Mountain Enterprises and Infrastructure

ICIMOD

Discussion Paper
Series No. MEI 96/1

Developing Energy Options for the Hindu Kush-Himalayas

Rethinking the Mountain Energy Development Paradigm

Kamal Rijal

International Centre for Integrated Mountain Development
Kathmandu, Nepal
1996

ISSN 1024 - 7564

Published by

International Centre for Integrated Mountain Development
G.P.O. Box 3226
Kathmandu, Nepal

Typesetting at ICIMOD Publications' Unit

ISSN 1024 - 7564

Developing Energy Options for the Hindu Kush-Himalayas

Rethinking the Mountain Energy Development Paradigm

Kamal Rijal

MEI Series No. 96/1

Dr. Kamal Rijal is the Energy Specialist for the Mountain Enterprises and Infrastructure Division, ICIMOD

July 1996
International Centre for Integrated Mountain Development
Kathmandu, Nepal

Preface

This paper provides a brief review of the current energy situation in the countries of the Hindu Kush-Himalayan (HKH) Region and compares it with the situation that prevails in the HKH Region *per se*. The paper also examines the energy use variability and concludes that there is a strong correlation between the human development index and energy requirements. It also examines implications on and for the energy sector as a result of mountain-specific constraints and opportunities, besides presenting the energy sector barriers. The present unsustainable energy use pattern is not only the result of the development paradigm that has been followed but also of the inability of energy planners and experts to understand the energy system in a holistic perspective. The paper highlights lessons that should be learned while implementing energy programmes.

Against this backdrop, the author attempts to provide a framework for sustainable energy development in the context of mountain areas, stressing the need for redefining the energy sector goals and incorporating issues related to the quality and quantity of energy demand, as these would have implications not only on the energy mix but also on the scale of energy technology and institution. The underlying philosophy for redefinition is that energy must not be treated as an end in itself but as a means to satisfy human needs. Nobody needs fuelwood, LPG, gasoline *per se*, but everybody needs energy to perform certain services such as cooking food, lighting homes, running engines, and so on. The energy systems thus need to be looked into from the energy services point of view rather than from the energy supply perspective.

The paper advocates that the development process in the mountains should be accompanied by energy system transformation which includes: increased availability of renewable energy and energy-technology supply infrastructure; introduction and /or increased use of energy conversion devices to alleviate human drudgery and boost productivity; a productivity increase which facilitates off-farm employment; improved use efficiency; higher value use of energy; and increased use of efficient devices. It further examines factors that affect energy system transformation and concludes that the mountain population requires the transformation of the energy systems to sustain the economic transition from subsistence to market, besides providing energy services for the fulfillment of basic needs.

Contents

1. BACKGROUND

The economies of the Hindu Kush-Himalayan (HKH) Region[1] are characterised by low levels of development reflected in the increasing poverty of its inhabitants. Levels of income and development differ within the HKH region, because the strategies adopted for economic growth in each country are different and the level of natural resource endowment and patterns of energy consumption and energy resource mix vary greatly and exhibit growing environmental stress. Natural resources, especially forests and water, are threatened by the food and energy demands of the growing population (represented by subsistence economic conditions evident in the heavy dependence on primary energy sources and consequent increasing rate of deforestation as well as the increasing share of imported commercial fuels) (ADB and ICIMOD 1992).

The livelihoods of mountain communities will not be sustainable unless concerted efforts are geared towards the development of a model that embodies transformation from a subsistence economy to a diversified economy. This should be based on economic and allocative efficiency along with the twin objectives of poverty alleviation and employment generation. Such a transition, inevitably, requires the development of energy resources and technologies that are suitable to the 'mountain specific' conditions.

Background of the Countries of the Hindu Kush-Himalayan Region

The countries of the HKH region have a total population of 2,365 million, of which more than five per cent live in the mountains. The average population density in the countries of the HKH region is 154/km^2, while it is 36 within the Hindu Kush-Himalayas. There is, however, substantial variation in the population density in the HKH region within countries, e.g., 130 in Nepal and 12 in China. Table 1 summarises selected development indicators in the countries of this region.

Against the global infant mortality rate of 60 per 1000 births that of the countries of the HKH region varies between 31 to 129. China and Myanmar have a higher Human Development Index (HDI) than Bhutan and Nepal. Though the HDI Index for the HKH, per se, is not available, the low literacy level and high poverty prevalence in the region are reflective of the poor quality of life for a majority of the population. There are also variations in the HDI Index within countries and within the HKH region.[2] A large majority of the population has no access to safe water or adequate health facilities; poverty levels are high and, as per the UNDP Human Development Report (1994), out of the total poor of 1,175 million in the entire world, the countries of the HKH region have 625 million, and most of these fall within the HKH region itself. Even though economic growth and development has improved living standards, the HKH region

---

1 The 3,500km mountain range that stretches from Afghanistan in the west through Pakistan, India, China, Nepal, Bhutan, Bangladesh to Myanmar in the east is home to more than 120 million people (ICIMOD 1995a).

2 For example, the HDI within Nepal among districts varies between 0.1 and 0.4.

remains one of the poorest in the world. Figures 1 to 6 present the various development indicators.

2. REVIEW OF THE CURRENT ENERGY SITUATION

Countries of the HKH Region

The total final energy consumption in the region amounted to 71,311 million GJ in 1992, of which 66 per cent was met by commercial energy sources and the rest by traditional fuels, though a large variation in the share of traditional fuels is observed. For example, in Afghanistan, Bhutan, Nepal, and Myanmar, the share of traditional fuels lies between 75 and 95 per cent, whereas in China and Pakistan it is less than 25 per cent (Table 2). Large countries, such as China and India, consume about 66 per cent and 29 per cent of the total energy respectively, while the remaining countries consume less than five per cent.

There is also a wide variation in the per capita final energy consumption pattern within the countries. For example, in India and China it is two to three times more than the average value amounting to 16,500 MJ per capita, while it varies between 7,500 and 16,500 MJ per capita in the other countries. This is the consequence of a combination of socioeconomic factors and the availability of energy resources and reliable technologies.

The energy resource base of the region incorporates a combination of traditional and commercial sources, including fuelwood, agricultural residue, animal wastes, hydroelectricity, petroleum, coal, wind, and solar. The energy potentials in the countries of the region are presented in Table 3. The present potential for a sustainable supply of energy amounts to more than six times the total energy consumption.

The resources available in the region vary significantly. For example, the share of coal as an energy resource occupies first place (with more than 90 per cent in China and India), whereas renewable energy accounts for less than two per cent in China and six per cent in India, eight per cent in Bangladesh, and 11 per cent in Pakistan. In Afghanistan and Myanmar, the sustainable supply of renewable energy amounts to 26 per cent and 20 per cent respectively, while it is 100 per cent in Bhutan and Nepal.

Almost 94 per cent of the annual supply is available in the form of coal for at least 50 years — mostly in China and India. Only about 60 per cent of the total final energy demand of the countries in the region can be met by a sustainable supply of renewable energy, assuming a loss of 50 per cent during conversion of primary energy into final energy. If India and China were to be excluded from the analysis, the sustainable final energy supply potential would exceed 3.7 times the total final energy demand, assuming an overall conversion efficiency of 50 per cent between primary and final energy supply. Similarly, if 70 per cent of the present energy demand is assumed to be met by biomass fuels in countries other than India and China, in that case only about

35 per cent of this demand in the countries overall can be met by biomass fuels with the remaining having to be met by mining of the forest or by the extensive use of renewable energy resources.

The per capita electricity production varies significantly in the region from 39kWh in Nepal to 535kWh in China as depicted in Figure 7 (World Development Report 1994), compared to 11,868kWh in the USA. Significant variations exist within the region. China and India have a notably higher commercial energy intensity of 187 and 132kg of oil equivalent per US $100 GDP respectively, while Nepal has less than 15kg, as shown in Figure 8.

In Nepal and Bhutan, hydropower typically occupies first place with more than a 60 per cent share, while biomass constitutes four per cent in Bhutan and 10 per cent in Nepal. The present usage pattern shows that the contribution of biomass to current energy needs is more than 90 per cent, while hydropower contributes less than one per cent.

The Hindu Kush-Himalayan Region

Although reliable estimates of the energy resource base of the HKH region are not available, the trend of resource availability as depicted in countries like Nepal and Bhutan may best represent the energy supply potential as well as the existing energy supply patterns. The preliminary understanding of the energy supply potential, as seen in the case of Nepal and Bhutan and mountain areas of the region, clearly indicates that there is a rich renewable energy resource base, with a tremendous potential for providing energy not only to the people of the HKH but also to the people living beyond the region.

Given the unreliability of estimates of total energy consumption in the HKH region, the energy consumption pattern in the domestic sector—as seen from various case studies — shows that the contribution of traditional fuels amounts to more than 90 per cent of the total energy requirement, apart from in Jammu and Kashmir (Table 4). The share of fuelwood in traditional energy is more than 65 per cent, with the exception of Ningnan County, China.

The trend indicates that the use of agricultural residue and animal dung as sources of energy is on the increase in the HKH region, but, in urban areas, the transition from biomass to commercial energy forms is evident. The urban areas of the HKH region are now increasingly dependent on imported conventional energy resources.

Investigations in typical villages of the HKH show that the useful energy requirement in the domestic sector amounts to from 65 to 80 per cent of the total useful energy requirement, as depicted in Tables 5 and 6 (Rijal 1991). The useful energy requirement for cooking varies from 55 to 85 per cent of the total energy required in the domestic sector, depending on the climatic condition of the area. The domestic sector depends on traditional forms of energy to meet its energy needs.

The useful energy requirement for farm activities varies from five to 25 per cent of the total energy requirement, depending on the intensity of cropping patterns; size of land holdings; ruggedness of the soil structure; and availability of, access to, and use of modern farm inputs (Tables 5 and 6). More than 85 per cent of the total useful energy required on the farms is for ploughing, planting, and threshing activities, which include farmyard manure and fertiliser application. These requirements vary significantly from village to village depending on the topography, accessibility, and availability of irrigation facilities. A substantial quantity of the farm energy requirement is met by muscle power (human and animal).

The type of industry dictates the choice of energy input. For example, in Lekhgaun village, in the Surkhet district of Nepal, almost 45 per cent of the useful energy is met by muscle power, e.g., weaving, mat-making, and agro-processing are the main activities, whereas, in Marpha, in the Mustang district of Nepal, more than 80 per cent of the useful energy requirement is met by fuelwood since alcohol brewing is the main rural industrial activity (Table 5).

As a result of various socioeconomic factors (Figures 1 to 6), a wide variation exists in the per capita final and useful energy consumption patterns within the HKH region the availability of energy resources and technologies can be considered a part of these socioeconomic factors.

A cursory analysis of energy supply and demand patterns indicates a severe imbalance of sustainable energy supply and demand in the HKH region. Actions and programmes were introduced in the mountains, but to no avail. The approach adopted for development of the energy sector did not show any significant increase in the use of renewable energy, despite the existing potential. This was due to the fact that the development of the energy sector was primarily biased towards fulfilling the energy needs of the people living in the plains. It was also due to the fact that renewable energy development required a substantial initial investment which, however, would turn out to be cheaper in the long run.

At the same time, the economic cost of biomass fuels is rarely perceived, neither by users nor by nations, and thus traditional sources of energy still play a predominant role at the cost of the resource decreasing at a faster rate than can be replenished. The present trend of unsustainable and indiscriminate use of biomass has affected the welfare of the population in the HKH region, as it increases the time needed to collect fuelwood and fodder. It has likewise reduced farm productivity and adversely affected the quality of life (Monga et al. 1988; Monga et al. 1992).

It is not that technologies to save energy, diminish adverse environmental impacts, or reduce life-cycle costs to consumers are not available. The problem is of matching energy resources and technologies with the energy services required as well as the availability of energy technologies at the desired location. Besides this, transfer of efficient energy technologies and their affordability are also critical problems. Efficient technologies may not be popularly adopted unless mechanisms for their transfer are improved upon, impediments to their adoption removed, and the issue of affordability appropriately addressed (PEP Project 1995).

Given the state of affairs, the energy sector in the HKH region needs to be looked at anew, for which rethinking is essential. The question that immediately needs to be addressed is how these renewable energy resources can best be exploited while maintaining the economic and social sustainability of the mountains.

3. ENERGY USE VARIABILITY

Socioeconomic factors are crucial to the understanding of energy use behaviour. Some of these factors affecting energy use patterns in the region are exemplified in this paper, though it goes without saying that many other factors could significantly influence energy use. These factors need to be clearly understood and taken into account for sustainable development of energy in the context of the HKH region.

Population Dynamics and Urbanisation

Limited potential for improving the quality of life in rural areas forces people to migrate to urban centres (Sharma 1994a). The resources and the demand patterns for energy vary notably between rural and urban areas (Table 7). Dependence on commercial fuels is much higher in urban areas as the transaction cost of these fuels is greater in the rural mountains due to lack of sufficient infrastructure. It should be noted that the transition from low-grade to high-grade energy in urban areas is instrumental to improving energy use efficiency. The outcome is a decrease in the absolute value of final energy input (a decrease of almost 35% is observed in Table 7).

