Final Report

Policy Gaps in "Household Energy and Indoor Air Pollution" in Nepal

Commissioned by
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March 2007

Executive Summary

The Practical Action, Nepal has initiated an important task titled “Study on Policy Gaps in "Household Energy and Indoor Air Pollution" in Nepal " to be discussed at the regional level. According to the WHO, smoke from burning solid fuels is estimated to be responsible for 1.6 million deaths each year in the world's poorest countries. Indoor air pollution affects poor women and small children far more than any other sectors of society, killing almost 1 million children under five every year. Almost one half of the world’s population still rely on solid fuels for their everyday cooking and heating; some 2.4 billion people burn biomass (wood, crop residues, charcoal and dung) and a further 0.6 billion burn coal.

The purpose of this study is to assess the gaps in the policy related with Household Energy and Indoor Air Pollution in case of Nepal and indirectly to raise awareness among the governments and concerned agencies on the health impacts of indoor air pollution from household energy use, and to national action to reduce people’s exposure to this substantial environmental health risk.

Of the observations from the study, it is notable that the country lacks any direct policies concerning Household Energy as well as Indoor Air Pollution. However, there are several underlying measures in Policies related with Rural Energy, Environment Science and Technology, which lead to reduction of what is called the "Smoke-Killer in the Kitchen". Even more commendable are the activities carried out by both Government and Non-Government Agencies (national and international) dedicated towards uplifting the rural livelihood through energy intervention which include creating awareness, promoting suitable technologies as well as capacity building in relevant areas for local dissemination of selected technologies.

The study also presentation an in-depth background on the subject, identifies a number of key barriers and offers strategic suggestions for incorporation of the indoor air pollution issues in the policies. Suggested steps included creating a standardised methodology to measure cost benefit analysis of investing in efforts to curb indoor air pollution. It cannot be denied that since indoor air pollution is an interdisciplinary and inter-sectoral issue, it is often difficult to determine which government ministries or departments should take responsibility for it within their institutional framework. Approaching the Finance Ministry directly with quantified impacts of addressing indoor air pollution is one way to alleviate this problem since the Finance Ministry determines allocation of resources.

It is clear that a majority of the Millennium Development Goals will not be achieved without addressing indoor air pollution since this issue has broad poverty, income, gender, health and environmental implications. Therefore, scaling up of efforts to reduce solid fuel use should be seen as a means to achieving the Millennium Development Goals. Attempts should be made to mobilise the private sector by engaging a core group of large corporations and demonstrating the potential market size among affected populations by offering market data on their products. Improved access to micro-finance was seen as a vital link to addressing indoor air pollution since many solutions to the problem include capital-intensive technologies. Lastly, the study emphasized that although studies have been performed that quantify health effects of indoor air pollution in the country, the amount of data available is surprisingly low. Therefore, continued research would help to engage the government and the development community on the issue.

Acknowledgements

The Study Group would like to express sincere gratitude to Practical Action for providing an opportunity to carry this study which is very important specially in the context of Nepal where more than 80 percent of the rural people still depend largely on biomass fuel which is of low quality and having consequently adverse effects not only on the user but the family as a whole including little children.

The issue relating energy and indoor air pollution has been a critical issue demanding action for improving the health and livelihood of rural areas. The vicious cycle revolving around access, affordability and enhancement, yet to be solved needs to be addressed at both macro and micro level. The initiation itself is half the battle won, we would like to congratulate Practical Action for pioneering this study in Nepal.

Gratitude is also extended to a number of generous and committed organisations and individuals.

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Acronyms and Abbreviations

ADBN:	Agriculture Development Bank of Nepal
AEPC:	Alternative Energy Promotion Centre
ASTED:	Association of Solar Thermal Energy Devices
CES:	Centre for Energy Studies
CRE:	Centre for Renewable Energy
CRT:	Centre for Rural Technology
CTEVT:	Council for Technical Education and Vocational Training
DANIDA:	Danish International Development Assistance
ESAP:	Energy Sector Assistance Program
FoST:	Foundation of Sustainable Technology
GJ:	Giga Joule
GTZ:	German Technical Co-operation Agency
HH:	Household
IAP:	Indoor Air Pollution
ICIMOD:	International Centre for International Development
ICS:	Improved Cook Stove
IUCN:	International Union for Conservation of Nature
JICA:	Japan International Co-operation Agency
LPG:	Liquefied Petroleum Gas
MHP:	Micro Hydro Plant
MMHP:	Mini-Micro Hydro Plant
MOEST:	Ministry of Environment, Science and Technology
NBPG:	Nepal Biogas Promotion Group
NEA:	Nepal Electricity Authority
NGO:	Non-Governmental Organization
INGO:	International Non-Governmental Organization
NOC:	Nepal Oil Corporation
NPC:	National Planning Commission
PM:	Particulate Matter
RECAST:	Research Centre for Applied Science and Technology
RETs:	Renewable Energy Technologies
NAST:	Nepal Academy of Science and Technology
SDC:	Swiss Development Co-operation
SHS:	Solar Home System
SNV/Nepal:	SNV Netherlands Development Organisation
ToE:	Tonnes of Oil Equivalent
UNDP:	United Nations Development Programmme
UNICEF :	United Nations International Children's Emergency Fund
USAID:	United States Agency for International Development
WECS:	Water and Energy Commission Secretariat
WHO:	World Health Organisation
g-C:	Grams Carbon
GoN:	Government of Nepal

Policy Gaps in "Household Energy and Indoor Air Pollution" in Nepal

1. Introduction

Energy is essential to meet our most basic needs: cooking, boiling water, lighting and heating. It is also a prerequisite for good health – according to WHO, a reality that has been largely ignored by the world community (*WHO, 2006*). 88 percent of the Nepalese populations still burn wood, dung, coal and other traditional fuels inside their homes (*Census, 2001*). In contrast to the electric range or a gas stove in a stylish kitchen in developed countries which makes cooking as an enjoyable pastime and passion for a privileged minority – cooking is a chore and threat to the lives of the great majority cooking on an open fire in shabby huts of rural Nepal. This population depends on solid fuels, including biomass (wood, dung and agricultural residues) to meet their most basic energy needs: cooking, boiling water and heating. Opening the door to their homes makes for a hazy welcome: thick grey smoke fills the air, making breathing unbearable and bringing tears to the eyes.

The inefficient burning of solid fuels on an open fire or traditional indoors stove, creates a dangerous cocktail of hundreds of pollutants, primarily carbon monoxide and small particles, but also nitrogen oxides, benzene, butadiene, formaldehyde, polyaromatic hydrocarbons and many other health-damaging chemicals. Day in day out, and for hours at a time, women and their small children breathe in amounts of smoke equivalent to consuming two packs of cigarettes per day. Yet, these families are faced with an impossible dilemma: don't cook with solid fuels, or don't eat a cooked meal. Being poor condemns humanity to depend on polluting household energy practices[1]. With increasing prosperity, cleaner, more efficient and more convenient fuels are replacing, step-by-step, traditional biomass fuels and coal. Climbing up the energy ladder tends to occur gradually as most low- and middle-income households use a combination of fuels to meet their cooking needs. It is to contemplate that 88 percent of the Nepalese population is still exposed to the hazards arising from the use of biomass.

Sources of IAP can be broadly linked to: combustion products used for cooking, smoking and lighting; off gassing from building materials such as paints, furniture, linen; biological pollutants such as dust mites, fungi, human and animal dander and viruses, etc. and human activities such as sweeping, dusting, vacuuming use of preservatives, aerosols etc. (http://www.epa.gov/iaq/biologic.html).

Indoor air quality is an important determinant of human health and comfort and individuals right for a dignified living. There is a large body of evidence on the hazardous nature of indoor air pollutants, their sources or conditions leading significant health effects to human when exposed to it. In addition, methods of pollution reduction are available in many cases. Besides, concentration levels of IAP is not restricted to the kitchen, it has significant temporal and spatial variations with its effect travelling from the kitchen to the other areas within a house, and from room to room. Thus, it is not wrong to state that no member of the household is free from IAP. This knowledge gives a strong basis to advocate for comprehensive actions aimed at eliminating or reducing the risk to health and well being caused by pollution in indoor spaces.

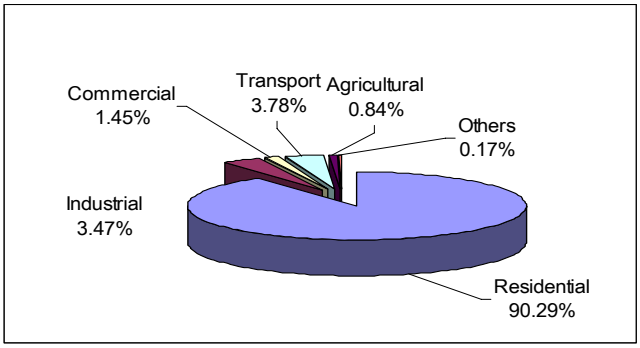
There are various successful technologies/products for alleviating the indoor smoke but they have not reached the general mass and especially the poor. Likewise, creating awareness only can bring significant changes. Micro –level interventions alone cannot mitigate the existing situation, the need is for macro level interventions. To achieve prominent reduction in IAP it is pertinent that there exists clear, adequate and appropriate government policy, without which it is difficult to fight against the issue, which results into many poor people to continue to suffer from the effects of IAP. Thus this study is undertaken for Practical Action with the purpose of assessing the gaps in policy regarding IAP in Nepal. This study however, limits itself to IAP rising specifically from cooking practices and household fuel use.

[1] Findings of a renowned physician, Dr. Pandey et al, 1985 indicate that personal exposure levels during cooking periods to be of: Respirable Suspended Particulates (RSP) 8,200 µg/m3; Carbon monoxide (C) and formaldehyde (HCHO) were 82.5 ppm and 1.4 ppm respectively for traditional stoves.

