefore, solid biomass fuels have remained import energy sources even after the initiation of planned development in the energy sector already over 50 years ago. The registered supply of traded fuel wood is under the jurisdiction of Ministry of Forest and Soil Conservation. But the other solid biomass fuels (i.e. residues of crops and animals) used for energy have largely been non-traded items therefore, a reliable statistics of production of these items have been difficult until recently.

It is reported that even with continuing heavy investment in the hydropower sector for development over the past four decades, the total installed capacity until 2002/03 has

only been about 552.2 Mega Watt (MW), including the power generated in the private sector. The cumulative effect of this development in the residential sector has been opening of access to electricity mostly for lighting for about 40% by the end of 9<sup>th</sup> five year plan of the country, that too primarily in urban areas (NPC, 2003).

Mahat (2003) reports that about 12% of the rural population (from current 7%) is expected to be served with alternative energy by the end of Tenth Five-Year Plan (2003-2007). However, considering the current pace of expansion of rural electrification networks, it would be difficult if not impossible, to expand the reach of the rural people to electricity even for lighting in next 25 years. Which is a sad reality and deserves serious thinking from all concerned agencies promoting renewable energy development, including GOs, I/NGOs, CBOs, POs. Considering the high cost of large hydro-power plant establishment and power transmission line expansion in rugged terrain and rural areas, the use of available electricity has been confined mostly for lighting in the most energy consuming residential sector.

Besides, the present discriminatory electricity tariff for higher consumption does not encourage its use for cooking in the residential sector. Therefore, it would not at all reduce the consumption of traditional biomass for cooking in the near future. Even if there has been a growing concern to overcome the adverse impact of improper biomass fuel use in the residential sector, particularly concerning the quality of life and health of women, children and elderly people in rural households, the reliance of residential sector on traditional fuel would not reduce until their problems receives a high priority for R&D, for promoting sustainable utilization of indigenous (and very low cost) solid biomass fuels.

Karki, et al. (2005) reported that 134,570 biogas plants have been installed in the country covering 66 districts by December 2004. Due to straight quality control from material selection to plant construction, installation and operation, a high success rate of 98% has been documented for operation of the plant and 96% of the clients satisfied with the overall system.

The estimated technical potential for biogas production in Nepal was 4.36 cubic meter per day, which is based on the number of cattle/buffalo in the country (in 1997/98), or specifically on the quantity of dung that could be available for biogas, and the micro-climatic pockets in different parts of the country. The estimated technical potential ranges between 1.53 and 2.9 million plants in the country (average plant volume is currently around 7 cubic meter). However, the estimated economic potential is considered to be 600,000 plants. Therefore, early tapping of this vast unutilized source would not only enhance the rate of employment, level of rural income, and open the access to clean, affordable, renewable, indigenous and carbon neutral source of energy, but also to improvement in quality of life and health of the rural people, mostly women, children and elderly people.

At the central level two ministries, Ministry of Water Resources (MoWR) and Ministry of Science and Technologies are responsible (MoST) for formulation of policies,

programmes and projects, and monitoring of development projects in the hydro-electricity sector and in the alternative (renewable) energy sector, respectively. The Nepal Electricity Authority (NEA) under MoWR is mandated to develop, manage and sale electricity. There is also a department known as the Department of Electricity Development (DoED) under MoWR which is mandated to regulate the electricity industry. All operating licenses for hydropower generation and sale are approved by the MoWR.

AEPC has been managed by an autonomous board for promoting the use of renewable, energy technologies in the country, chaired by the Minister of Science and Technology. Numerous bilateral and multilateral donors and lending agencies, internal non-governmental organizations, etc have been playing important roles in the development of energy sector in Nepal.

### **Rural Energy Development Strategies**

The positive role of alternative energy technology in meeting the basic energy needs of rural people was first acknowledged in the Seventh Five Year Plan (1987-1992). The Eighth Five Year Plan (1992-1997) identified the need of and the PEPN endorsed the establishment of a central body for coordination of all alternative energy technologies being promoted in the country and AEPC was established during this plan period.