In most urban areas of the HKH the increasing dependence on non-renewable energy will render the consumption pattern unsustainable in the long run. The need to change the present supply mix, which is dominated by imported fossil fuels, to the desired supply mix, with a high share of renewable energy, is crucial.

The relationship between the ratio of urbanisation and final commercial energy consumption for the countries of the HKH clearly indicates that increase in the urbanisation ratio increases the per capita commercial energy consumption (Figure 9).

Income and Energy Transition

The increase in per capita income level and the proportionate increase in per capita energy consumption is depicted in Figure 10. The trend is not uniform throughout. The low income groups in the region tend to depend more on fuelwood, and, in the event of non-availability of fuelwood, they are inclined to switch over to non-monetised energy forms. The high-income households show a tendency to move up on the energy ladder (i.e., more use of kerosene, LPG, and/or electricity).

The choice of energy resources and technologies clearly depends on the affordability of the household. As people move out of a subsistence economy they tend to use more efficient energy technology and high-grade energy sources. This relationship is depicted in Figure 11.

Process of Industrialisation

The mountains cannot remain in isolation from the present global process of industrialisation if they are to accomodate to the growing concerns of improving the quality of life through more employment generation. The analysis indicates that the increasing rate of industrialisation creates a higher demand for input of commercial fuels (Figure 12), besides also compelling an increasing rate of urbanisation. Ample opportunities exist to sustain the increasing rate of urbanisation and industrialisation by maximising the use of indigenous renewable energy sources.

Various studies point to the need to reorient the development paradigm in relation to urbanisation and industrialisation in the context of the HKH (Sharma 1994b). The nature and forms of industrialisation and urbanisation will exert different impacts on the energy sector. A development paradigm that does not consider the provision of energy, taking into account the mountain-specific situation, is bound to face severe constraints in relation to the supply of energy and technology and is also certain to suffer from inevitable environmental challenges in years to come.

Diversification and Intensification of Agriculture

Concerted efforts by the governments as well as the commitment of donor agencies to the elimination of poverty and to improvment in the quality of life in mountain areas would entail diversification and intensification of the agricultural sector, which in turn requires an increased amount of useful energy for its sustenance (Shrestha 1992; Jodha and Shrestha 1994).

Currently, human and animal labour is the main form of energy employed in this sector, though the direct and indirect use of energy is on the increase. The input of muscle power needs to be gradually replaced with motive power through utilisation of renewable energy sources in order to both reduce the human drudgery, especially on women and children (Omvebt 1995; Overholt et al. 1995) and to release livestock for productive purposes. All of these would require an increased supply of high-grade energy with appropriate technological interventions.

Human Development Indicators

Analysis of the relationships between HDIs, adult literacy, infant mortality, and GNP per capita of the countries of the HKH shows a strong correlation among these variables (Figure 13). Some of the variations could be attributed to the policies and implementation strategies of respective governments and are indicative of how economic growth is tied to the equity concerns and the governments' expenditure on the social sector. At this point, it is interesting to note that, in regional terms, the average HDI, adult literacy, infant mortality, and GNP per capita are well balanced, and the countries of the region seem to be doing quite well. Unfortunately, a closer look at the condition of the countries of the HKH region with HDIs of about 0.1 indicates an increasing disparity among the mountain people compared to the rest of the population in the countries of the region.

The relationship represented in Figure 14 prompts us to state that an increased level of final energy consumption is a manifestation of economic progress and a better quality of life for the nation (Philips et al. 1995). However, close observation between energy consumption per capita, HDI, industrialisation ratio, and urbanisation ratio clearly reflects that this does not completely hold true, as a substantial variation is observed in Figure 15. This means that the availability of energy resources and technologies alone does not necessarily imply the desired level of human development.

4. ENERGY SECTOR BARRIERS

As identified in various studies, the energy sector in the region faces numerous barriers (Codoni et. al. 1985; ICIMOD 1986; Ramani et.al 1995; Vinod Kumar et al. 1987; Munasinghe et al. 1992; Phillips et al. 1995; Goldemberg et al. 1988). These need to be removed to ensure a sustainable supply of energy for the growing concern for human development besides providing an impetus to the economic growth of the mountain region. The following are the major barriers in the energy sector which have led to the present patterns of unsustainable energy use in the mountains. However, the magnitude of the problem varies from country to country, while the general characteristics remain similar.

Policies, Planning and Programme Barriers

- Most of the development policies in the mountains failed to understand the role of energy in reducing human drudgery and presumed that the supply of energy was available as and when required.
- Conventional wisdom on electrification assumes it to be a welfare package and electricity prices are always subsidised.
- Supply expansion bias in planning energy investments and poor attention to demand management
- Mechanistic use of planning models that do not adequately consider energy efficiency and renewable energy technology options
- Absence of policies for decentralised energy systems and end-use appliances

- View of final energy as an end use rather than as a service
- Inability of planners to incorporate different scenarios for mountain areas
- Decision-making based on poor and often unreliable data, especially in the mountains
- Policies on import duties and foreign capital that ignore the importance of renewable energy

Technological Barriers

- No clear understanding of the technology transfer process
- Donors view technical assistance as a market promotion effort, while the HKH countries view it as an opportunity for 'window shopping'
- Lack of standardisation in components and parts, leading to weak local manufacture and servicing capabilities
- Limitation of technologies in meeting the essential user needs, such as cooking and space heating, at affordable prices
- Lack of data on local manufacturing capabilities for effective technology transfer arrangements
- Low R & D investment in renewable energy technologies

Cost, Financing and Investment Barriers

- Lack of cost-effectiveness and high cost of renewable energy systems as well as subsidies in the price of commercial fuels
- Lack of consumer awareness on the distinction between energy costs and life-cycle costs
- Application of the 'Least Cost' approach, without sufficient understanding of the implications for low-income groups and the poorest of the poor
- Bilateral and multilateral donor biases towards centralised energy supply financing instead of multiple decentralised energy projects
- Conservative lending practices of national and international financing agencies, accompanied by an aversion to risk in new energy markets
- Inability of vendors to acquire venture capital and financing for initial market creation

- Unpreparedness of financing institutions to cater to small-scale energy financing and also the inability of credit policies to address low-income groups.

Institutional Barriers

- Evolution of energy decision-making as a supply side activity, hence centralised planning institutions

- Lack of energy awareness among demand side agencies, especially rural and urban development bodies

- Marginalisation of specialised agencies for renewable energy development in energy decisions

- Alienation of the private sector and NGOs from energy decisions

- Domination of rural electrification by centralised public monopolies

5. EFFECTS AND IMPLICATIONS OF MOUNTAIN SPECIFICITIES ON THE ENERGY SECTOR

In general, the extremely slow pace of energy transition in the mountains can be attributed to the slow growth rate of economic activities due to the prevailing rate of development as well as the aforementioned energy sector barriers. These barriers are further aggravated by mountain specificities, displayed by inaccessibility, marginality, and fragility, although the existence of several comparative advantages for the development of the HKH region has been pointed out by many studies (Jodha and Shrestha 1994, Sharma and Banskota 1992). These will have a direct bearing on the energy sector as well.

Box 1 shows the effects and implications of mountain specificities on the energy sector (Sharma 1994a; Jodha and Shrestha 1994, Sharma and Banskota 1992). Inaccessibility induces isolation which means high costs for energy supply systems, and this, in turn, forces local residents to modify their needs to what they have and develop a better understanding of sectoral links (i.e., to maintain the delicate balance between fuel, fodder, and food requirements).

Fragility reflects the vulnerability of energy resources. The decrease in productivity and low resource capability result in diverse settlements and, consequently, the establishmwent of an energy infrastructure system would incur extremely high costs.

Marginality means exploitation of energy resources by people living near the available resources. The rapid process of 'destruction on the margin' becomes a visible phenomenon, promoting extensive use of marginal areas by people without easy access to resources. Furthermore, people residing in the mountains have a marginal say in the development process, as the cost of not doing anything for the mountain people does not affect the power equation. Thus, it remains outside major development negotiations and, subsequently, energy technology interventions.

Box 1: Mountain Specificities and Implications on and for the Energy Sector

Mountain Specificities	Primary Attributes	Adaptation Characteristics	Implication on Energy Sector	Implication for Energy Sector
Inaccessibility	Isolation; high cost of supply system; limited access; invisibility of problems	Multiple use of resources and technologies	Interventions failed due to a sectoral approach	Better understanding of sectoral links, i.e., fuel, fodder, and food chain
Fragility	Resource highly vulnerable to rapid deforestation; low productivity and resource capacity, dispersed settlements	High community participation; people-oriented problem-solving; integrated farming system; prevailing barter system	High cost of interventions; higher level of energy input	Augment energy supply; improve efficiency of conversion
Marginality	Limited resources and productivity; minimal consideration of areas/people	Exploitation of potentials by core areas/population, use of marginal areas by others, dependency	Destruction at margin process	Encourage forest management to provide fodder, fuel, and timber
	Subsistence economy	Low risk-taking capability	Slow pace of dissemination	Link energy and income generation
Diversity	Diverse resources and approaches; environmental situation; large-scale micro-variations in physical/biological attributes; interdependence of production bases	Multiple cropping, diversified upland/lowland farming systems	Increase in energy inputs, increased dependency on a specific fuel	Adopt the need-based approach and diversify fuel use
Niche	Small-scale specialisation; location and area-specific comparative advantage; location-specificity of production and consumption	Emphasis on activities that are mostly of an extractive nature; logging; hydroelectricity	Decentralised energy system preferable	Indigenous technical knowledge-base for maintaining forest areas, traditional machinery/ water wheels

Source: Sharma and Banskota (1992), Sharma (1994a), Jodha and Shrestha (1994), PEP (1995).

Diversification means that the cost of extraction of energy resources in a usable form is high. And also realisation of the economy of scale is not feasible due to the diverse nature of economic outputs (in terms of quality and quantity of output). In order to countermand the disadvantages associated with economic outputs, particular resources and technologies tend to be used for multiple applications.

The opportunities that exist in the mountains include the huge potential of renewable energies and the indigenous technical knowledge systems that are used to maintain ecological balance and operate traditional institutions and technologies.

Given all the facts, the positive approach would be to capitalise on the diversity of the available energy resources for specific purposes by minimising the constraints imposed by mountain specificities (ICIMOD 1995). The positive outlook would be to capture the opportunities generated by mountain specific characteristics rather than harping on the constraints.

6. PARADIGMS SHAPING THE PRESENT ENERGY USE PATTERN

The development paradigms which have shaped the present trend of unsustainable energy use patterns in the HKH region are briefly illustrated in the following paragraphs.

The agriculture-led development paradigm focussed on increasing the productivity of basic food crops to meet the objectives of food security without establishing sufficient infrastructure (access to market, information and technology, and the provision of energy) and associated costs to support the rural economy. In this process, the mountain-specific opportunities for growing high-value energy-intensive, agro-based or skill-based commodities always remained marginal. As a result no technological innovation occurred. Consequently, the quantity and quality of energy requirements received no attention and thus technological and institutional innovations in the energy sector did not occur.

The industrial development strategy completely neglected the fact that resource degradation and consequent change in the environment entailed a cost to the society. For example, forest resources, always viewed as a source of national revenue, led to large-scale felling in accessible mountains areas. Therefore, the accessibility of mountain areas became instrumental in the destruction of the environment rather than enhancing the economy. The regeneration of forest resources never received priority for investment in the name of providing social infrastructure in the mountains. The resources that were available in the mountains always found their way to the plains and whatever value-addition occurred it was to the advantage of the population living outside the mountain economy.

Fuelwood from forests remained a main source in the newly-created demand for energy (i.e., for incoming tourists, road construction, and cottage industries) without considering energy technology interventions or without expanding the supply base of the energy resources and cost of afforestation. The cost envisaged for fuelwood extraction from the forest was the opportunity cost of collection rather than its real resource cost. The new areas opening for tourism, as well as cottage industries, did not consider energy as a constraint that might pose a threat to their growth in future.

Traditional belief is that the emerging energy transition in the HKH region can be made sustainable with the provision of imported fossil fuels and by minimising the cost of transaction by improvement in accessibility. This is reflected in the increasing share of fossil fuels with increase in the per capita income level, even in Nepal where dependency on imported fuels is increasing. This strategy may be suitable in countries where mountain areas do not form a large part of the landmass, but this is not the case in largely mountainous countries.

7. LESSONS LEARNED

Prior to an understanding of rural dynamics, the imposition of the success story of a particular place on other places should be avoided. For example, the success of the biogas programme in China prompted energy experts to replicate the programme in Pakistan, but this failed miserably.