1.1. Overview of Energy Scenario in Nepal

A reliable and sustainable supply of energy is vital for the survival and economic development of any country. The per capita energy consumption of a country and the type of energy use depicts the economic growth and well being of the nation. Nepal's per capita energy consumption of about 0.3 ToE (15 GJ) is one of the lowest in the world as well as in the region. Figure 1 illustrates the pattern of overall energy by different sectors in 2005/06. Of the total 380 million GJ the major consumption of biomass energy is localized within the domestic sector with the consumption of about 90.29 percent as compared to 3.47, 1.45, 3.78 and 0.84 percents in the industrial, commercial, transport and agricultural sectors respectively. The pattern of fuel consumption in this sector constitutes of 86.71 percent biomass, 12.72 percent commercial and 0.56 percent renewable, (*WECS, 2006*).

Figure 1. 1: Energy Consumption in Different Sectors

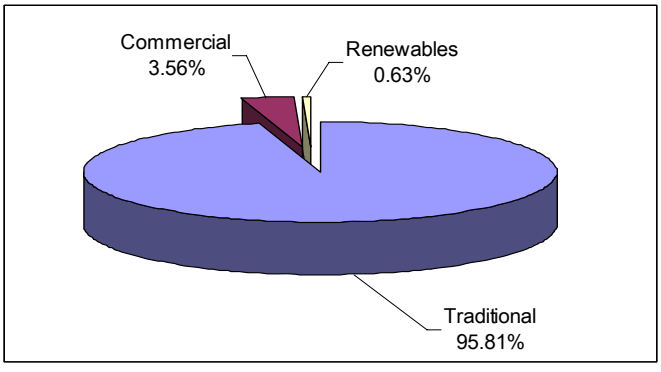


Source: WECS 2006

1.2. Status and Trend of Energy Consumption in the Residential Sector

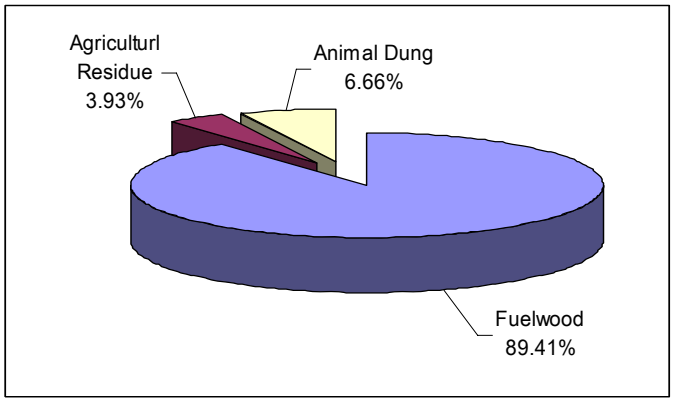
The total energy consumption in the residential sector for the period 2005/2006 was 339 million GJ and largely constituted of biomass. The residential sector alone consumes more than 90.29 percent. The characteristic of energy consumption is dominated by the traditional energy sources like fuel wood, agricultural residue and animal waste. The share of these traditional energy sources to the overall energy consumption is about 95.81 percent followed by 3.56 percent commercial sources, and 0.63 percent renewable sources (*WECS, 2006*), Figure 1.2.

Figure 1. 2: Energy Consumption pattern in the Residential Sector, 2005/06



Source: WECS, 2006

Figure 1. 3: Biomass Energy Consumption in the Residential Sector



Source: WECS, 2006

The residential sector energy consumption is the largest. This energy constitutes mainly of biomass energy comprising of 89.41 percent fuelwood; 3.93 percent agricultural residue and 6.66 percent animal dung, Figure 1.3, (*WECS, 2006*). It is estimated that, out of the total biomass consumed in the residential sector, 88 percent is accounted for the rural areas and only 10 percent is consumed in the urban areas. There is a tendency of substitution of biomass in the urban areas by commercial fuels although at a slow pace, and in the rural sector it is almost status quo. The determining factors being accessibility and affordability, which are comparatively, lower in the rural areas than that in the urban areas.

A substantial amount of biomass is used in the residential sector for cooking in both the rural and urban households. Other than these end-uses, biomass is also used for heating, water boiling and agro-processing. Generalizing the estimated data of 2003/04 regarding the end-use of fuel wood, cooking alone accounts for nearly 80 percent and 64 percent for rural and urban areas respectively. Similarly animal feeding takes the second largest share with 17 percent in the rural sector and 8 percent in the urban sector. Table 1.1 illustrates the pattern of different biomass energy consumption in 2003/04 in the residential sector of the urban and rural areas.

Table 1. 1: Different End-uses of Biomass fuels in Urban and Rural Residential Sector

Purpose	Urban (%)	Rural (%)
Cooking	67.42	65.39
Heating	15.47	8.35
Agro-processing	5.37	3.33
Animal Feed Preparation	7.58	16.41
Religious Purpose	4.16	4.28
Water Boiling		2.23

Source: WECS 2004

Comparative assessment of the energy consumption in the residential sector within a period of 10 years, using 2001 as the base year reveals (Table 1.2), the following features:

- Existing prominence in the use of traditional biomass, with an increase of nearly 0.85 percent within this period
- A decrease in the use of commercial energy forms by more than 1.22 percent
- A rise in the use of renewable technologies by 0.36 percent

Table 1. 2: Historical Trend of Energy Consumption by Fuel Type

Fuel Type	2001	2010
Traditional	86.72%	87.57%
Fuelwood	77.11%	77.99%
Agricultural Residue	3.80%	3.83%
Animal Dung	5.81%	5.74%
Commercial	12.92%	11.71%
Petroleum	9.33%	8.12%
LPG	0.59%	1.81%
Kerosene	3.42%	0.75%
Other Petroleum Products	5.32%	5.56%
Coal	2.22%	0.99%
Electricity	1.37%	2.59%
Renewable	0.36%	0.73%
Biogas	0.35%	0.69%
Micro Hydro	0.01%	0.02%
Solar	0.00%	0.02%
Grand Total	100.00%	100.00%

Source: WECS 2006

2. Indoor Air Pollution and Health Implications

Use of low grade biomass fuels in indoor cooking leads to levels of indoor air pollution many times higher than what international ambient air quality standards allow, exposing poor women and children on a daily basis to a major public health hazard. This exposure increases the risk of important diseases including pneumonia, chronic respiratory disease and lung cancer (coal only), and is estimated to account for a substantial proportion of the global burden of disease in developing countries.

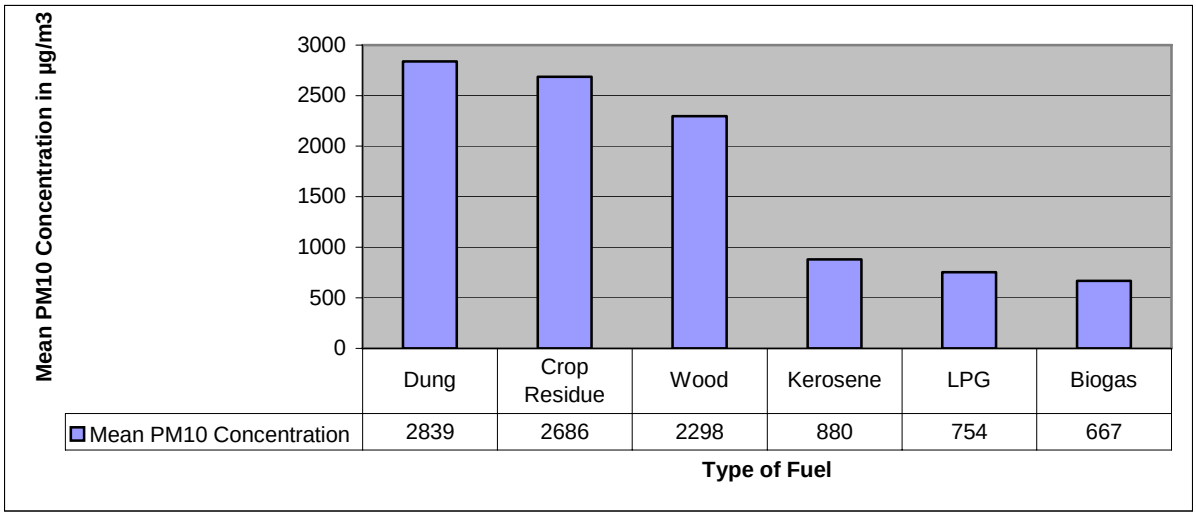
Evidence is also emerging that exposure may increase the risk of a number of other important conditions, including tuberculosis, low birth weight, and cataract. Other important direct health impacts from household energy use among the poor include burns to children and injuries to women from carrying wood. Furthermore, a range of inter-related quality of life, economic and environmental consequences of household energy use impact on health through such factors as the time women spend collecting scarce fuel, and restrictions on educational and economic activity. A wide range of factors affects the indoor air pollution. These include types of fuel used, living environment and user behaviour. Changes in these factors can be delivered through policies operating at national level (supply and distribution of improved stoves/cleaner fuels) and local level (through community development). A brief discussion is presented below.

2.1. Factors Affecting IAP

Fuel Used

When we use more efficient fuels we produce less pollution. It is as simple as that. This has been described as the energy ladder. The dirtiest fuels such as grass and animal dung are at the bottom. Going up the ladder, step by step with wood, then coal, until the next most efficient type of fuel is used. Dramatic reduction in pollution occurs when the next physical state, liquid kerosene is reached. Liquid fuel is less polluting than solid fuel. Natural gas is dramatically less polluting than solid or liquid fuels. Electricity does not produce pollution at the users' end although it's generation does produce pollution. Wind, solar and hydropower are the cleanest forms of energy, as there is no combustion. Figure 2.1 presents the emission (P10 in $\mu g/m^3$) observed by different fuel as one moves up the energy ladder.

Figure 2. 1: Energy Ladder by PM10 Emission



Source: NHRC, 2004

The values observed even for LPG and biogas are high thus it can be concluded that besides the fuel itself there are other factors which affect indoor air pollution. This can be attributed to improper or lack of ventilation as well as smoke exhaust measures-chimney.