The PEPN strategies emphasize for meeting the cooking energy needs of the people in rural areas. It acknowledges that biomass fuels would remain the main supplier of energy in rural areas. Therefore, suggests strategies that would ensure increase in the volume of fuelwood as well as in the availability of new and renewable energy technologies and decrease in the level of fuel consumption. In the urban and modern sectors of the economy the requirement of high-trade energy has been acknowledged to fuel the process of emerging industrialization. And to sustain the growing needs in urban areas and the modern sector of the economy, it envisages the share of commercial fuels to increase year after year. But, which source would be most desirable and appropriate for promotion has not been categorically defined as it would depend on the comparative prices of alternative sources available commercially in both local as well as international markets.

The prevailing structure of relative prices between indigenous hydro-electricity and imported petroleum fuels favored the growth of the latter due to government born subsidies in the use of imported fuels with implications not only on foreign exchange but also on the use of indigenous hydropower and biomass energy in modern forms. Therefore, it recommends reducing the cost of indigenous electricity delivery to divert this situation and increase self-reliance on energy, reduce release in per capita carbon and ensure local capability of harnessing hydropower.

The Tenth Five Year Plan (2002-2007), therefore, puts emphasis on increasing energy consumption in rural households by developing and extending alternative energy sources as energy could be a powerful tool in poverty alleviation. The other consideration has been driving the concept of commercialization in rural areas by developing and promoting alternative energy technology based on local resources and tools, not to

mention the aim of reducing consumption of imported commercial fuels and increasing their access to indigenous alternative sources.

The forestry sector related strategies suggest to enhance biomass fuel production by integrating energy production in all major development programmes under implementation in the sector, including community forests, private forests, leasehold forests, industrial plantations, and national forestry. The strategies also call for enhancing technical, research and institutional capacity and financial support. The need for overcoming the human resources and gender related issues in the sector have also been considered in the strategies.

The biomass fuel supply enhancement strategy has remained unchanged from the one recommended in the Master Plan for the Forestry Sector (MPFS), 1988. The suggested development strategy for the biomass fuel sub-sector in PEPN has been similar to the strategies suggested in MPFS. The alternative energy development strategies in the current Tenth Five Year Plan continues to promote only the development and dissemination of ICS in the biomass fuel sub-sector, and it has no strategy to promote modern biomass energy applications.

A number of strategies for hydropower development have been recommended in the PEPN. The general strategies in NRET sub-sector have been the development and promotion of alternate energy resources and technologies; integration NRETs into over all rural development activities; and internalization of NRETs in the development projects of other sectors. Specific strategies have been suggested for promoting micro-hydropower, biogas technology, solar energy, wind power, and briquetting technology. Separate strategies have been suggested for the imported fossil fuels.

Biogas is a modern form of energy which has been produced from indigenous and renewable biomass resources. Therefore, it has received a high priority for wide-scale dissemination in the country. Currently, *gobargas* (biogas produced from dung) has been very popular in the plain and middle hill regions of the country where climatic conditions are favorable to biogas production. In high altitude areas with cold climatic R&D has been directed to artificial creation of optimal conditions for dependable *gobargas* production.

*Biogas* started receiving importance as an important alternative energy source since the Seventh Five-Year Plan (1985-1990) of Nepal, when it was first incorporated in the national development plan. Ever since, there has been progressive review of policy and revision of annual installation targets revision for promoting its expanded applications.

Provision of subsidy has played a crucial role in the promotion and adoption of new and renewable energy technologies. All components of NRETs in the country have been supported with subsidies of different kinds, material cost, financial incentive, bank credit, or more than one. Subsidy has been considered essential during initial years of NRETs promotion, development and dissemination.