The methodological frameworks used to evaluate various technologies were different, because most experts based their evaluation to substantiate their own technology in circumstances in which there was a lack of sufficient information. For example, on the one hand, experts working in the field of agricultural residue-based technologies, such as briquetting and biomass gasifiers, tend to carry out financial analyses assuming the cost of the input energy source to be almost zero, in order to show a high profitability; on the other hand, experts working with biogas technologies tend to carry out economic analyses which incorporate the slurry value in the analysis to make the biogas plant option attractive.

Various studies indicate that availability and/or provision of energy alone does not necessarily trigger development processes in mountain regions. For example, The Report of the Task Force on Rural Electrification Impacts in Nepal (WECS 1988) concluded that "... *in the past the impacts of rural electrification have been minimal. For strong proponents of rural electrification this conclusion may be seen as a criticism that threatens the development aspirations of Nepal....... It does not mean there is no future for rural electrification.*" Similarly, the study on Linking Rural Electrification with Rural Development in Asia (ESCAP 1990) concluded that .... *electrification does not seem to induce economic development, unless as one element in a coordinated rural development effort. But ... electricity shortages can act as an important constraint to industrial growth.*"

'New and renewable energy programmes' were too often 'rural biased' ignoring the fact that urban areas could have been the right choice as an entry-point for the promotion of energy development activities. For example, the 'Improved Cookstoves' programmes were designed to be implemented in the rural areas where users do not perceive the opportunity cost of collecting fuelwood; instead programmes should have been designed to cater to the needs of the urban population who were paying the price for fuelwood and would have been interested in saving fuelwood to reduce their energy budget. Another interesting example is the failure and success of solar water heating systems in Himachal Pradesh, India, and Kathmandu, Nepal, respectively. A solar water heating system in Kathmandu has become a status symbol, whereas in Himachal

Pradesh it is considered the poor man's fuel because of high subsidies received in the past.

Also, the treatment of energy as an input to the production and consumption process rather than as an important element of sustainable human development has led to the present status of unsustainable use of energy.

A review of the present energy situation, examination of barriers imposed on the energy sector, and understanding the effects on and implications for the energy sector, as a result of mountain-specific situations clearly indicate a need to change the existing paradigm of energy development, especially as the present trend in energy use patterns in the context of the HKH region is not at all sustainable.

8. RETHINKING THE ENERGY DEVELOPMENT PARADIGM

A basic feature of the HKH region is that the majority of the population that lives in the countryside, quite removed from the amenities of modern cities and towns. These people are forced to lead simple lives, extracting virtually all their energy requirements from their environment. The price of this energy self-sufficiency, particularly for the poor and specifically for women and children, can be quite enormous in terms of human effort. This tedious and arduous labour is aggravated by the low efficiency of end-use devices. As a result: i) biomass is the principal fuel for cooking and space heating; ii) animate energy is the main source of mechanical energy; iii) the domestic sector is the main consumer of energy; and iv) cooking and space heating are the dominant end uses. People in the region are, therefore, bearing the cost of excessive reliance on traditional energy resources and technologies (as well as other economic activities due to mountain specific conditions) (Bajracharya 1986; Rijal et al. 1987; Junejo and Sharma 1994).

Emergence of New Development Philosophies and Their Energy Implications

Recognition of the dilemma between progress and human well-being has led to the emergence of two important development philosophies (WECD 1987; UNDP 1993; UNDP 1994; UNDP 1995).

1. The concept of sustainable development incorporating inter-generational equity with an emphasis on meeting basic needs and conserving environmental resources.
2. The concept of human development incorporating intra-generational equity with emphasis on 'universalism of life claims' and, to quote the Human Development Report 1994, "*the right of all human beings to a just opportunity to make use of their potential capabilities*"

These concerns stress that energy must be considered both as a critical input to socioeconomic development and as a source of environmental degradation as stated in Agenda 21, Chapter 9 (Keating 1993). It is also important to realise that energy is not an end in itself, but merely a means to the ultimate end of human development. The success of an energy strategy in the context of the HKH region depends on its relevance to development priorities and its adaptability to changing approaches and strategies in the mainstream of development.

The role of energy in development must be conceived both as a means to satisfy basic human needs and as an input to economic transformation. For example, energy is required not only to meet the increasing demand created by promotional activities to support on-going agricultural diversification and intensification in the HKH region, but also to meet the needs of poor people for provision of the basic necessities of food, shelter, and better health (Ramani et. al. 1995; Philips et. al. 1995; Vinod Kumar et. al. 1987; ILO 1987 Paul 1985; FAO 1993; Khator 1989). This has necessitated the redefinition of energy sector goals along with the reorientation of energy programmes to those that are sustainable from the perspective of mountain communities.

Redefining Energy Sector Goals

The objective of the energy system is to provide energy services. Energy services are the desired and useful products, processes, or services that result from the use of energy–for instance illumination, cooking, space conditioning, etc. The energy chain that delivers these services begins with the collection or extraction of primary energy, which is then converted into energy carriers that are suitable for end uses. These energy carriers are used in end-use devices to provide the desired energy services, as presented in Figure 16.

It is noteworthy that it is useful energy which determines the extent of fulfillment of energy needs and improvement in the physical quality of life. Therefore, better efficiency of energy use permits significant improvements in the physical quality of life without increase, or even decrease, in the amount of primary energy, while at the same time it reduces the release of effluents into the environment (Codoni et al. 1995). Also, when a particular energy carrier is used efficiently, or a shift is made into more efficient energy carriers, then inefficiently-used sources will be available for alternative uses. For example, large-scale dissemination of improved cooking stoves could possibly facilitate the use of animal dung as farmyard manure (Goldemberg 1988).

Mountain development and the related field of poverty alleviation are believed to be feasible if development is both equitable (in group, gender, generational dimensions) and sustainable in both its environmental and fiscal aspects (deLucia 1994; UNDP 1995). This would require a significant change in the energetics of mountain lives. The provision of energy thus needs to be considered from the point of view of the twin objectives: i) to ensure energy security; and ii) to sustain and increase economic growth.

i) *Energy Security*, i.e, a minimum level of the energy needed must be ensured in order to meet the basic needs of the mountain people. Energy security means that cooking and space heating are of prime importance for mountain communities and must be ensured. At this point, it is also important to estimate the required amount of energy in order to gauge the feasibility of its provision (Philips et al. 1995; Ramani et al. 1995).

ii) *Energy for Growth*, i.e., sufficient energy must be ensured to support economic growth as perceived by the countries of the HKH region. It is not sufficient to remove energy constraints alone. What is more important is the identification of the lead role that energy can play in increasing the productivity of the mountain population. This would mean that the energy requirements for agriculture, industry, and transport must be met.

These twin objectives are believed to be feasible if appropriate energy system transformations can be conceptualised and made sustainable.

9. ENERGY SYSTEM TRANSFORMATIONS

Energisation of mountain communities can be feasible only if appropriate technological interventions in terms of energy sources, technologies, and institutional mechanisms are conceived and translated into reality. Energy technology interventions with increased economic activities would lead towards breaking the vicious cycle of poverty and environmental degradation, as exemplified in Figure 17. If energy transformations are implemented appropriately, even the poor can contribute significantly to development, which in turn would positively affect their lives as well as the overall economy.

The appropriateness of technological intervention (energy resource, technology, and institution) needs to be assessed not only from the quality and quantity of energy services required but also in the context of the physical environment. For example, the quality of energy services required dictates the choice of energy resources (fuelwood, biogas, electricity), whereas the quantity required dictates the choice of energy technologies (decentralised, centralised) and institutions (private, public, participatory). The choice of particular energy resources, technologies, and institutions depends on technical parameters (availability of energy resources and technologies, prices, life and efficiency of the device), though the final selection should be based on social and cultural acceptability. All of these factors are location specific and require close scrutiny in the context of the mountain-specific situation.This would mean that mountain-specific opportunities and constraints should be considered in designing a package for energy technology interventions.

The development process in the mountains should be accompanied by energy system transformations which include (Philips et al. 1995; Goldemberg 1988; World Bank 1993; Monga et al. 1992), but are not limited to: i) increased availability of renewable energy and energy-technology supply infrastructures; ii) introduction and/or increased use of energy conversion devices to alleviate human drudgery and boost productivity; iii) an increase in productivity which facilitates off-farm employment; iv) improved efficiency of use; v) higher value use of energy forms; and vi) increased use of efficient devices.

Sustainable human development could be achieved if energy systems' transformation means a movement towards the model that embodies (Ramani et al. 1995; deLucia 1994; UNDP 1995):

- lower system supply costs (infrastructure, technology) for any and all types of energy systems;
- improved environmental sustainability through greater reliance on renewable energy and improvement in the supply chains of traditional fuels;
- greater financial sustainability reflective of user's preference, ability, and willingness to pay;
- adoption of a system in a manner that maximises both direct and indirect benefits; and
- use and development of alternative institutional and financial approaches and incentives by all key players – international agencies, government at all levels, NGOs, and the communities themselves.

10. FACTORS AFFECTING ENERGY SYSTEM TRANSFORMATIONS

The following factors might significantly affect energy system transformations in the context of the HKH region and need further deliberation.

Energy Resources and Technology: Access and Availability

Availability of energy resources and their quality are the prime determinants of energy use behaviour, followed by access to and abundance of a particular source of energy. For example, unavailability of kerosene and LPG (liquid petroleum gas) in the mountains induces people to exploit forest resources, compromising their most efficient economic use (deLucia 1993). This is a consequence of the fact that energy needs cannot be substituted, though there is a possibility of trade-off between labour and energy. Even when available, access to energy may be denied to some of the mountain people due to market and non-market factors, e.g., pricing, finance, and policy. On the one hand, affordability becomes a prime concern in regard to access to high-grade energy resources, on the other, subsidies may preclude supply entities in finance investment in mountain areas which could hamper the process of energy systems' transformation.

Energy and Other Infrastructure: A Complementary Issue

Changes in mountain energetics are necessary, though they are not sufficient to facilitate sustainable environment-friendly development. Other infrastructural development activities as well as income-generating activities associated with credit facilities are also crucial (World Bank 1994). At the same time, a decentralised institutional structure and identification of appropriately-designed technology with in-built institutional attributes need to be packaged for intervention in mountain communities.

Energy Services to Exceed Subsistence: Poverty Elimination through Employment Generation

At first, energy services must be ensured for the poor and disadvantaged mountain population to fulfill basic energy requirements. Once access to energy resources are secured for the fulfillment of basic needs, they must be made available to support development. This task is feasible only if energy system transformation is envisaged for improvement of the economic conditions of the poor (Goldemberg et al. 1989; Philips et al. 1995).

Though the exact patterns of energy system transformations may vary, they are, nevertheless, necessary. Efficient energy and related technology-focussed interventions supporting such transformations should be capable of generating employment opportunities by being linked appropriately with income-generating activities in order to reduce poverty.

Mountain Energy Development as Part of the Food, Fuel, Fodder, Fertiliser and Fibre Systems

It is important to understand the overall, food, fuel, fodder, fertiliser and fibre systems (F5) in considering the possibilities for transforming energy systems to support economic development. In the HKH region, F5 systems are intertwined in many ways. For example, the same resource – biomass – can be used as a fuel, fertiliser, or building material (Rijal 1987; Rijal 1991). Similarly, the same technology – a traditional cooking stove – is employed for cooking, space heating, or lighting (ICIMOD 1986). This is not to imply that resources and technologies cannot have competitive or complementary uses. Rather, the relationships and competition for scarce resources – and complementarities in the use of these resources–are quite complex, and understanding these problems as scarce resource endowments is often critical to understanding the possibilities for development that are equitable and sustainable and can be facilitated through cost-effective interventions.

Transforming Animals and Animal Energetics

Animals and animal energetics are important in both subsistence and market-based development phases, the value of the multiple outputs of animal husbandry and how it affects the alleviation of drudgery, increased productivity, and overall livelihood of the household are significant (ILO 1987; Omvedt et. al. 1995). This aspect is dependent on the energy transformation capacity of animals, as they can transform grasses, leaves, cereals, and so on into various valuable outputs (deLucia 1993). Through this capacity there is a transformation into the stated valuable service and product outputs with significant embodied energy.

Accounting for Gender, Generational and Group Dimensions

Too often in the past, interventions were made without giving attention or priority to the gender, generational, or group aspects. For example, there are cases in which biogas technologies change the value of dung for the highest income households who own cattle. The poor who previously collected dung for fuel are now deprived of this fuel (WECS and CIDA 1991; Overholt 1995; Omvedt 1995; deLucia 1994). Such shortcomings and/or failures caused by ignoring gender, generational, or group dimensions, or by having a myopic single-sector focus can result, for instance, in examining only the labour requirements for household and crop and/or tree production and ignoring the requirements for other activities. This results in failed interventions.

Energy and related technology-focussed interventions must take into account gender, generational, and group dimensions. The work demands of the poor are burdensome, and their productivity is low. Lessening this burden and increasing productivity are essential to poverty alleviation. Hence, the importance of interventions that raise labour productivity. Particular priority must be given to measures that facilitate the increased productivity of the poor, including women. It is also important to understand how access to various energy resources and technologies differs according to class, gender, and generation.