Cooking Devices

Traditional fuel based energy system in Nepal is significant in terms of volume of consumption and net energy content. This is due to the low efficient traditional cooking stoves (5-10%) against the improved cook stoves (15-30%). The common end-use devices are mainly the tripod stand, mud stoves, improved cooking stoves and so on. In these stoves the combustion is very incomplete and thus results in high emissions. Table 2.1 presents the achievement made through simple improvement made even in the clay stove.

Table 2. 1: Pollution Reduction due to Improvement in the Stove

Study	Stove type(s)	Indoor air quality	Health outcomes
(Reid et al. 1986) Nepal	Improved "Chulo" vs. traditional stoves	PM10 during cooking: Improved = 1 130 µg/m3 Traditional = 3 140 µg/m3 CO during cooking: Improved = 67 ppm Traditional = 300 ppm	Not reported
(Pandey M. R. et al. 1990) Nepal	Improved "Tamang" vs. traditional stoves	RSP during cooking (1 hr): Tamang = 3000 µg/m3 Traditional = 8200 µg/m3 CO during cooking (1hr): Tamang = 11.6 ppm	Not reported

Cooking Practices

Despite significant development efforts and evidence of their effectiveness, the costs to governments, donor agencies and households associated with technical intervention efforts are still prohibitive for many of the poorest people in developing contexts. This is particularly true among the rural poor where biomass is abundant, obtainable free of charge and where access to improved technology is poor. If we are to assume that take-up of current technology-based interventions is impeded by the slow regional and household socio-economic growth in developing countries, then fuel, ICS and household modification interventions must be viewed as medium- to long-term strategies. Cheaper, short-term strategies are needed to reduce child indoor air pollution exposure until access to cleaner burning fuels and ICS programs is more accessible and sustainable. Table 2.2 presents some of the studies related with behavioural clusters.

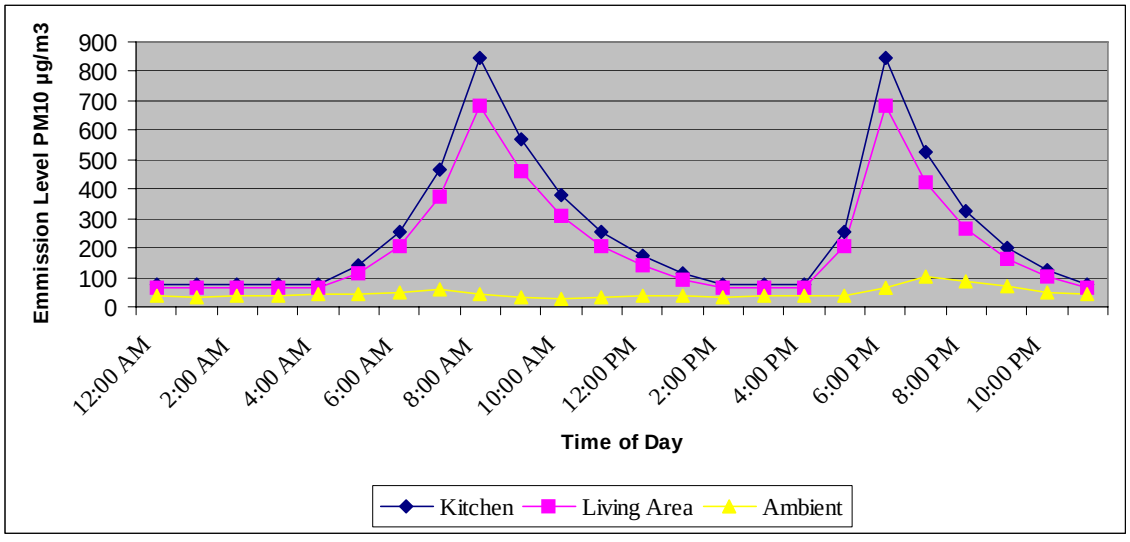
Table 2. 2: Behavioural opportunities to reduce exposure to IAP

Behavioural cluster	Practices	Studies
Tending fires	Dry wood//dung before burning Use smaller pieces of wood Use pots that correctly fit open fires Reduce duration of burning	(Manibog 1984): Laboratory research has shown that well tended fires display much higher levels of efficiency and lower emission characteristics than previously thought, and in some cases are comparable to efficiency figures obtained from some ICS programs.
Stove maintenance and use	Fix holes in stoves and or flues Clean and maintain stove and flues Use pots that correctly fit stove opening	Reid et al (1986): PM reduced from 4900 to 1100 µg/m3 and CO from 500 to 31 parts per million (ppm) when correct fitting pots were used. The study found that cleaning stove flues (by removing 1.5 litres of soot) reduced CO from 500 to 56 ppm (Reid et al. 1986).
Ventilation use	Improve ventilation in the cooking area	NHRC, 2004, observation sin the IAP level in the hills and Tarai were attributed to the ventilation conditions
Safer child location practices while fires are burning	Keep children away from fires	Pandey et al. (1989): Study found that the number of episodes of ARI was positively associated with the amount of time that children spent close to fires (n=233). Children on piggyback were associated with higher risk of ARI (OR between 0.5 – 1.9) compared to children not allowed in burning room.

Cooking Location

The traditional kitchen in the rural areas is damp, full of smoke and serves as a place for storing agricultural inputs and outputs. Commonly, all household activities are carried out in this area. The open cook stove is in one dark corner of the room, which has small windows providing some ventilation but hardly any light. The windows are intentionally made small to thwart off thieves and wild animals as well as to keep the space warm in cold areas. Other kitchenware like utensils, water pots, fuelwood, dishes and plates, grinding stones are dumped in the same room. Food preparation, washing and cleaning too are done in the same area. Besides, this room is also the family room in the evenings especially during winter as this often is the only lighted area in the house and the hearth provides warmth for all. All in all it is a multi functional area. In the majority of the households there is inadequate ventilation in the kitchen, this combined with inefficient cooking stoves causes serious health hazard on the direct users, the women, as well as the indirect users, i.e. the family as a whole and especially the younger children whose movement is closely tied to that of their mother.

Figure 2. 2: Pollution Variation by Location

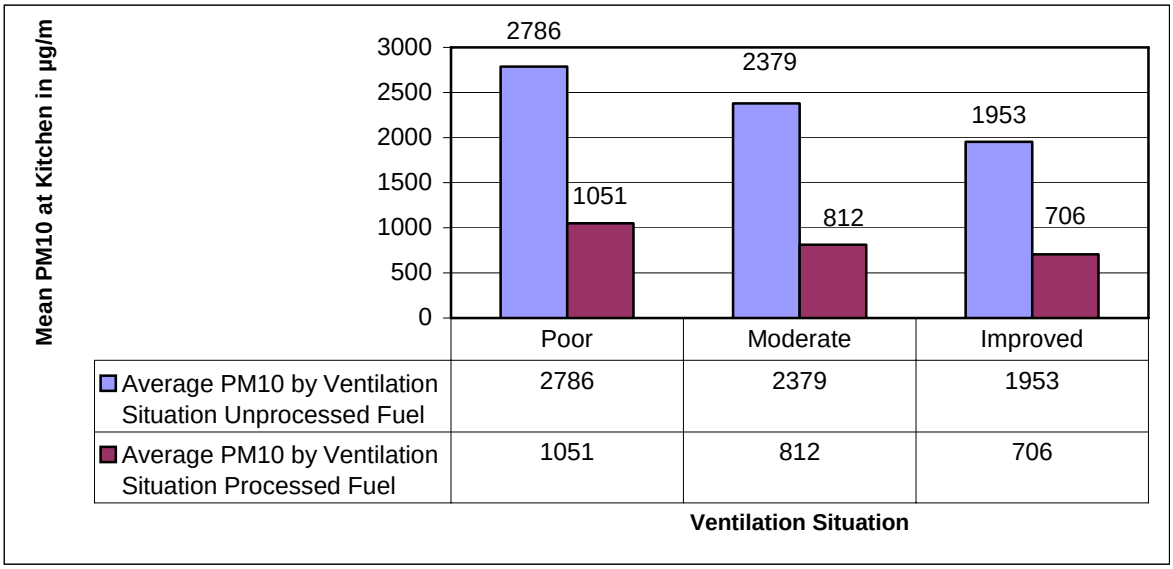


Source: World Bank 2004

To interpret these results, it is useful to note the 24-hour standard for rural exposure to PM_{10} is 100 µg/m^3. Over the daily cycle, outdoor pollution only rises to this level during one hour in the early evening (around 7:00 P.M.). However, the standard is exceeded in the indoor cooking area for 15 hours per day, and in living areas for 14 hours. During peak cooking periods, the PM_{10} concentration rises to 845 µg/m^3 in the cooking area and 683 µg/m^3 in the living area, Figure 2.2.

This along with the poor ventilated kitchen of rural Nepalese houses results in very high levels of indoor air pollution. A study conducted for households using traditional clay stoves with chimney revealed the improvement in kitchen condition with respect to ventilation and types of fuel. The unprocessed fuels used were dung, agro-waste and fuelwood while the processed fuels are LPG, kerosene and biogas. *See Figure 2.3.*

Figure 2. 3: Average PM10 by Ventilation Situation



Source: NHRC, 2004

Similarly comparison of smoke PM_{10} pollution also varies by ecological regions for solid fuel users. The kitchens in the hill are more polluted with mean PM_{10} of 2545 µg/m^3 while the kitchens in the plain have PM10 of 2186 µg/m^3.

Exposure Characteristics

Indeed characterisation of exposures is one of the most challenging aspects in this field. Apart from biomass, a number of other sources of indoor air pollution may be associated with adverse health outcomes, making it difficult to assess the independent contributions of various fuel sources to ill health. It is important to note that in many parts of the country and settings today, a mixture of fuels is used, including biomass fuel, liquefied petroleum gas (LPG), and kerosene.

Concentration levels of pollutants may vary significantly over time and space. For example large variations in exposure may result in the course of a day, month, season, or year. Significant variations may also occur from room to room in a house. In low-income, high density housing areas (formal or informal), indoor air pollution also contributes to outdoor air pollution.