Mahat (2003) states that micro-hydro started receiving a capital subsidy of 50-75%, for power generation up to 100 kW since 1985. Biogas development started drawing subsidy since 1991/92 at separate flat rates for Terai and the hills. In this scheme remote hills were also included with larger subsidy amount in 1996/97. Similarly, subsidy (capital subsidy of 50% total not exceeding already fixed amount) has been introduced since 1996/97 for the household photovoltaic system. Even the self financed Solar Home System (SHS) receive subsidy from the government. PV powered irrigation receives as much as 75% subsidy. Solar dryers and solar cookers have also been included in the list of technologies entitled for subsidy. Wind power generation started receiving subsidy in the same year with PV. In the ICS sub-sector however, there has been no uniform programme of subsidy. There have been separate ICS support programmes running under the government as well as NGOs. There has been no direct financial subsidy to ICS but donors have been encouraged to support with technical know how and monitoring of the installation quality and performance of ICS installed in rural households. The provision of subsidies for different components of NRET development get incorporated into the sector specific as well as periodic development plans of the country for financing from the public sector.

However, forestry development activities that complement the energy sector through enhanced fuel wood production do not receive any direct subsidy from the point of view renewable energy development in the country. The key player in forestry sector development used to be Danida through its natural resources management sector assistance programme (NARMSAP) besides many others which assisted specific development components stated in the MPFS.

### **Conclusion and Recommendation**

Currently, most of the devices used for cooking and space heating in the residential sector have been direct combustion of solid biomass fuels, for heat application. These primitive devices have been both inefficient and polluting, having adverse impact on health and environment. Therefore, continuation of such devices would not be desirable without massive improvement in fuel combustion as well as heat transmission even in medium and long terms. Further, as the economic conditions of present solid biomass fuel users improve over years, they too would not like to continue using traditional energy without significant improvement in the quality of combustion devices.

Therefore, long term use of the present day ICS may not, and should not continue, as the rural people would also be asking for a cleaner and efficient biomass fuel combustion technology. Without these considerations, the chronic residential energy problems in rural areas are likely to prevail for a long time.

Therefore, the need for exploring, analyzing and initiating adoptive research, including in country R&D on efficient and smoke free cook stoves, efficient charcoal kilns and briquette plants, household- and medium- scale biomass gasifiers etc, has become paramount to overcome the chronic energy problems in the domestic sector.

Expansion of the present gobargas plant installation targets must continue together with the present incentives arrangement so that the full economic potential in the sub-sector could be utilized as early as possible.

The other components of RETs mostly the newly emerging ones (i.e. solar photo voltaic, wind power etc) and even the micro hydropower, though important in their specific cases, could not be a long-term solution to overcome the chronic energy problem in rural Nepal. Their expanded development and use could only provide limited services in the residential sector, primarily for lighting and operating equipments for communication and entertainment, in some cases also for lifting water for drinking and irrigating vegetable and high value cash crop fields.

Although not included under the current activities of AEPC, local level collection, processing and use of liquid biomass fuels from indigenous trees and oil bearing plant resources must be promoted, wherever feasible. As the high transportation cost, makes the use of kerosene unaffordable to a majority of people in remote areas even for limited lighting, liquid fuels extracted from indigenous sources could serve as a best alternative available locally.

In conclusion, development and promotion of renewable energy technologies also for cooking in the residential sector must be incorporated in the activities of AEPC. The success in gobargas sub-sector has been an exemplary achievement not only within Nepal but also in the region. It is only hoped that R&D in the biomass energy sub-sector received a fair treatment from energy planners while allocating resources during annual planning, so that this carbon neutral, indigenous source, could sustainably ensure the supply of energy in the residential sector.

Besides, question could be raised, why a country with enormous hydropower generation potential should not invest in the development of and subsidize the use of electricity for cooking and space heating, together with its uses in the industrial and commercial sectors, instead of supplying imported subsidized commercial fuels like kerosene and LPG in urban areas? Both, transmission and distribution costs in such areas should not pose any problem as these could be supplied through the existing national grid.

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