At the same time, dwindling fuelwood reserves force the rural people, particularly women, to spend a significant portion of their time collecting fuelwood. In many areas, scarcity and the high price of fuelwood forces rural people to increase the use of agricultural waste and animal dung, with an obvious detrimental effect on soil fertility.

Energy and Environmental Linkages: Global Concerns

The production and use of energy contributes negatively to the environment. It is widely believed that, if the present trend of energy consumption continues, it will create environmental problems which, in the long run, could become a constraint for economic growth and social well-being.

The most prominent globally recognised problem is that of greenhouse gases. Carbon dioxide, methane, and nitrous oxide, the main greenhouse gases, are emitted mainly from combustion of fossil fuels, deforestation, and biomass burning. Energy is estimated to account for more than half of the global greenhouse gases (PEP Project 1995). The energy-related emission in the HKH is modest if estimated on the regional level, but it is rising at an alarming rate in urban areas. Illustrating this phenomenon are urban centres, such as Kathmandu and Dehra Dun, which have already become some of the most polluted places in the region in terms of fossil fuel-related emissions. The emission of greenhouse gases caused by deforestation and biomass burning is bound to increase in the event of the economic transformation foreseen for poverty elimination and development of the mountain population, as it will mean an increase in the demand for useful energy (i.e., heat, light, and shaft power).

Population growth is placing extreme pressure on the region's forest resources. This, in turn, contributes to landslides, soil erosion, and flooding, thereby endangering the lives of thousands of people every year. Furthermore, the possibility of substituting fuelwood with commercial fuels in mountain areas is limited, mainly for two reasons. First, fuelwood collection is a subsistence type of non-monetised activity – it is free if the labour cost is not considered. Second, the cost of distribution of commercial fuel is very high. Unless the cost of fuelwood rises considerably, as a result of physical or economic scarcity, this situation is not expected to change; the rural population, for whom per capita income is less than US $ 100, cannot afford to use modern fuels.

The intricate relationship which exists between energy-economy-environment is understood generally. However, there is a lack of knowledge concerning the dynamic linkage among these sectors because of the weak database and lack of analytical capabilities.

Public Health and Poverty Linkages

Of particular concern is the health impact associated with the household use of traditional fuels. This issue has important linkages to the gender and generational aspects. The majority of the people, especially women and children, are seriously affected by exposure to very high concentrations of emissions as a result of cooking with low-grade fuels and with stoves in poorly ventilated environments (deLucia 1993; Rijal 1994). An energy system transformation that reduces health risks as well as poverty must be promoted.

Proper evaluation and understanding of these factors will lead to the development of sustainable energy programmes to promote the energy systems' transformation process in the mountains.

11. CONCLUSION

The region's concern to substantially uplift the living standards of the mountain populations requires transformation of the energy systems to sustain economic transitions from subsistence to market, besides providing energy services for fulfillment of basic needs. A major challenge is that of creating an atmosphere for the transformation of energy systems without disrupting the ecosystemic balance of the mountains.

Table 1: Development Indicators of the Countries of the HKH Region

Descriptions	Population in Millions 1992	Area Th. Sq.km. 1992	People in Ab. Poverty % 1992	Adult Literacy % 1992	Infant Mort. (per 1000 births) 1992	GNP per Capita US $ 1992	HDI Index 1992	Industrialisation Ratio % 1992	Urbanisation Ratio % 1992	Pop. Without Access to Health % 1992	Pop. Without Access to Water % 1992
Afghanistan	21.5	652.2	47	29			0.21			46	71
- HKH only	14.5	390.5									
Bhutan	1.5	46.5		38	129	180	0.15	36	6	33	73
- HKH only	1.5	46.5									
Bangladesh	114.4	144.0	81	35	91	220	0.31	26	18	42	
- HKH only	1.2	13.2									
China	1162.2	9581.0	9	73	31	470	0.65	34	27	10	18
- HKH only	19.9	1647.7									
India	883.6	3287.3	40	48	79	310	0.38	44	26		
- HKH only	37.3	482.9									
Myanmar	43.7	677.0	35	81	72	230	0.41	17	25	52	69
- HKH only	5.9	280.9									
Nepal	19.1	147.2	65	26	99	170	0.29	26	12		62
- HKH only	19.1	147.2									
Pakistan	119.3	796.0	29	35	95	420	0.39	45	33	11	55
- HKH only	23.2	404.2									
Regional Average			26	59	56	384	0.51	37	26	9	14
Regional Total	2365.3	15331.2									
HKH Average											
HKH Total	122.6	3413.0									

Source :

1. Statistical Abstract - INDIA (1984), Central Statistical Organisation, Ministry of Planning, GOI, India (1985)
2. Basic Statistics of North Eastern Region, North Eastern Council, GOI, Shillong (Statistical Abstract - INDIA (1984)
3. Statistical Hand Book of Bhutan (1985), Statistics Division, Planning Commission, Thimpu (1985)
4. Statistical Yearbook of Bhutan (1987), Central Statistical Office, Planning Commission, Thimpu (1987)
5. China: A Statistics Survey in 1985, State Statistical Bureau, China (1985)
6. Demographic Trends in China from 1950 to 1982, Hill Kenneth, World Bank Discussion Papers, The World Bank (1988)
7. Population Estimates by Province, District and Sub-district: Afthanistan, UNIDATA (1991)
8. Statistical Yearbook of Bangladesh - 1992, Bangladesh Bureau of Statistics, Ministry of Planning, Dhaka (1993)
9. Pakistan Statistical Yearbook - 1992 & 93, Federal Bureau of Statistics, Govt. of Pakistan (1993)
10. Statistical Yearbook of Nepal - 1993, Central Bureau of Statistics, National Planning Commission, Kathmandu (1993)
11. Statistical Yearbook - 1991, Central Statistical Organisation, Yangoon, Myanmar (1992)
12. Sharma, P. (comp.), Population and Employment Division, ICIMOD (1993)
13. Human Development Report, 1993 and 1994, UNDP

Table 2: Energy Consumption Pattern in the Countries of the HKH Region, 1992

Energy Forms	Units	Afgha-nistan	Bhutan	Bangla-desh	China	India	Myanmar	Nepal	Pakistan	Total
Hard Coal	'000 MT	8	18	338	1090809	240405	34	92	4222	1335926
Coke	'000 MT	0	0	0	78999	10800	10	0	737	90546
Lignite	'000 MT	0	0	0	0	16560	39	0	0	16599
Fuelwood	'000 M3	19852	1842	7900	611295	549347	22358	15569	17065	1245229
Ag. & Animal Residue	'000MT	1985	92	29033	339820	376303	360	2425	10784	760800
LPG	'000 MT	0	4	8	3508	2760	4	6	151	6441
Motor Gasolene	'000 MT	82	3	106	25753	3762	121	19	1131	30977
Kerosene	'000 MT	10	5	424	4322	9597	11	97	607	15073
Jet Fuel	'000 MT	83		24		1100	19	19	431	1676
Diesel	'000 MT	125	15	1042	35290	24430	272	147	5026	66347
Fuel Oil	'000 MT	2	0	444	34545	10050	115	10	3298	48464
Natural Gas	TJ	73732	0	195306	614720	455760	37950	0	467310	1778419
Electricity	Million kWh	834	185	9554	758920	329340	2674	926	51972	1154405
- Thermal	"	225	7	8758	621470	251285	1395	61	30965	914166
- Hydro	"	478	1620	796	132470	69848	1279	870	20582	227943
- Nuclear	"					6784			425	7173
- Geothermal	"					32				32
Import	"	131	3		4980	1500		80		6694
Export	"		1445			73		85		1603
Final Energy Consumption Pattern Units : '000 GJ										
Biomass Fuels		257282	22712	458240	11433882	11168770	266129	212709	335536	24155259
Petroleum Products		13606	1261	94502	4801950	2392089	25007	13719	489803	7831938
Natural Gas		7373	0	195306	614720	455760	37950	0	467310	1778419
Coal		202	454	8518	29858357	6680286	1859	2318	128504	36680497
Electricity - Renewables		2192	641	2866	494820	280998	4604	3114	75625	864860
Total		280655	25068	759431	47203729	20977902	335550	231860	1496779	71310974
Traditional Energies		257282	22712	458240	11433882	11168770	266129	212709	335536	24155259
Commercial Energies		23373	2356	301192	35769847	9809133	69421	19151	1161243	47155715
Units : 'MJ per Capita										
Biomass Fuels		11945	15141	4006	9838	12640	6090	11160	2813	9204
Petroleum Products		632	841	826	4132	2707	572	720	4106	1817
Natural Gas		342	0	1707	529	516	868	0	3917	985
Coal		9	302	74	25691	7560	43	122	1077	4360
Electricity - Renewables		102	427	25	426	318	105	163	634	275
Total		13031	16712	6638	40616	23741	7678	12165	12546	16641
Traditional Energies		11945	15141	4006	9838	12640	6090	11160	2813	9204
Commercial Energies		1085	1571	2633	30778	11101	1589	1005	9734	7437
Unit: % of total										
Biomass Fuels		91.7%	90.6%	60.3%	24.2%	53.2%	79.3%	91.7%	22.4%	33.9%
Petroleum Products		4.8%	5.0%	12.4%	10.2%	11.4%	7.5%	5.0%	32.7%	11.0%
Natural Gas		2.6%	0.0%	25.7%	1.3%	2.2%	11.3%	0.0%	31.2%	2.5%
Coal		0.1%	1.8%	1.1%	63.3%	31.8%	0.6%	1.0%	8.6%	51.4%
Electricity - Renewables		0.8%	2.6%	0.4%	1.0%	1.3%	1.4%	1.3%	5.1%	1.2%
Total		100%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Traditional Energies		91.7%	90.6%	60.3%	24.2%	53.2%	79.3%	91.7%	22.4%	33.9%
Commercial Energies		8.3%	9.4%	39.7%	75.8%	46.8%	20.7%	8.3%	77.6%	66.1%

Note : 1/ includes hydro, nuclear, and geothermal

Source : 1. Energy Statistics Year book 1990, 1991, 1992, United Nations (1994)
2. Energy Indicators of Developing Member Countries of ADB, ADB, Manilla (1992)

Table 3: Energy Resource Base in the Countries of the HKH Region

Energy Forms	Unit	Afgha-nistan	Bhutan	Bangla-desh	China	India	Myan-mar	Nepal	Pakistan	Total
Coal	000 MT	112000		1054000	286400000	131254000	5000		28590	418853590
Oil	000 MT			4983	3264000	810000	7000		28826	4114809
Natural Gas	Mil. M3	100000		360000	1127000	730000	265000	5	728000	3310005
Uranium	MW					10000			10000	20000
Peat	000 MT			138000	4687000	10571167			0	15396167
Geothermal	Mwh								30000	0
Hydro	MW		2000	1400	335000	150000	20000	83000	2642	639400
Wind	MW					20823		15		23480
Wave	Mwh									0
Biomass	000 MT	15882	1382	34563	767726	767726	16011	13323	22729	1632460
Solar	MW	130400	28800	28800	1912200	1912200	127953	26649	159200	3052202
Note: a/- sufficient for 10000 MW development										
Coal	Mil. GJ	2822	0	26561	7217280	3307601	126	0	720	10555110
Oil	Mil. GJ	0	0	229	150144	37260	322	0	1326	189281
Natural Gas	Mil. GJ	3600	0	12960	40572	26280	9540	0	26208	119160
Uranium	Mil. GJ	0	0	0	0	158	0	0	158	315
Peat	Mil. GJ	0	0	2484	84366	190281	0	0	0	277131
Geothermal	Mil. GJ	0	0	0	0	0	0	0	0	0
Hydro	Mil. GJ	0	315	22	5282	2365	315	1309	473	10082
Wind	Mil. GJ	0	0	0	0	328	0	0	42	370
Wave	Mil. GJ	0	0	0	0	0	0	0	0	0
Biomass	Mil. GJ	233	20	506	11247	11146	235	195	333	23916
Average Insolation	Mil. GJ	2056	148	454	30152	10369	2018	420	2510	48127
Total	Mil. GJ	8711 0%	484 0%	43217 0%	753943 67%	3585788 32%	12555 0%	1925 0%	31770 0%	11223493 100%
Renewable	Mil. GJ	2289 3%	484 1%	983 1%	46681 57%	24209 29%	2567 3%	1924 2%	3358 4%	82495 100%
Non-renewable	Mil. GJ	6422 0%	0 0%	42234 0%	7492362 67%	3561579 32%	9988 0%	0 0%	28412 0%	11140998 100%
										Average
Yearly Supply Potential MJ/Capita		112232 1.0	322545 2.8	15972 0.1	169100 1.5	108013 0.9	63324 0.5	100964 0.9	32910 0.3	115633 1.0
Renewable		106269 1.2	322545 3.7	8589 0.1	40166 0.5	27398 0.3	58752 0.7	100964 1.2	28147 0.3	86604 1.0
Non-renewable #/		5964 0.2	0 0.0	7384 0.3	128934 4.4	80615 2.8	4571 0.2	0 0.0	4763 0.2	29029 1.0
Energy Density GJ/sq.km.		3707 0.3	10294 0.8	12689 1.0	20555 107	29027 203	4088 0.3	13648 1.1	4932 0.4	12368 1.0
Renewable		3510 0.5	10294 1.5	6823 1.0	4882 0.7	7363 1.1	3792 0.6	13648 2.0	4219 0.6	6816 1.0
Non-renewable #/		197 0.0	0 0.0	5866 1.1	15673 2.8	21664 3.9	295 0.1	0 0.0	714 0.1	5551 1.0