Individuals' exposure to indoor air pollution (IAP) can be analysed according to exposure at two levels: differences within households attributable to family roles, and differences across households attributable to income and education. Within households, we have related individuals' exposure to pollution in different locations during their daily round of activity. High level of exposure for children and adolescents of both sexes have been found, with particularly serious exposure for children under 5. Among prime-age adults, we find that men have half the exposure of women (whose exposure is similar to that of children and adolescents). Besides elderly men also have significantly lower exposure than elderly women. Refer to Table 2.3

Table 2. 3: Daily Average PM_{10} Exposure by Age and Gender (PM10 measured in $\mu g/m^3$)

	Typical Household**		Monitored Households***	
Age	Female	Male	Female	Male
0-1	216	214	209	195
1-5	212	212	199	192
6-8	173	172	156	163
9-19	207	174	196	194
20-60	227	116	221	118
60+	220	161	264	188

*Note:** Outdoor PM_{10} = 50 $\mu g/m^3$, ** PM_{10} concentrations: cooking area 260 $\mu g/m^3$; living area 210 $\mu g/m^3$

*** Averages for 236 separate calculations using monitored PM_{10} $\mu g/m^3$ levels

Source: World Bank 2004

Economic Status

Fuel choice is also linked with the socio-economic status of the country. At present around 38% of the total population lives under US$1 per day. Poverty is Nepal's major problem. These people mostly comprise of socio-economically deprived indigenous and marginalized communities. They are deprived of all kinds of economic activities mainly due lack of energy as a whole and electricity in particular. Biomass and fuel wood are used for cooking in traditional inefficient stoves and kerosene wick lamp (in some places resin rich plants) are used for lighting.

People generally move to cleaner, more convenient, more efficient and more costly fuels when their socio-economic condition improves. Besides development efforts are urban-biased. With no opportunities to increase income, the choice of fuel thus remains biomass, mostly low quality twigs and agro and animal wastes that do not lay a burden on the already impoverished purse.

Across households, pollution variation can be related to choices of cooking fuel, cooking locations, construction materials and ventilation practices. These choices are significantly affected by family income and level of adult education, particularly that of women. It is obvious that the poorest, least-educated households have twice the pollution levels of relatively high-income households with highly educated adults. It can be concluded that young children and poorly-educated women in poor households face pollution exposures that are four times those of men in higher-income households organized by more highly-educated women. Studies also suggest that female education; male education and family income all have large, highly significant effects on pollution via fuel choice. Female education has an equivalent effect on the structural determinants, but male education and family income do not appear to be significant. Female education appears to be the strongest and most pervasive determinant of arrangements that reduce indoor air pollution.

2.2. Implications of the Present Energy Use

As mentioned earlier there are a wide range of factors associated with the supply and use of household energy in poor countries that can be expected to have direct as well as indirect impact on the users.

Direct Impact

Direct health consequences such as burns to children falling into open fires, as well as the less direct health impacts associated with a range of other energy-related socio economic factors are a result of using traditional biomass fuel. The total evidence available on the health consequences is of variable extent and quality, partly due to a paucity of research attention in this field, but also due to the methodological challenges of demonstrating cause and effect where a range of social, environmental and other factors interact.

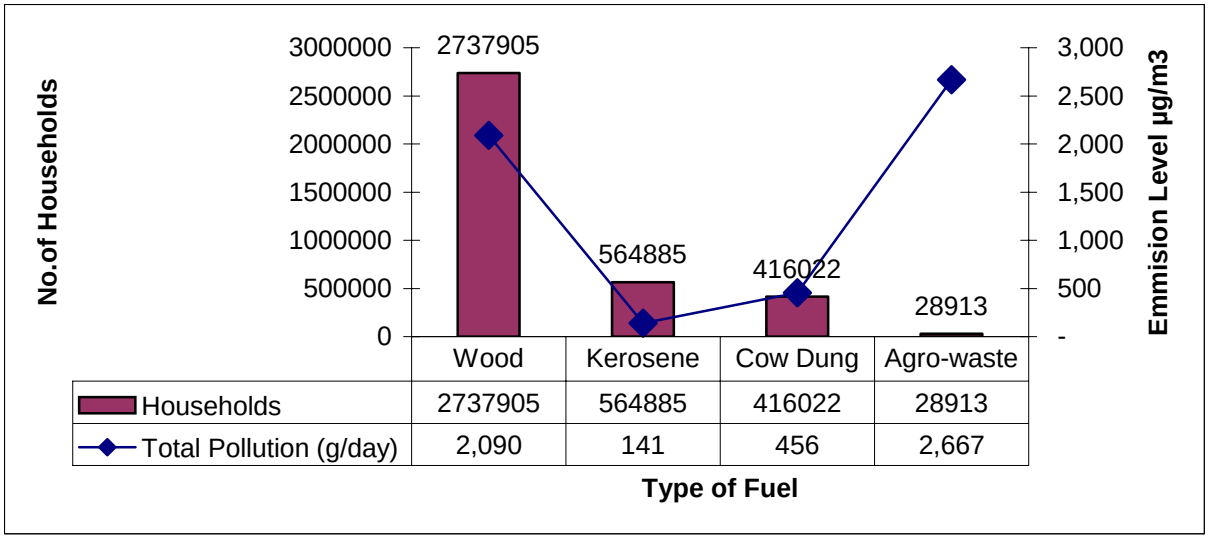
In recent years, new evidence has emerged which suggests that indoor air pollution (IAP) may also increase the risk of other important child and adult health related problems, although this evidence is more tentative, being based on fewer studies. It includes conditions such as low birth weight, prenatal mortality (still births and deaths in the first week of life) asthma and middle ear infection for children, tuberculosis, nasopharyngeal and laryngeal cancer, and cataract in adults. (*Holdren and Smith, 2000*).

There is consistent evidence that exposure to biomass smoke increases the risk of a range of common and serious diseases of both children and adults. Chief amongst these are acute lower respiratory infections (ALRI) in

childhood, particularly pneumonia. A study conducted in a hilly remote area of Nepal to find out the relation between indoor air pollution and ARI in infants and children less than 2 years showed that episodes of moderate and severe ARI increased with increments in the level of exposure to indoor air pollution. The study suggested that indoor air pollution is an important risk factor causing ARI (*Pandey, M. R, 2001*). This is because the mobility of children less than 5 years of age is directly proportionate to that of the mother.

Nearly 300,000 houses in Nepal using fuelwood are exposed to pollution levels of above 2,000 g-C per day[2]. While 2,800 houses using agro-wastes are exposed to pollution levels more than 2,500 g-C per day. The number of households exposed to the pollution with respect to fuel use clearly indicates the need for moving into the regime of cleaner energy forms (Figure 2.4).

Figure 2. 4: Households by Fuel Use for cooking alone and Resulting Pollution



Source: CBS 2001

Other Impacts on Health and Quality of Life

This is an important area for consideration. Some of the key factors, which are often the consequences of using low quality fuel are summarised below:

- The opportunity cost of women's (and children's) time spent collecting fuel, estimated at 0.5-2 hours per day;
- Vulnerability of women to injury and violence when collecting fuel, especially when supplies are scarce and at times of political unrest
- Burns to children falling into fires
- Accidental poisoning of children drinking kerosene (paraffin) stored in soft drink containers
- Restrictions on economic and educational activity in the home due to poor air quality lack of adequate light, and the inflexibility in use of available fuels and appliances
- Degradation of the local environment: although it is now recognised that the use of wood as a fuel is not a major cause of deforestation and land erosion (as most is collected rather than cut), it does contribute.
- Perhaps more important is that poor people who are dependent on wood in areas where the environment is under stress will have more difficulty in meeting their energy needs, and women may have to spend more time collecting wood or alternative biomass.

[2] Emission level of various fuel used follow thus: per kg fuelwood – 418 g-C, kerosene-843 g-C; dung – 334 g-C; agro residue-381 g-C (Smith et al, 2000)

3. Policy formulation, Roles and Responsibilities

It was only in the 1950s that Nepal assumed many of the forms of the modern state. The strategy of Nepal, as expressed in all the country's development plans, has focused on achieving socio-economic growth with basic needs fulfilment, emphasising on rural development, equity in distribution, people's participation and employment generation.

The government of Nepal has the sole responsibility of establishing the statutory, legal and policy framework for the energy sector as that of other development sectors. A number of government departments and agencies are involved in the policy formulation, sub-sectoral planning and project implementation. The statutory framework, under which public and private energy supply activities take place, is embodied in a number of Acts and Regulations approved by the parliament.

3.1. Main Stakeholders Involvement

The institutions dealing with the energy development, environment and IAP are mainly under government ownership and are spread cross different ministries. With the Local Self-Governance Act 1999, the local bodies like the VDC, DDC and the Municipalities can act autonomously for the development of rural energy. Table 3.1 below lists the principal institutions involved in the energy, environment and health sector. It is found that the process of planning and management of energy resources, environmental concern and health impacts is totally a top-down approach and also there lies very little coordination or networking among the institutions. Moreover, it can be observed that the process of energy planning is not at all integrated with other development activities.

Government institutions

The government institutions, such as the National Planning Commission (NPC), Ministry of Environment, Science and Technology (MoEST), Water and Energy Commission Secretariat (WECS) Ministry of Finance, etc. influence the RETs development policies and programmes. Alternative Energy Promotion Centre (AEPC): The overall objective of AEPC is to popularise and promote the use of RETs for raising the living standards of the rural people and protecting the environment also by developing commercially viable alternative energy industries in the country. Now, it has been working in the 75 districts of the country in the field of mini and micro hydropower, biomass including biogas, solar energy, wind energy, improved cook stove and other alternative energy sources. It is the apex body of the government for strategic planning and policy formulation for RETs in Nepal. AEPC created a substantial demand on RETs by channelling the government's subsidy programme. In order to meet this growing demand it also has qualified some non-governmental organisations.

Bank and financial institutions

The Agriculture Development Bank of Nepal *(*ADBN*)*: ADBN, with its large network of field offices scattered in the rural areas, is committed in the field of renewable energy development in Nepal. The bank has been providing credit support to MHP development, SHS and biogas installation in the rural area. Bank credit has been made available for MHP and biogas plant installation for more than 25 years. However, credit on SHS has been introduced since 1995–1996. Till June 2002, it alone had invested over NRs. 146.6 million for the implementation of MHP projects, NRs. 155.4 million for biogas and 51.3 million for SHS installation. Being the pioneer in this area, the bank is represented on the board of AEPC (*ADBN, 2002*).

Local commercial banks have also started to act as financing intermediaries for the development of RET by participating in various programmes under the priority sector lending.

Research institutions

Institutions such as Royal Nepal Academy of Science and Technology (RONAST), Research Centre for Applied Science and Technology (RECAST), Centre for Energy Studies (CES), etc. are involved in different levels of R&D activities focused on the development of cheap, socially adoptable, economically viable and sustainable RETs that can be directly implemented in the focused area. Institutes such as CES and Council for Technical Education and Vocational Training (CTEVT) are involved in human resource development at different levels for the successful planning, designing, installation, operation and maintenance of RET projects. Research Centre for

Applied Science and Technology (RECAST): It is one of the four research centres in Tribhuvan University, Nepal. RECAST was established in 1977, with the objectives of undertaking research in development and promotion of indigenous technology, identification of exogenous technologies appropriate to Nepal and their technical adaptation and conduction of research on basic and applied sciences. RECAST has a specialised division for energy development and processes various laboratory and fabrication facilities and trained technical personnel.

Non-government organisations

INGOs such as International Centre for Integrated Mountain Development (ICIMOD), ITDG, and Winrock International have been engaged in the active promotion, development and dissemination of RETs. Similarly, many NGOs such as CRE, CRT, Foundation of Sustainable Technology (FoST), Nepal Biogas Promotion Group (NBPG), Association of Solar Thermal Energy Devices (ASTED), etc. have been involved in the continuous promotion of these technologies.

Donor agencies

Various donor agencies such as USAID, SNV/Nepal, SDC, ESAP/Danida, UNDP, UNICEF, etc. have been involved in the promotion of various RETs through financial support in the form of grant-aid and soft-loan.

Private sector

They are responsible for the success of RET systems through the quality service of the RET systems manufacture, installation and after sales services. HMG/N has initiated various policies and programmes to encourage them by tax exemption, loan granting scheme, etc.

Users

Users are the main components whose awareness and information about RETs cause widespread demand of the technology. Experiences have shown that only demand-driven RETs become successful. These activities will directly affect the effectiveness and sustainability of the programme undertaken for fulfilling their energy requirement. The active participation of the users is vital for RET projects if it is to succeed.

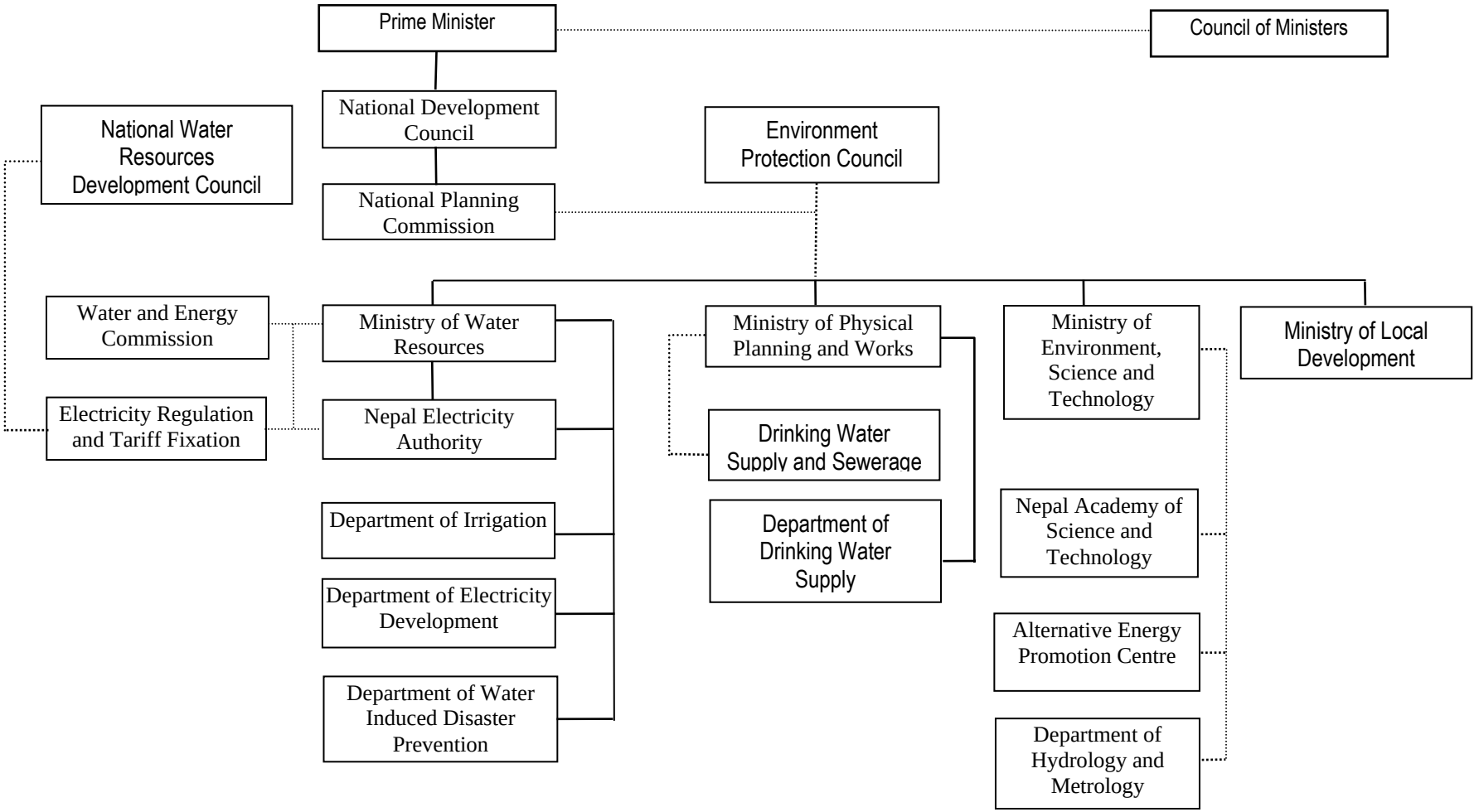
3.2. INSTITUTIONAL FRAMEWORK

Rural energy overlaps with energy planning and development as well as with rural development. Activity under both these areas involves a large number of players that fall into a wide range of categories: government line agencies, ministries and other entities, development assistance programs, local and international NGOs (*See Figure 3.1 for existing linkages between various organisations responsible for national energy development)*. The rural development efforts, which constitute the major portion of the development effort in Nepal, are distributed over many line agencies. The major ministries involved are Agriculture, Industry, Local Development, Water Resources, Forests and other social sector line ministries.

Table 3. 1: Main Stakeholders Involved in Energy, Environment and Health

Organizations	Area of responsibility	Type of Organizations	Functions
National Planning Commission	Planning	Nepal Government	Planning and Coordination
Ministry of Water Resources • Nepal Electricity Authority • Small Hydropower Development Board Water and Energy Commission Secretariat	Mainly Water resources and hydropower development	Nepal Government	Planning and Project Execution, Survey and Study reports
Ministry of Industries • Office of the Energy Efficiency • Department of Mines and Geology	Mineral resources like coal, petroleum, natural gas, lignite and efficiency	Nepal Government	Planning and Project Execution, Survey and Study report
Ministry of Forest and Soil Conservation • Community Forestry Division	Forest resources and Afforestation program, ICS	Nepal Government	Planning and Project Execution, Survey and Study report
Ministry of Health and Population	Heath	Nepal Government	Curative and Preventive measures
Ministry of Local Development	Local Development	Nepal Government	Planning and project execution
Ministry of Supply • Nepal Coal Limited • Nepal Oil Corporation • Timber Corporation of Nepal	Supply of Coal, Petroleum products and fuel wood.	Nepal Government	Supply
Ministry of Agriculture	Agriculture Residue	Nepal Government	Promotion and Research
Ministry of Environment, Science and Technology • Alternate Energy Promotion Centre • Royal Academy of Science and Technology (RONAST) • Department of Hydrology and Meteorology	Renewable Energy, Environment, and Indoor Air Pollution	Nepal Government	Promotion and Research in renewable technology
Ministry of Education and Culture • Centre for Energy Studies (CES) Institute of Engineering • RECAST • Institute of Agriculture and Animal Science • Institute of Forestry	R& D on Alternative energy	Nepal Government	Teachings and R&D
District Development Committee and Village Development Committee, Municipalities	All forms of Energy	Autonomous Govt. body	Planning and Project Development, Implementation and Monitoring
Practical Action, Winrock International, REDP (UNDP), BSP, Micro hydro Association, ICIMOD, GTZ, DANNIDA, JICA CRT, CRE, CARE, USAID, etc	Renewable energy and Indoor air Pollution	INGOs & NGOs	Promotion and development

Figure 3. 1: Institutional Structure Linking Various Organisations Related to Energy Sector



4. Analysis of Existing Policies

4.1. Policy Interventions

The country has no specific policy addressing the issues of Indoor Air Pollution. Even the existing energy policies remain distant from the issues of IAP. An insight of relevant polices of selected sectors that have come a little closer to mitigating indoor air pollution through plans and programmes are presented in Table 4.1. Selected policies that have a direct linkage with Indoor Air Pollution alone have been analysed here in this Table.

The Rural Electrification Project was instituted in 1981 to promote rural electrification through the installation of micro-hydro plants. The Agricultural Development Bank of Nepal (ADB/N) provided technical as well as financial assistance for mini-micro-hydro (MMHP) promotion. HMG of Nepal, with a view to encourage private participation in rural electrification, initiated the de-licensing of MMHP installations. This initiative was further extended to provision of subsidies in 1985. Under this provision 75% of the cost of electric components of MMHP was subsidised for remote districts and 50% for the remaining districts. Since then the government has been actively pursuing rural electrification[3].