Note: #/- Non-renewables being consumed within 50 years

Source: 1. Energy Statistics Year Book 1990, 1991, 1992, United Nations (1994)
2. Energy Indicators of Developing Member Countries of ADB, ADB, Manila (1992)

Table 4a: Per Capita Final Energy Consumption in the Domestic Sector of the HKH Region

Description	Fuel-wood	Agric. Residue	Animal Dung	Biogas	Total Bio-mass	Kerosene	Electri-city	Coal	LPG	Total Com-mercial	Total
Natural Unit per Capita	kg	kg	kg	MJ		lit	kWh	kg	kg		
Nepal	450	164	105	0		8	12	0	0		
- Mountain	657	75	121	0		2	5	0	0		
- Hills	527	172	7	0		6	11	0	0		
- Terai	354	174	178	0		10	14	0	0		
India											
- Jammu & Kashmir	392	33	248	0		26	136	0	0		
- Himachal	874	198	59	0		8	106	0	0		
- Uttarakhand (U.P.)	577	87	0	0		6	19	0	0		
- Sikkim	447	52	0	0		12	7	0	0		
- North-eastern States	547	181	0	0		13	38	0	0		
- West Bengal	527	172	7	0		6	11	0	0		
Bhutan	1848	0	0	0		6	9	0	0		
China											
- Ningnan County	358	402	0	44		3	16	15	0		
Pakistan											
- Swat District	719	20	12	0		6	62	0	19		

Source:
1. Energy, Environment and Sustainable Development in the Himalayas, ed. Monga, P. and Ramana, P.V., Indus Publishing Company, New Delhi (1992)
2. Himalayan Energy Systems, ed. Dhar, T.N. and Sharma, P.N., Gyanodaya Prakashan, Nainital, India (1987)
3. A Case Study in Energy Planning and Management in Mountain Districts, Thimphu, Bhutan, MIT Series No. 1, ICIMOD, Kathmandu (1991)
4. A Case Study in Energy Planning and Management in a Mountain County, Ningnan China, MIT Series No. 2, ICIMOD, Kathmandu (1991)
5. A Case Study in Energy Planning and Management in Mountain Districts, Almora District, India, MIT Series No. 3, ICIMOD, Kathmandu (1991)
6. A Case Study in Energy Planning and Management in Mountain Districts: Kulu, Himachal Pradesh, India, MIT Series No. 4, ICIMOD, Kathmandu (1991)
7. A Case Study in Energy Planning and Management in Mountain Districts: Dhading District, Nepal, MIT Series No. 5, ICIMOD, Kathmandu (1991)
8. A Case Study in Energy Planning and Management in Mountain Districts: Swat District, Pakistan, MIT Series No. 6, ICIMOD, Kathmandu (1991)
9. Energy Sector Synopsis Report, Water & Energy Commission Secretariat, Kathmandu (1995).
10. Perspective Energy Plan for Nepal, NPC/UNDP National Execution Project, Kathmandu (1995).

Table 4b: Per Capita Final Energy Consumption in the Domestic Sector of HKH Region

Descriptions Unit : MJ per Capita	Fuelwood	Agric. Residue	Animal Dung	Biogas	Total Biomass	Kerosene	Electricity	Coal	LPG	Total Commercial	Total
Nepal											
	7522	2071	1140	0	10733	286	43	0	0	329	11062
- Mountain	68%	19%	10%	0%	97%	3%	0%	0%	0%	3%	100%
	10979	947	1317	0	13242	58	17	0	0	75	13317
- Hills	82%	7%	10%	0%	99%	0%	0%	0%	0%	1%	100%
	8803	2167	81	0	11050	217	38	0	0	255	11305
- Terai	78%	19%	1%	0%	98%	2%	0%	0%	0%	2%	100%
	5912	2191	1941	0	10044	380	52	0	0	432	10476
	56%	21%	19%	0%	96%	4%	0%	0%	0%	4%	100%
India											
- Jammu & Kashmir	6542	412	2703	0	9657	957	490	0	0	1446	11103
	59%	4%	24%	0%	87%	9%	4%	0%	0%	13%	100%
- Himachal	14591	2501	646	0	17737	288	382	0	0	670	18407
	79%	14%	4%	0%	96%	2%	2%	0%	0%	4%	100%
- Uttarakhand (U. P.)	9635	1096	0	0	10731	228	70	0	0	298	11029
	87%	10%	0%	0%	97%	2%	1%	0%	0%	3%	100%
- Sikkim	7457	651	0	0	8109	420	26	0	0	446	8555
	87%	8%	0%	0%	95%	5%	0%	0%	0%	5%	100%
- North-eastern States	9131	2282	0	0	11413	456	137	0	0	593	12006
	76%	19%	0%	0%	95%	4%	1%	0%	0%	5%	100%
- West Bengal	8803	2167	81	0	11050	217	38	0	0	255	11305
	78%	19%	1%	0%	98%	2%	0%	0%	0%	2%	100%
Bhutan	30862	0	0	0	30862	227	33	0	0	259	31121
	99%	0%	0%	0%	99%	1%	0%	0%	0%	1%	100%
China	5979	5071	0	44	11094	117	58	376	0	551	11645
- Ningnan County	51%	44%	0%	0%	95%	1%	1%	3%	0%	5%	100%
Pakistan	12001	254	131	0	12386	218	223	0	563	1004	13389
- Swat District	90%	2%	1%	0%	93%	2%	2%	0%	4%	7%	100%

Source: Table 4a

Table 5: Per Capita Useful Energy Consumption in Lekhgaun Village of the HKH Region, 1990

Descriptions	Population Nos.	Altitude Mtrs. (msl)	Human Labour MJ	Animal Labour MJ	Fuelwood MJ	Agric. Residue MJ	Animal Dung MJ	Total Tradi. MJ	Electricity MJ	Diesel MJ	Kerosene MJ	Motive Appl. MJ	Chemical Fert. MJ	Total Comm. MJ	MJ	TOTAL %
Lekhgaun	3855	1176														
Domestic								0.0								
- Cooking					1502.7	36.8		1539.6						0.0	1539.6	
- Heating					1902.7			1902.7						0.0	1902.7	
- Lighting								0.0			2.3			2.3	2.3	
Total			0.0	0.0	3405.4	36.8	0.0	3442.3	0.0	0.0	2.3	0.0	0.0	2.3	3444.6	65%
			0%	0%	99%	1%	0%	100%	0%	0%	0%	0%	0%	0%	100%	
Farm Activities																
- Ploughing			136.4	303.8				440.2						0.0	440.2	
- Weed/Planting			74.4					74.4						0.0	74.4	
- Irrigation			31.4					31.4						0.0	31.4	
- Harvesting			99.4					99.4						0.0	99.4	
- Threshing			62.0	164.7				226.7						0.0	226.7	
- Others			13.2				341.6	354.9					14.5	14.5	369.4	
Total			416.9	885.3	0.0	0.0	341.6	1643.8	0.0	0.0	0.0	0.0	14.5	14.5	1241.5	23%
			34%	71%	0%	0%	28%	132%	0%	0%	0%	0%	1%	1%	100%	
Commercial Sector																
- Cooking					17.7			17.7						0.0	17.7	
- Heating								0.0						0.0	0.0	
- Lighting								0.0			0.1			0.1	0.1	
Total			0.0	0.0	17.7	0.0	0.0	17.7	0.0	0.0	0.1	0.0	0.0	0.1	17.8	0%
			0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	
Village Industry																
- Weav./Mat making			38.9					38.9						0.0	38.9	
- Agro-processing			11.4					11.4				15.6		15.6	27.0	
- Black Smithy			3.9		54.5			58.4						0.0	58.4	
- Alcohal Brewing								0.0						0.0	0.0	
Total			54.2	0.0	54.5	0.0	0.0	108.7	0.0	0.0	0.0	15.6	0.0	15.6	124.3	2%
			44%	0%	44%	0%	0%	87%	0%	0%	0%	13%	0%	:3%	100%	
Transportation																
- within Village			411.4					411.4						0.0	411.4	
- Farm Activities			249.5					249.5						0.0	249.5	
- Fodder Collection			48.5					48.5						0.0	48.5	
- Agro-processing			21.0					21.0						0.0	21.0	
- Drinking Water			57.3					57.3						0.0	57.3	
- Others			35.0					35.0						0.0	35.0	
- To & From Village			95.7					95.7						0.0	95.7	
Total			507.1	0.0	0.0	0.0	0.0	507.1	0.0	0.0	0.0	0.0	0.0	0.0	507.1	2%
			100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	10%
TOTAL			978.2	885.3	3477.7	36.8	341.6	5719.7	0.0	0.0	2.4	15.6	14.5	32.5	5335.3	100%
			18%	17%	65%	1%	6%	107%	0%	0%	0%	0%	0%	1%	100%	

Source : Rijal, K., Technology Assessment, Planning and Modelling of Rural/Decentralised Energy Systems in Nepal, Ph. D. Dessertation, IIT, Delhi (1991)

Table 6: Per Capita Useful Energy Consumption in Marpha Village of the HKH Region, 1990

Descriptions	Population Nos.	Altitude Mtrs. (masl)	Human Labour MJ	Animal Labour MJ	Fuelwood MJ	Agric. Residue MJ	Animal Dung MJ	Total Tradi. MJ	Electricity MJ	Diesel MJ	Kerosene MJ	Motive Appl. MJ	Chemical Fertilizer MJ	Total Comm. MJ	MJ	TOTAL %
Marpha	1212	2660														
Domestic								0.0								
- Cooking					2267.3			2267.3						0.0	2267.3	
- Heating					14669.1			14669.1						0.0	14669.1	
- Lighting								0.0	23.1					23.1	23.1	
Total			0.0	0.0	16936.5	0.0	0.0	16936.5	23.1	0.0	0.0	0.0	0.0	23.1	16959.6	79%
			0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	
Farm Activities																
- Ploughing			60.2	101.5			296.2	161.7						0.0	161.7	
- Weed/Planting			71.0	68.5			296.2	139.4						0.0	139.4	
- Irrigation			40.4				35%	40.4						0.0	40.4	
- Harvesting			52.8					52.8						0.0	52.8	
- Threshing			47.0	5.0				52.0						0.0	52.0	
- Others			12.4	38.8				347.4					56.1	56.1	403.5	
Total			283.8	213.7	0.0	0.0		793.7	0.0	0.0	0.0	0.0	56.1	56.1	849.8	4%
			33%	25%	0%	0%		93%	0%	0%	0%	0%	7%	7%	100%	
Commercial Sector																
- Cooking					379.1			379.1	4.3					4.3	383.4	
- Heating					217.0			217.0	21.3					21.3	238.3	
- Lighting								0.0	0.5					0.5	0.5	
Total			0.0	0.0	596.1	0.0	0.0	596.1	26.1	0.0	0.0	0.0	0.0	26.1	622.2	3%
			0%	0%	96%	0%	0%	96%	4%	0%	0%	0%	0%	4%	100%	
Village Industry																
- Weav./Mat making			42.9					42.9						0.0	42.9	
- Agro-processing			17.3					17.3	18.2			11.6		29.7	47.0	
- Black Smithy			5.8		104.8			110.6						0.0	110.6	
- Alcohol Brewing			20.6		493.4			514.0	10.7					10.7	524.8	
Total			86.6	0.0	598.2	0.0	0.0	684.8	28.9	0.0	0.0	11.6	0.0	40.4	725.2	3%
			12%	0%	82%	0%	0%	94%	4%	0%	0%	2%	0%	6%	100%	
Transportation																
- within Village			335.8	37.1				372.9						0.0	372.9	
- Farm Activities			245.9					245.9						0.0	245.9	
- Fodder Collection			28.1	26.4				54.5						0.0	54.5	
- Agro-processing			8.3					8.3						0.0	8.3	
- Drinking Water			28.1					28.1						0.0	28.1	
- Others			25.6	10.7				36.3						0.0	36.3	
- To & from Village			552.0	1450.5				2002.5						0.0	2002.5	9%
Total			887.8	1487.6	0.0	0.0	0.0	2375.4	0.0	0.0	0.0	0.0	0.0	0.0	2375.4	11%
			37%	63%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	
TOTAL			1258.3	1701.3	18130.8	0.0	296.2	21386.6	78.1	0.0	0.0	11.6	56.1	145.7	21532.3	100%

Source : Rijal, K., Technology Assessment, Planning and Modelling of Rural/Decentralised Energy Systems in Nepal, Ph. D. Dessertation, IIT, Delhi (1991)

Table 7: Final Energy Consumption Pattern in the Rural and Urban Residential Sectors of Nepal

Type of Fuel	Rural Areas		Urban Areas	
	MJ/Capita	Percent	MJ/Capita	Percent
Fuelwood	10688	71%	7800	82%
Agric. Residue	2596	17%	260	3%
Animal Dung	1373	9%	540	6%
Total Traditional	14657	98%	8600	90%
Kerosene	290	2%	485	5%
LPG	0	0%	123	1%
Electricity	25	0%	292	3%
Coal/Coke	0	0%	10	0%
Total Commercial	315	2%	910	10%
TOTAL	14972	100%	9510	100%

Source: Energy Sector Synopsis Report, Supporting Doc. 1, PEP, WECS, 1995.