The main thrust of energy policy is to reduce dependence on traditional fuel sources and on imported oil through development of water resources and non-traditional energy sources such as bio-gas and solar and wind power. Investment in small hydro-power plants in the private sector through a participatory approach and the mobilisation of local resources is a principal feature of energy development in Nepal. The Hydro-power Development Policy (*1992*) emphasise the need to cater for remote and inaccessible mountain regions where extension of the national electricity grid is not possible. The policy therefore makes the implementation of small-hydro-power projects in rural and remote area a matter of priority.

The positive role of alternative energy technology for the fulfilment of energy needs of the rural people have been recognized by the National Planning Commission, Nepal even in the Seventh Five Year Plan (1987–1992). The Eighth Plan (1992–1997) envisaged the need of a coordinating body for a large-scale promotion of alternative energy technologies in Nepal and the AEPC was thus established to promote the use of RETs and act as the government coordinating body.

The current Tenth Five Year Plan (2002–2007) emphasises on (*NPC, 2002*):

- increasing the consumption capacity of rural families by developing and extending the alternative energy sources, seen as a powerful tool in poverty alleviation
- supplying energy for commercialisation of domestic needs and the professions of rural people by developing alternative energy technologies based on local resources and tools
- reducing dependence on imported energy sources and reducing negative environmental effects by the proper use of resources and tools of local energy
- by improving and increasing the energy use competency and increasing the access of rural people by reducing the cost of development and installation of alternative sources of energy.

In the current Tenth Five Year Plan (2002–2007), HMG/N plans to install the following (NPC, 2002):

- 52,000 units of solar PV home systems
- 200,000 biogas plants
- 250,000 improved cooking stoves in about 45 districts of the country
- Generation of extra 10,000 kW of electricity through pico and micro-hydropower.

[3] Subsidy allowed for electrical equipment includes generator, control/instrument panel, ELC, transmission lines, etc.

Table 4. 1: Review of different Policies

Sector	General Statement of the Policy	10th Plan Statement that supports IAP	Remarks	
			Opportunity	Weakness
Science and Technology (2002)	The policy emphasises for implementing programmes for long-term development of Science and Technology through management of natural resources and environment conservation for the overall development and self – reliance.	Special emphasis will be given to developing and expanding technologies that would minimise the labour and time of women in household chores and enhance employment opportunities to create economic benefits	Economic enhancement and increase in HH income is a path for moving up the energy ladder and exposure to less pollution and hence improvement in health as well	Lack of co-ordination between agencies responsible for execution of national policies and programs and in mobilisation of appropriate manpower (quality and quantity) Research activities are hardly need based, most activities are supply driven rather than demand driven thus failing to meet the necessity of the users
Alternative Energy		Developing and expanding alternative energy as a tool for alleviating poverty, raising purchasing power of rural people, increasing consumption of alternative energy and reducing dependency on imported energy	Economic enhancement and increase in HH income is a path for moving up the energy ladder and exposure to less pollution and hence improvement in health as well. Imported fuel are mainly fossil fuel that are highly polluting as compared to alternative energy	Cost of alternative energy technologies is prohibitive for the rural poor. Subsidy driven approach reveals this dilemma Technologies are being imported, manpower is not sufficient thus sustainability is yet doubtful
Environment Policy and Action Plan	Addresses only ambient pollution			
Rural Energy, 2006	Promoting and increasing the access to healthy, reliable and appropriate technology in the rural areas for alleviating poverty and environment conservation; enhancing the efficiency of traditional technologies through research and development of new technologies and their management and undertaking and encouraging activities related to rural energy that will generate awareness of the implications on women, children, rural development, poverty alleviation		Sounds out its thrust on indoor air pollution through developing and promoting the use of environment friendly technologies;	Does not focus on the need based approach of technology development Does not identify responsible body or how to go about

The major concern of rural energy sector in Nepal is related to rural electrification and providing efficient forms of energy for cooking. Rural-based programmes and activities are a key priority in Nepal's own Poverty Reduction Strategy with special emphasis on the mountain and hill areas. With persisting low purchasing capacity of the rural poor denies them the access to modern energy services such as LPG, kerosene, electricity and modern energy services. In order to facilitate the access to electricity, the government has initiated the following programs micro-hydro technologies:

a. De-licensing of all electricity installations below 100 kW initiated in 1984
b. 50 percent subsidy (75 percent in case of remote areas) on electro-mechanical[4] costs, including generators, initiated in 1985

Besides, the Government of Nepal is also initiating long-term credit at a lower interest rate for investment in the field of renewable energy. In order to encourage financial institutions to invest in renewable energy efforts are on for creating an institutional credit mechanism through credit line and credit guarantee scheme under the Rural Energy Fund, which will supervise and disburse the subsidy. The necessary detail is being worked out in this regard in the delivery mechanism.

4.2. Technology Intervention

It cannot be denied that in Nepal there have been various technical efforts in developing and promoting efficient technologies that are based on biomass, electricity as well as solar[5]. Besides, focusing on increasing the efficiency of traditional technologies, the move has also been in introducing new technologies. Similarly, joint initiatives of Biogas Support Program, BSP and Energy Sector Assistance Program ESAP have been undertaken with the Government of the Netherlands and Denmark respectively. The primary objective is improving the living conditions of the rural population of Nepal by easing their access to energy technologies with better performance in terms of productivity, versatility in use and environmental impacts. The programs under BSP (through biogas Sector Partnership-Nepal) as well as ESAP (through AEPC) provide subsidies for communities' and households' establishment of biogas systems, electricity generation by micro-hydro plants and solar energy solutions. The fund also supports technical assistance in planning and execution of individual plants. Further activities in training in building improved cooking stoves for private households are also focus areas of ESAP. Support for activities in on-grid electrification (through NEA) is extended by ESAP for supporting a rural electrification scheme in Kailali and Kanchanpur districts targeting on-grid electricity supply for more than 20,000 rural households.

Currently, with non-governmental organisations and the private sector as intermediaries, the programmes have reached nearly 500,000 households with different technologies since the inception of the programmes (Table 4.2). Though un-intended, these technologies have helped acquire necessary reduction in IAP, Table 4.3. Besides these, the use of hoods leading to significant reduction in IAP have been promoted by Practical Action Nepal and Kathmandu University in recent years (See Annex-1).

Table 4. 2: Achievements of Technological Interventions

Technology	Number Installed (Nos,)
Micro-Hydro mini-grid plants (2006)	1,541
Solar energy solutions (2006)	90,172
Improved cooking stoves (2005)	250,000
Biogas systems (2006)	157,675

Source: WECS 2006, AEPC/ESAP 2006 and BSP 2006

Table 4. 3: Status and Contribution to IAP by Selected RETS

Programme	Installed FY 2005/ 2006	Total Replacement (kg/day)		Reduction in IAP (g-C/day)	
		Fuelwood	Kerosene	(Fuelwood)	(Kerosene)
Biogas Systems	140,519	702,595	238,88.23	293,684,710	20,137,778
Solar Home Systems	90,172		9,017.2		7,601,500
Improved Cook Stoves	250,000	250,000		104,500,000	

Source: WECS 2004; CRT/N, AEPC website

[4] Subsidy is not provided for the turbine, intake system etc.
[5] Wind and geothermal are still at its infant stages hence they have been ignored in this study.

Conclusively, there exists an inter-linkage relation between emission, concentration and exposure. Exposure is complex product of three subsystems forming the household energy system: the source, the living environment and users. From the review of the policies it is evident that the achievements made in reducing IAP have not come from any intentional efforts either from the government or the stakeholders involved in the promotion of these technologies. It has only been a slogan used for promotion of the technology as a commodity rather than a means for IAP mitigation. There have been isolated research conducted in this area in the past by individuals but their findings have yet to be recognised as areas demanding immediate attention. The analysis in terms of policy measures and stakeholders' involvement, irrespective of the adequacy of achievements, the areas focused upon so far in the country is indicated below in Table 4.4.

Table 4. 4: Focus Area, Measures Adopted

Approach Point	Focus Areas	Government Policy	Implementing organisations
Source	Improved cooking devices Chimneyless improved biomass stoves Improved stoves with chimneys	N/A • Targeted Long-term program	• Technology Development and promotion, • Awareness creation, community mobilisation construction, local skill development
	Alternative fuel-cooker combinations • Briquettes and pellets • Charcoal • Kerosene • LPG • Biogas • Solar cookers (thermal) • Electricity	• Yet to be recognised • Restriction in the use • Market –oriented • Market Oriented • Targeted Long-term program • Targeted Long-term program • Targeted Long-term program	• Technology Development and promotion, Awareness creation, community mobilisation construction, local skill development • Technology Development and promotion, Awareness creation, community mobilisation construction, local skill development • Technology Development and promotion, Awareness creation, community mobilisation construction, local skill development
	Reduced need for the fire • Efficient housing	N/A	N/A
Living Environment	Improved ventilation • Hoods / fireplaces/• Windows / ventilation holes	N/A	• Awareness creation, construction, local skill development, pilot programs
	Kitchen design and placement of the stove • Kitchen Improvement	N/A	• Awareness creation, construction, local skill development
User	Reduced exposure through operation of source Fuel drying Use of pot lids Good maintenance Sound operation Reductions by avoiding smoke Keeping children out of smoke	Elements to be to be monitored periodically	• Awareness creation, construction, local skill development, focus areas within the elements to be periodically monitored

One of the important aspects of IAP is that it is closely linked with poverty and cases have revealed the transition to cleaner technologies once living standards increase. Further, the absence of co-ordination between relevant

organisations and in linking common policy issues adds to the dilemma of the situation. However there exist challenges in specific technologies and the policy measures with respect to their promotion.

4.3. Barriers in Promotion of Efficient Bio-energy Technologies

Technical Barriers

- *Technical immaturity*. Most traditional Nepalese biomass energy technologies have been focused on small-scale projects and only in recent years has medium and large-scale energy projects begun to emerge. This evolving nature of these technologies creates significant risk for the suppliers and users.

- *Technology transfer*. Prevailing practices of technology transfer often do not sufficiently take into account the local conditions under which imported technology has to be operated and managed, the training required for its use, maintenance requirements and capabilities, and backstopping arrangements. Promoters need to consider both hardware and software aspects of technology transfer.

- *Limited adaptive R&D and Demonstration*. The adapted biomass energy technologies are not standardized and local artisans are not trained to the extent at which they are capable of perform necessary repair and maintenance job. The lack of national standards and specifications of end-use devices is the main hindrance on the promotion and commercialisation of biomass energy technologies. Limited expertise, manufacturers, agents and researchers to promote the biomass energy technologies. Limited site demonstration on biomass energy technologies by promoters is not sufficient to convince the users to invest on these technologies.

Institutional Barriers

- Absence of an effective central planning organization: Though there exist Ministry of Forest and Soil Conservation, Ministry of Agriculture and National Planning Commission, for planning of Forest and Agriculture related matters, these institutions overlook the planning aspect of biomass energy resources and technology. Water and Energy Commission Secretariat maintains the database of biomass energy resources but it also lacks the planning aspects. The Ministry of Environment, Science and Technology look after environment and alternative energy systems and Ministry of Health and Population look upon the health aspects of indoor air pollution. The previous plans and the recent 10th Five Year Plan have not address the issues of IAP, and strategies for overcoming these problems in its document. The government should mandate an institution for effective planning at the central level for the development and promotion of biomass energy resources integrating with environment and health.

- Blurred responsibilities between policy, implementation, operational and regulatory institutions: The responsibilities allocated to various organizations for policy planning, strategy formulation, implementation and operation and regulations is not well defined. There should be clear-cut policies to mandate various institutions for executing the various activities as mentioned above.

- Absence of an institutional framework for coordinated and integrated development: Presently there is no well-defined institutional framework for the coordinated and integrated development of biomass energy system, environment and health. A clear-cut institutional framework is to be defined for the effective coordination and development of biomass energy resources and technologies. There exist jurisdictional overlaps and the challenge of maintaining coordination between public and local bodies, which have to be sorted out.

- Need for demonstration/ pilot units for boosting the use of technologies.: For the promotion of proven and feasible biomass energy system, there is need for demonstration/pilot units for boosting the use of these biomass energy systems. Institutional support should also be provided for dissemination & regulation of biomass energy technologies.

- Inventory of locally available technologies and adoption of unified classification of biomass resources/ of biomass energy technologies: Institution mandated for the promotion of Biomass Energy System should develop an inventory of the locally available biomass energy technologies for effective dissemination and

record keeping of the proven and feasible technologies. The biomass resources and technologies should be well classified and according addressed.

Policy Barriers

- Lack of priority in policy regarding biomass energy: The Forestry Acts and Regulations and any other policies do not adequately address the policy issues on biomass energy. Moreover there is no any policy document on IAP related matters in Nepal except for the guiding principles of the Five Year Plan Documents of National Planning Commission. The government should focus on the development of policy on biomass resources.

- No integrated/comprehensive energy policy: There is a need for a comprehensive Energy Policy, which includes Indoor Air Pollution and Techniques and Technologies to tackle IAP. As mentioned above there exist no policy document on energy in Nepal and as such there is requirement for the formulation of a Comprehensive Energy Policy. This policy should be guided by the principle of Integration, participation, decentralization etc. that will lead to meet the national objective of Poverty Alleviation. The Rural Energy Policy has recently been revealed and has yet to come into implementation.

- No incentives on biomass based technologies except in Biogas: The government of Nepal has not given any attention and incentives for the development and promotion of biomass energy technologies except for the biogas and improved cooked stoves. As such huge amount of the biomass energy resources is being wasted. The government should promote and provide incentives for the proven biomass energy technologies like gasification, pyrolization, briquetting etc.

- Policy Support for R & D on Biomass Energy System: There exist no policy support for the research and development of biomass energy system in Nepal. The government should formulate policy for promoting and developing biomass energy systems and also provide adequate financial resources for the same.

Information Barriers

- There exists limited information on national renewable energy resources and biomass energy technologies in Nepal. Even this information is not accessible by all stakeholders. Lack of information about efficient and reliable technologies, health and environment concern on biomass energy resources, market potential etc are the primary barriers for promotion of efficient energy technologies.

Financial and Fiscal Barriers

- Investment in bio-energy is minimal in Nepal. Although the country is highly dependent on biomass, investments in this sector are very low. The reason may be perceived high risks of investment on biomass energy technologies. That is, investors lack confidence in technology to finance. And fund available from donors is also limited.

- Biomass energy technologies are expensive against those technologies run on subsidized fossil fuels. Subsidy for fossil fuel distorts market in biomass energy; technology push policies need to be substituted or augmented by market pull polices as mentioned by Shukla (1997). Lack of biomass energy market has been the barrier to the penetration of modern biomass technologies. Technology push policy will not create market. It should be other way round – market pull policy for biomass energy technologies by providing lucrative incentives.

Social Barriers

Un-acceptance of technology: Some technologies are difficult to be accepted by the communities. For example, beehive briquettes stove was promoted to Phakdung village (2653m) of Khumbu Region in Nepal. After the training period the conclusion was that the making of the briquettes was a dusty affair and disliked by the women because of the high emission of black charcoal dust (Nienhuys, 2003). Similar cases have been reported while introducing the combined use of human faeces and animal dung in biogas technology.

4.4. Recommendations

Indoor air pollution comes out to be a major environmental and public health hazard for large numbers of the poorest pollution, most disadvantaged people. The existing studies on indoor-air pollution in Nepal, provides important evidence of associations with a range of serious and common health problems. In view of both common and serious health outcomes from indoor-air pollution due to burning of biofuels there calls for attention to actions at the national level. This section outlines the following policy and strategy recommendations have been made.

- A general improvement in the health status especially that of women and children, is a critical input for economic growth and poverty reduction, thus addressing the health impacts of household energy and indoor air pollution should be an integral part of poverty reduction efforts.
- Improved biomass stoves and cleaner biomass based fuels will continue to be an option for reducing exposure for a large majority of the rural poor in developing countries. Facilitating behavioral changes in women, children and other household members is another way of reducing exposure and alleviating the associated health impacts. Improving the status of women can be an effective method of promoting markets for better stoves and other household energy use services.
- The government should ensure sustained upshot market mechanisms for distribution of improved stoves and commercial fuels. Programmes that propagate improved biomass stoves with higher efficiency and lower emissions commercially, with proper certification and quality control by government agencies, have greater financial sustainability, respond better to user demand and produce more durable stoves. Therefore, government interventions should be re-oriented towards creating a effective regulatory framework and incentive structure that works with the market.
- One of the most important elements of a strategy to mitigate indoor air pollution is to bring about a behavioural change, including a greater demand for cleaner cooking. This will require raising awareness amongst rural households about the health impacts of traditional household energy use and providing specific information on the range and effectiveness of mitigation options.
- Among the rural poor, at the household level the decision making regarding fuel use patterns largely depend on men, while girls and women continue to put up with the burden of collecting fuel wood and use it for cooking, thus exposing themselves to highest levels of indoor air pollution. It is therefore important to ensure mechanisms that allow both women and men to make choices and influence household decisions regarding the use of fuels. Creating self-help groups, promoting energy entrepreneurship and ensuring income generation opportunities for women as part of household energy strategy are the approaches that may improve rural living standards.
- The effective household energy programmes should address the range of sustainable livelihood and poverty needs of both women and men. In poor households, energy and time use for consumption and production are closely interrelated such as food and beverages may be prepared for family use as well as for sale; fuel wood may be collected for cooking and for sale etc. Increasing opportunities for women to earn income outside of the household may be the only way to reduce the use of fuel wood collected with unpaid family labour and therefore engagement in paid informal activities may generate income for the rural women. Programmes to improve household energy services and mitigate indoor air pollution need to address these aspects, by providing opportunities for income earning for women engaged in the informal economic activities.

The primary need is to set up a responsible body for undertaking all activities regarding indoor air pollution. Keeping in view the status of IAP and the policy measures together with activities on quality analysis and standardisation. The recommendations are further categorised under short and long term actions, discussed below:

Short Term

- Incorporate the IAP reduction strategies in the existing relevant policies: Energy, Rural Energy, Environment as well as Science and Technology policies.
- Policy formulation, planning, implementation and monitoring of the biomass energy systems

- Setting up quality control standards of indoor air quality that are easily achievable at the early stages and with time make them more stringent and measures for biomass energy equipments,
- Awareness creation on the implications and solutions of IAP, disseminate information impacts of IAP, available interventions
- Assess market and develop market mechanisms for promoting certified appliances/equipment
- Assess the variation in the need and economic factors determining the choice of technology and develop necessary end use devices accordingly
- Develop resources and technology database and technology packages appropriate for local needs
- Assess the effectiveness of existing technical solutions and their implementation; generate much needed information from ongoing small- and large-scale projects. This information will provide the basis for the development of a catalogue of options that review both the effectiveness of interventions, and lessons learnt in relation to their implementation
- Implement technological interventions such as better ventilation, windows, hoods and chimneys
- Research and development for the improvement of the combustion efficiency of various effective techniques for reducing indoor air pollution
- Capacity Building for quality assessment of technologies, assessing implications of IAP, quality assurance and standardisation, Developing IAP reducing technologies
- Health, indoor air pollution, energy, development must be included in school curricula, and also disseminated through various media as well as adult education programs
- Demonstrate in rural areas on adverse effect of Indoor Air Pollution on health in general and to women and infants/small children in particular by field demonstration and through TV and Radio programmes
- Inclusion of indoor air pollution, energy and development in school curricula

Long Term

- Introduce programs related to fuel efficiency, combustion efficiency leading to the use of cleaner fuel
- Enforcements of compliance with the standards should be pursued.
- Regulate air quality standards and design standards for stoves
- Stringent monitoring
- Capacity Building for up scaling/upgrading existing technologies as well as that of existing capacity of Research organisations, Health professionals, Energy experts, Local development personals
- Commercialisation of environment friendly technologies with appropriate market mechanisms in place
- Providing time-limited subsidies for initial uptake and generating demand and thereby creating market conditions for lower prices and more consistent quality
- Access to technology through local retailers and available local service centres

IAP reduction program must be integrated with economic development. Increasing economic status has been found lure users to move up the ”energy ladder” thus energy interventions must be integrated with measures for increasing the household income. Development organisations, Donors and the Government must strategise energy interventions such that they are linked with IAP programmes and income generation activities.