Figure 1: Human Development in the Countries of the Region

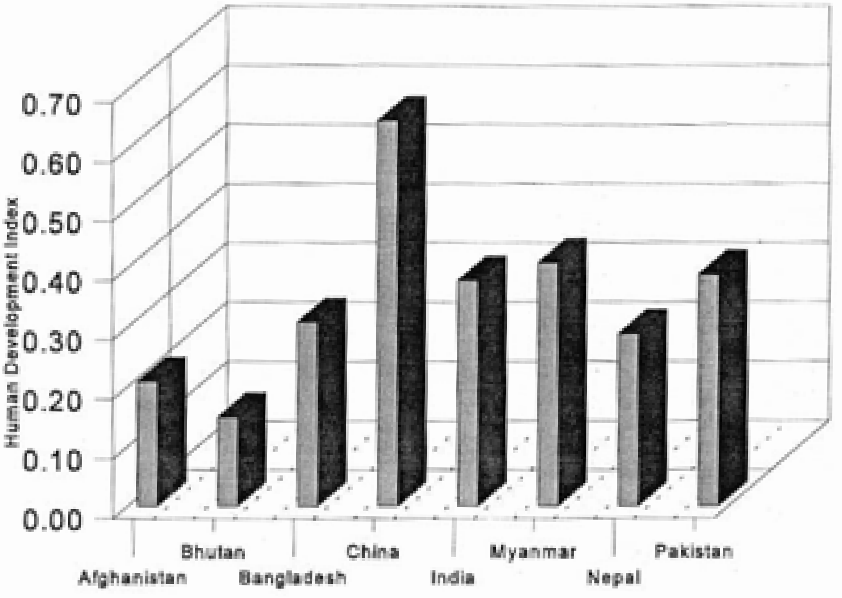


Figure 2: Adult Illiteracy in the Countries of the HKH Region (%)

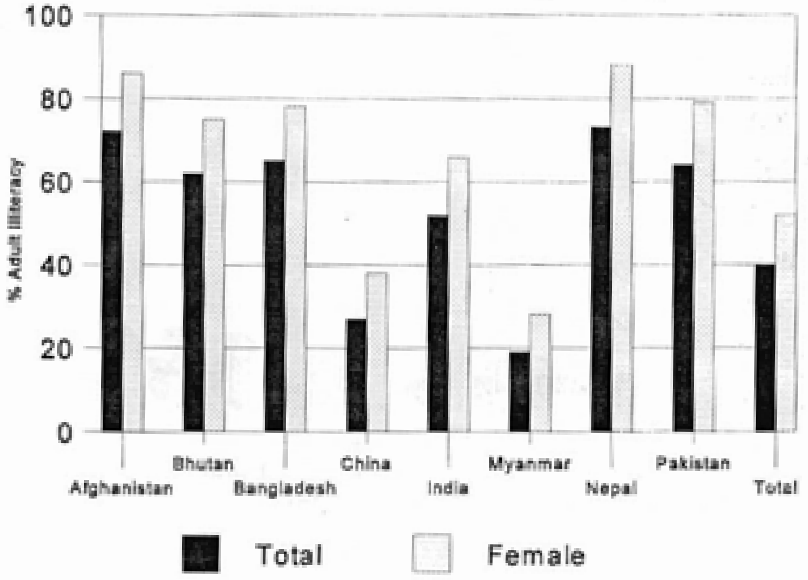


Figure 3: Infant Mortality Rate in the Countries of the HKH Region

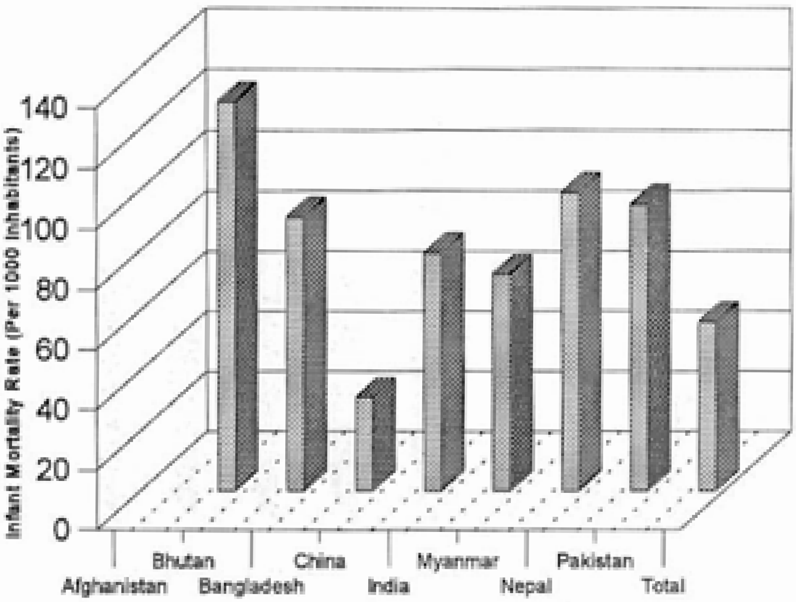


Figure 4: Population Density in the Countries of the HKH Region

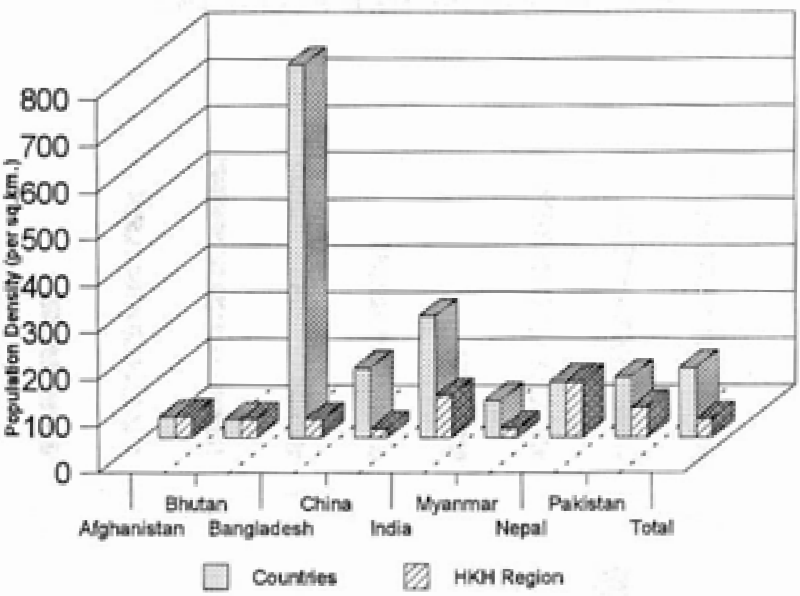


Figure 5: People in Absolute Poverty in the Countries of the HKH Region

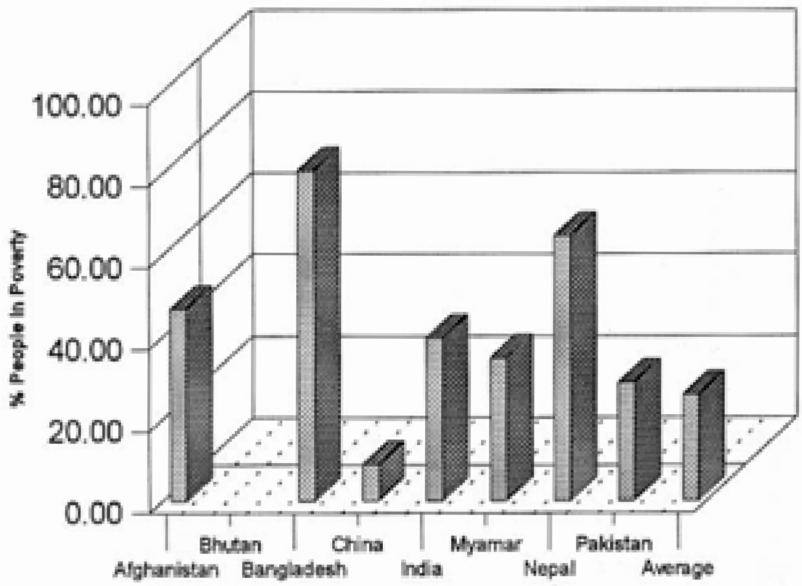


Figure 6: People without Access to Health Services in the Countries of the HKH Region (%)

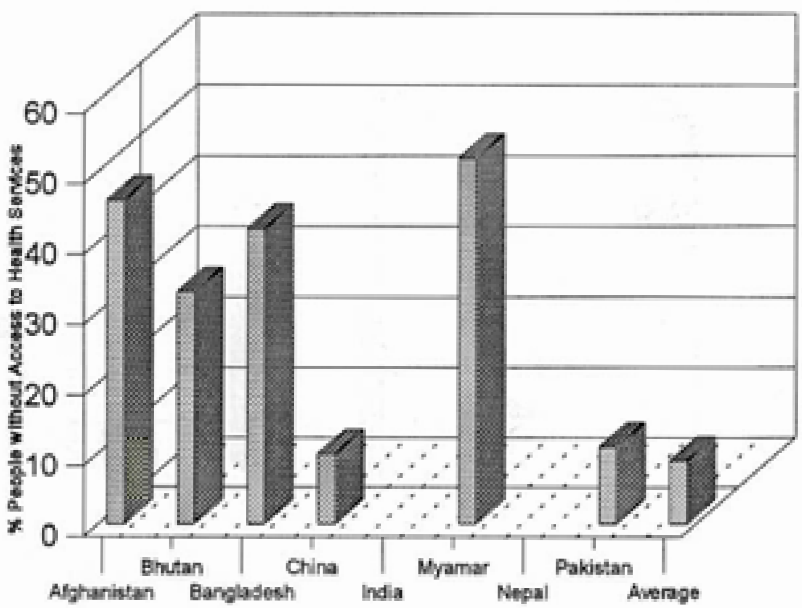


Figure 7: Per Capita Electricity Production
in the Countries of the HKH Region

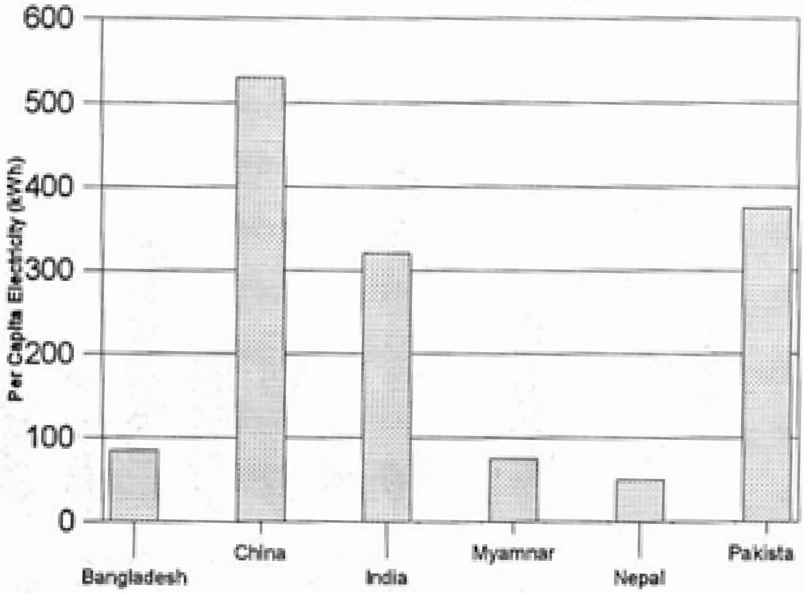


Figure 8: Commercial Energy Intensity
in the Countries of the HKH Region

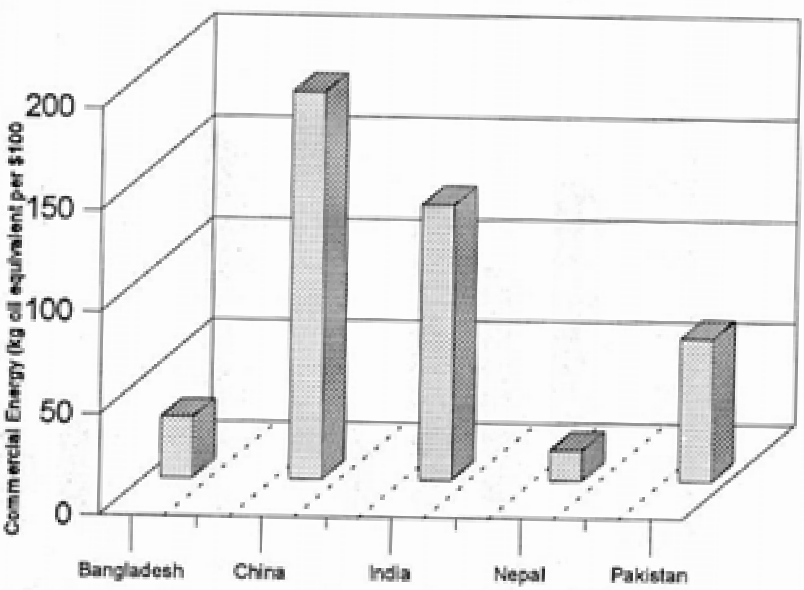


Figure 9

Relationship between Urbanisation and Commercial Energy Consumption

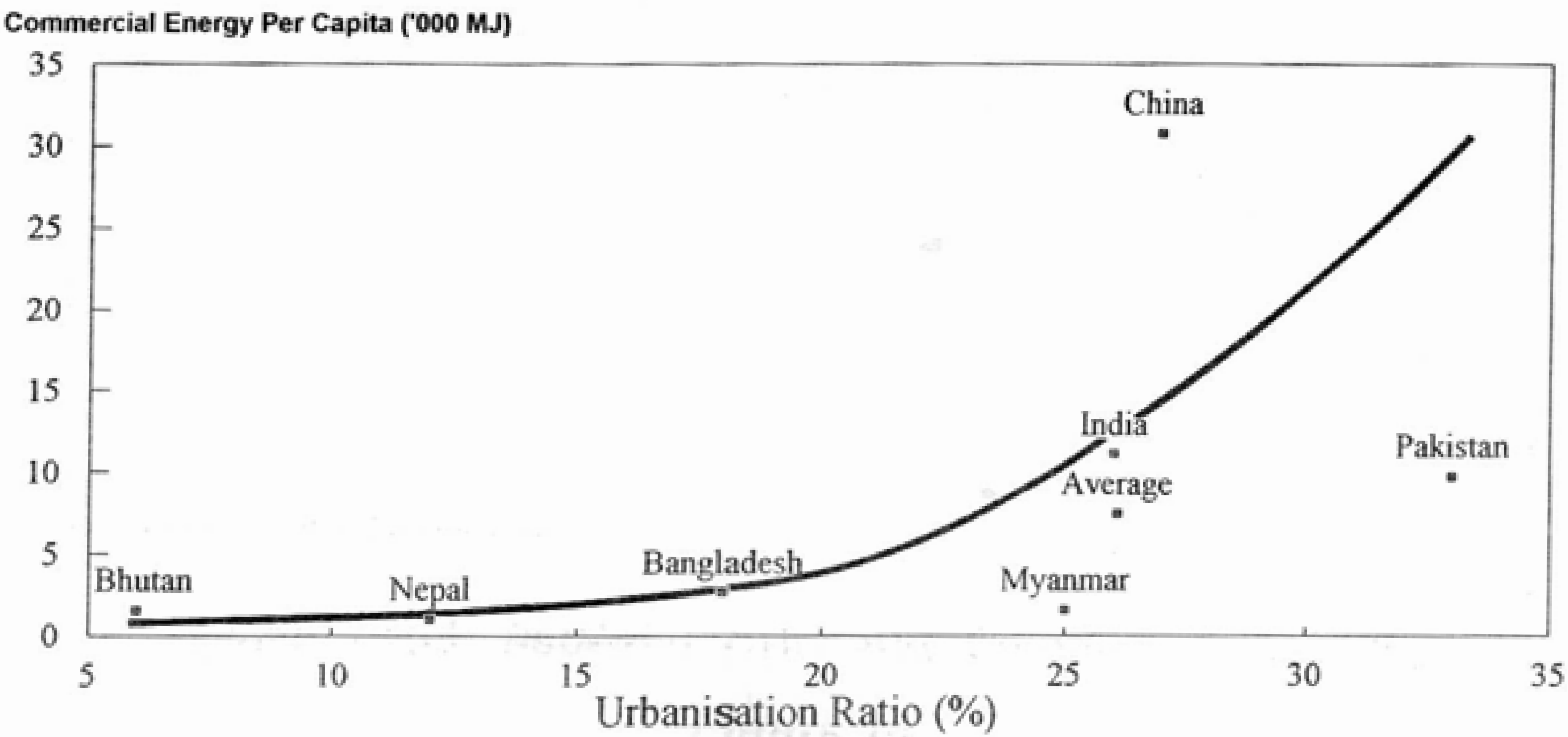


Figure 10

Relationship between GNP and Commercial Energy

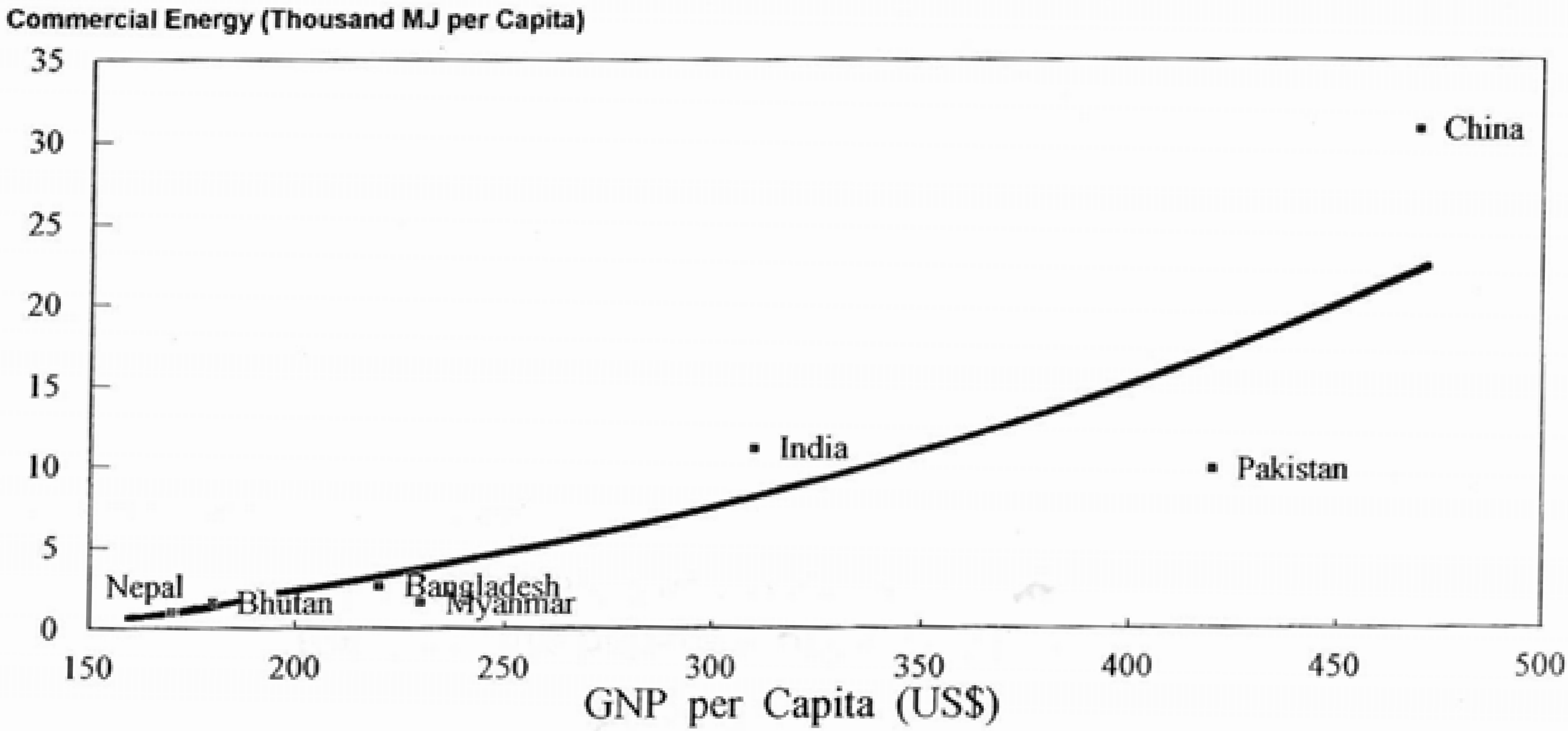


FIGURE 11

ENERGY RESOURCES AND TECHNOLOGY TRANSITIONS

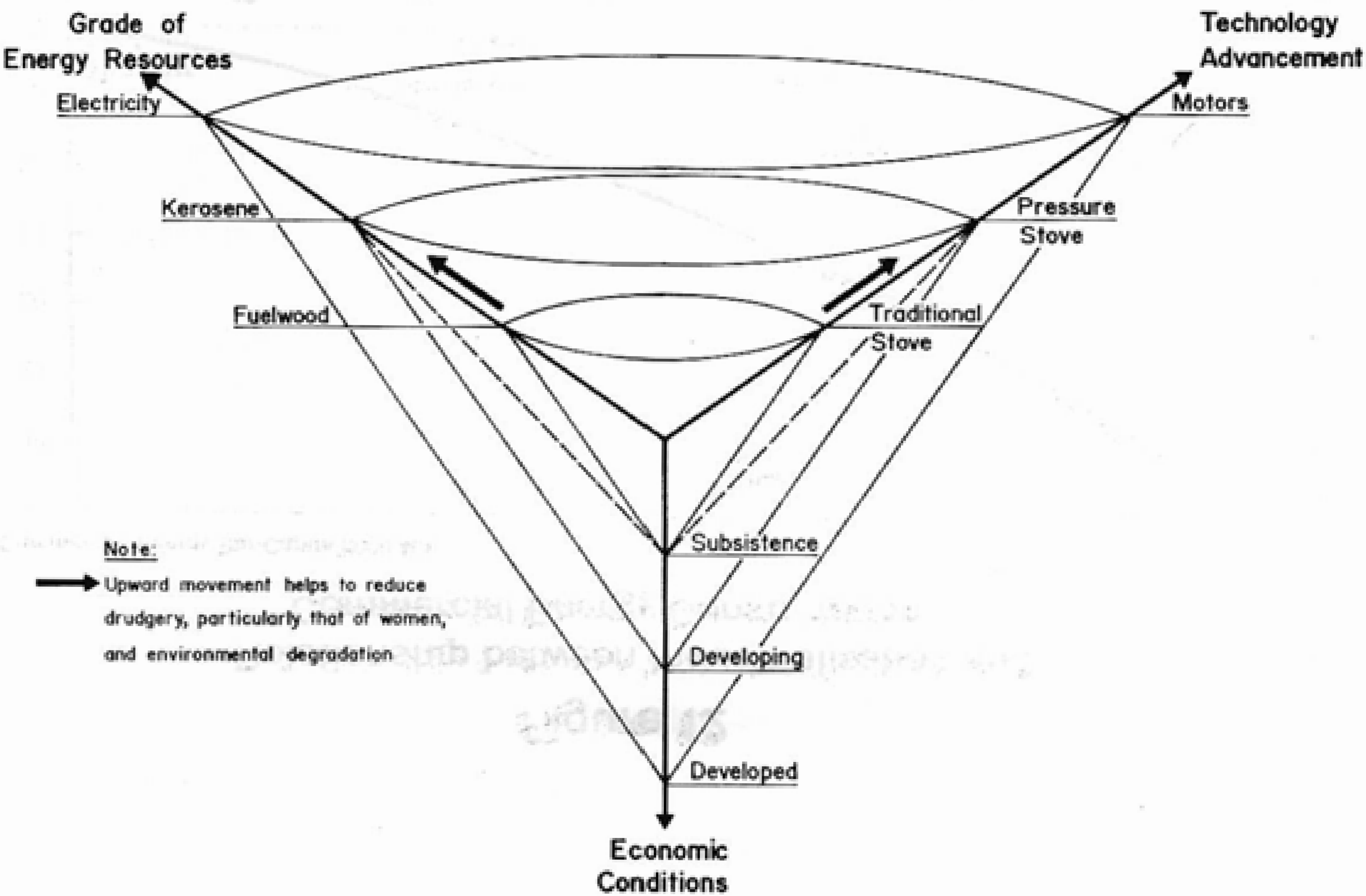


Figure 12

Relationship between Industrialisation and Commercial Energy Consumption

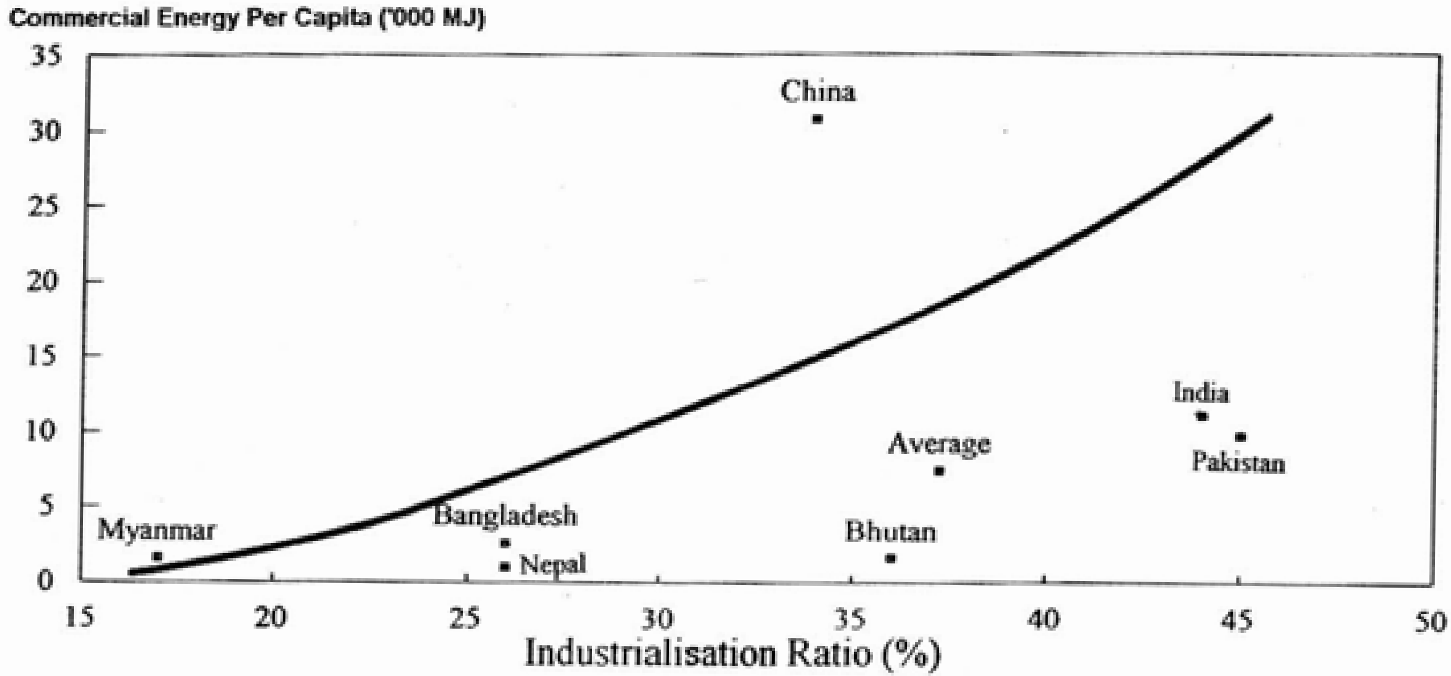
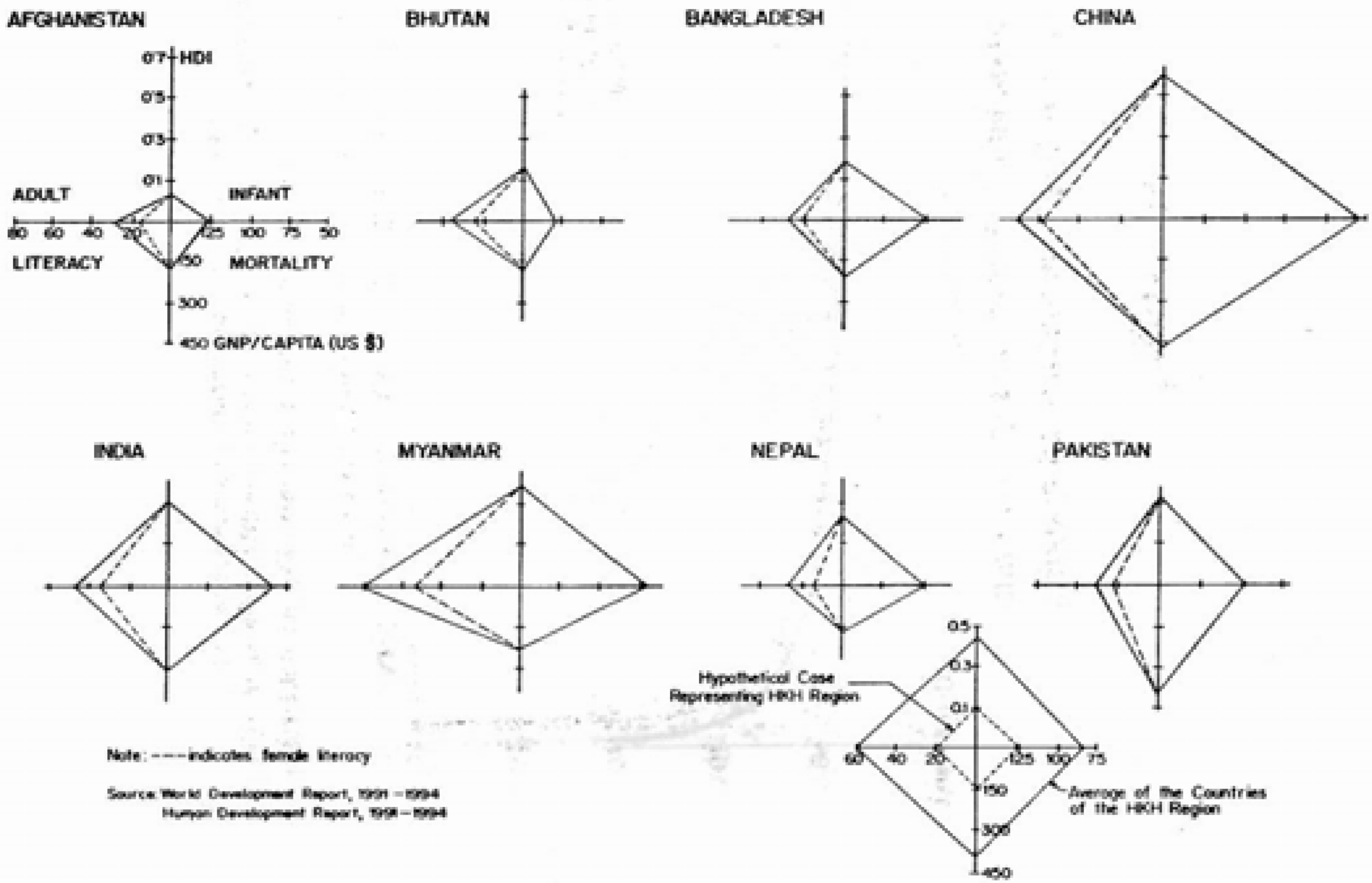