Above all rhetorically, the IAP activities must be initiated with a clear-cut institutional framework that is well defined for the effective coordination and development of biomass energy resources and technologies. There is the need to manage jurisdictional overlaps and to sort out the challenges of maintaining coordination between public and local bodies. Equally pertinent is the need to conduct demonstration of pilot units for promoting of cleaner technologies: promotion of proven and feasible biomass energy system. Despite the impending bureaucratic maze a framework has been stipulated regarding activities to be undertaken by different stakeholders and is presented in Table 4.5.

Table 4. 5: Framework for IAP Program

Issue	What	Who	How	Why
Recognise	• Important role of biomass fuels in various social and economic sectors; e.g. in rural development and health sectors, in order to develop and support coordination of different sectoral policies. • Need to educate, inform and communicate the issues within heath professionals, communities	• National policies makers • Program implementers • Development workers • People at large	• Advocacy • Awareness creation • Evidence based debates on ∗ Measures for behavioural changes ∗ Use of proper ventilations ∗ Use of pollution friendly technologies	• One needs to be healthy before one strives to become wealthy • Tackling indoor air pollution could be one of the most cost-effective ways to improve public health and decrease infant mortality • Time spend in fuel collection inhibits literacy among rural poor women,
Identify and Implement	• Institutions to be involved in the policy formulation, planning, implementation and monitoring of the biomass energy systems • Quality control standards and measures for biomass energy equipments • Research and development for the improvement of the combustion efficiency of various Appropriate cost effective techniques for reducing indoor air pollution	• Government • IAP problem encompasses housing, health, gender, energy and environmental implications specialists focussing on these thematic areas in country governments and inter governmental organisations should be made to work together to take responsibility • Research institutions	• Form a unit within the organisations that has made strides in this step or form a new body to take up this responsibility and work in collaboration with the institutions listed earlier • Review past works, compile necessary data and develop standards that include the emission aspects and the overall conversion efficiency. • Enforcements of compliance with the standards should be pursued. • Disseminate, create awareness, assess market and develop market mechanisms for promoting certified appliances/equipment • Regulate air quality standards and design standards for stoves	• IAP is an inter-disciplinary and intersectoral issue it is difficult to determine who should take responsibility for it within an institutional framework.

Issue	What	Who	How	Why
Assess	• Combustion characteristics in order to reduce indoor air pollution and health risk for the users. • The variation in the need and economic factors determining the choice of technology and develop necessary end use devices accordingly • Resources and technology database and technology packages appropriate for local needs	• Nationally recognised body authorised to lay the stamp of standards/quality • Development organisations, research centres • Development organisations, research centres with necessary technical support	• Set up strengthen existing institutions working in the quality analysis and standardisation • Resource assessment must be done periodically • Revisit the energy policies and subsidies allocated to various fuel and technologies and bring about level footing for cleaner fuel • Planning must be based on need-based information • Development and assessment of interventions • Health implications	• Different fuel causes different rates of and kinds of pollution • Choice of fuel is determined by economy status and purpose • Resource must be mobilised to attain sustainability • Choice is an ever changing element of life
Capacity Building	• IA quality assessing • Assessing implications of IAP • Quality assurance and standardisation • Developing IAP reducing technologies • Research on the subject	• Research organisations • Health professionals • Energy experts • Local development personals • Community	• For creating awareness of the users, promoters in various aspects including that of indoor air pollution reduction and health benefits of the technologies • Dissemination and delivering services for the technology – production, sales, after sales services etc. • After sales services • Stringent monitoring activity	• The country lacks necessary infrastructure for conducting this program • Things are happening in an ad-hoc basis
Enable Access and Affordability	• Access to finance • Access to technology • Access to information • Increase household income	• Development organisations • Donors • The community • Government	• Subsidy to be provided at the initial stage and phased out gradually using the periodic diminishing rate on the subsidy amount • Micro-financing to be promoted to support people to access the biomass energy technologies in the rural areas • Create opportunities for income generation • Link up energy and IAP programmes with income generation activities	• To prevent the dependency • To increase livelihood and increase purchase capacity • To increase the ownership value

In view of the fact that women and children are harder hit by indoor air pollution the activities must ensure:

* Task force must be gender balanced
* Data must reflect gender perspectives of the issues
* It is pertinent that the advocacy with gender involvement on issues related to gender benefits
* Awareness programmes must be focused on the users of the technologies
* Monitoring must include gendered indicators
* Gender budgeting must be enforced

These measures have been developed focusing on the growing effect of using solid biomass especially the rural areas. However, indoor air pollution is not the problem of rural areas alone. The urban population suffer similarly from pollution arising from modernisation; the problem arises from paints, aerosol and different preservatives. Hence similar steps must be taken to protect this population as well.

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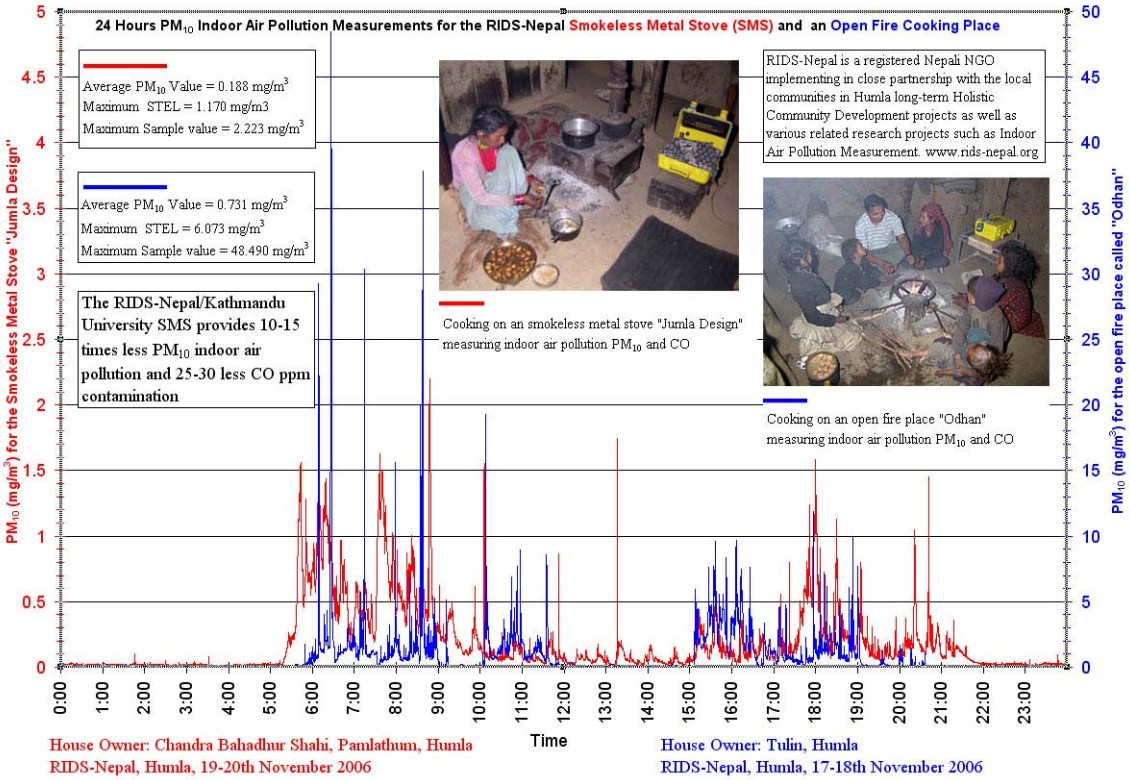

Source: Alex Zhand, Kathmandu University

Challenges and Promotional Measures

Technology	Challenges	Promotional Measures
Improved cook stoves	No centralised research and development activities Single technology given priority Choice for users limited Lack of awareness Not suitable in all areas do to non-availability of suitable clay Stipulated accessories not available at all places Cost prohibitive to the user Non-existence of subsidy as in other technologies distant potential users	At National Level
		Awareness creation Decentralised approach adopted in the promotion No subsidy Pricing left to the negotiation between the installer and the client
		NGOs/CBOs/ INGOs
		Media Free distribution Tied-up with other programmes Periodic Training up gradation to local promoters, trainers
Biogas	Use of feed material other than dung Acceptance by the people specially when attached to the toilet Affordability of poor people low Lack of water by area and season Up-scaling the technology Limited number of accessory manufacturers Some components still need to be imported thus increasing the cost of the system Dependent on the weather and quantity of feed material Difficulty in using the Tax exemption	At National Level
		Subsidy provided by geographical region Periodic Training up gradation to local promoters, trainers Availability of credit Encourage Micro Financing Organisations to finance the technology for users Vat exemption
		NGOs/CBOs/ INGOs
		Occasionally awarding best performers: supervisors, construction companies, manufacturers Working in partnership with local agencies for promotion Linking up with income generation activities Training of manpower of special skills
Solar PV	Cost Prohibitive Site specific Dependent on the import of specific components	At National Level
		Subsidy provided by geographical region Availability of credit Encourage Micro Financing Organisations Vat exemption
		NGOs/CBOs/ INGOs/Others
		Working in partnership with local agencies for promotion Availability of credit Encourage Micro Financing Organisations Linking up with income generation activities Training of manpower of special skills Assemble locally