Figure 13

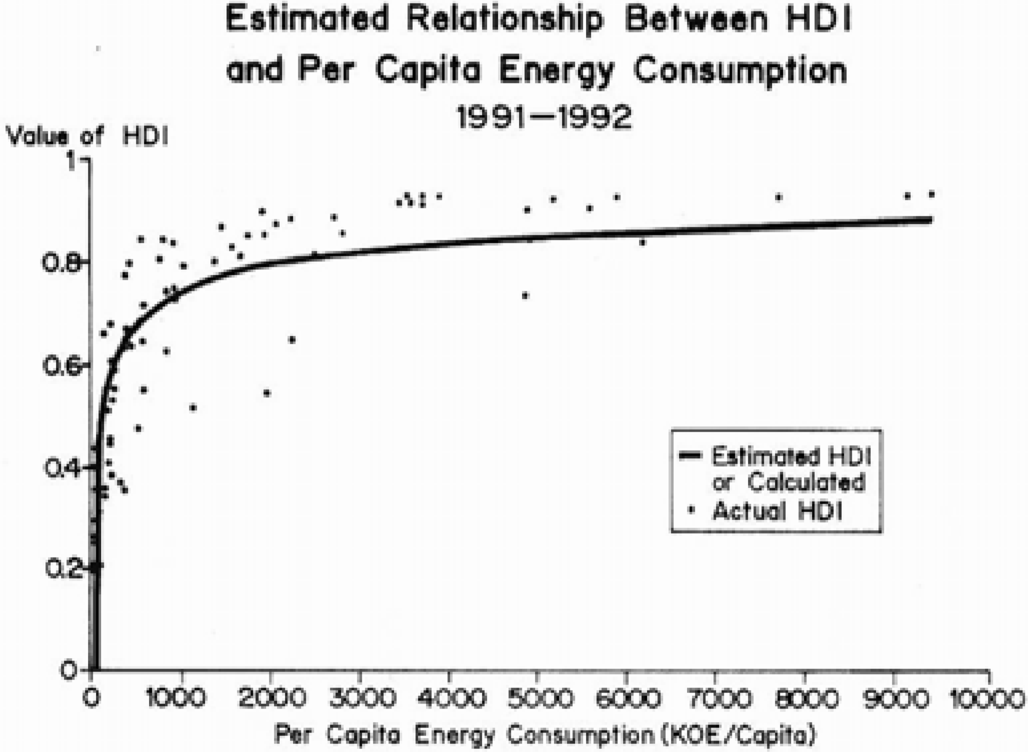
HUMAN DEVELOPMENT INDICATORS IN THE COUNTRIES OF THE HKH REGION



Note: ----- indicates female literacy

Source: World Development Report, 1991–1994
Human Development Report, 1991–1994

Figure 14

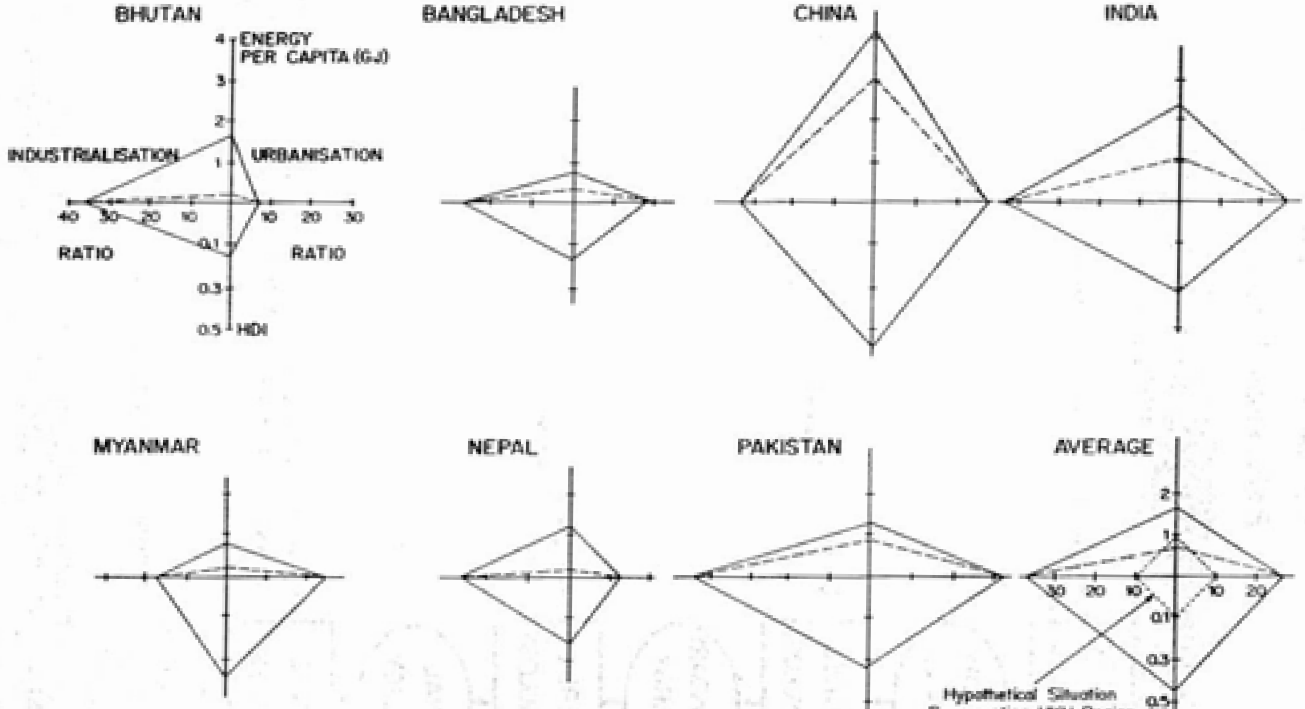


Note: Data for 100 developed and developing countries

Source: Philips, R., Goldemberg, J. and Johansson, T.B., Energy as an Instrument for Socioeconomic Development, UNDP (1995)

Figure 15

ENERGY CONSUMPTION PATTERN AND SOCIOECONOMIC VARIABLES



Note: - - - indicates commercial energy per capita

Source: World Development Report, 1991–1994
Human Development Report, 1991–1994
Energy Statistics Year Book, 1990–1994

FIGURE 16

Conceptual Framework for Reference Energy System

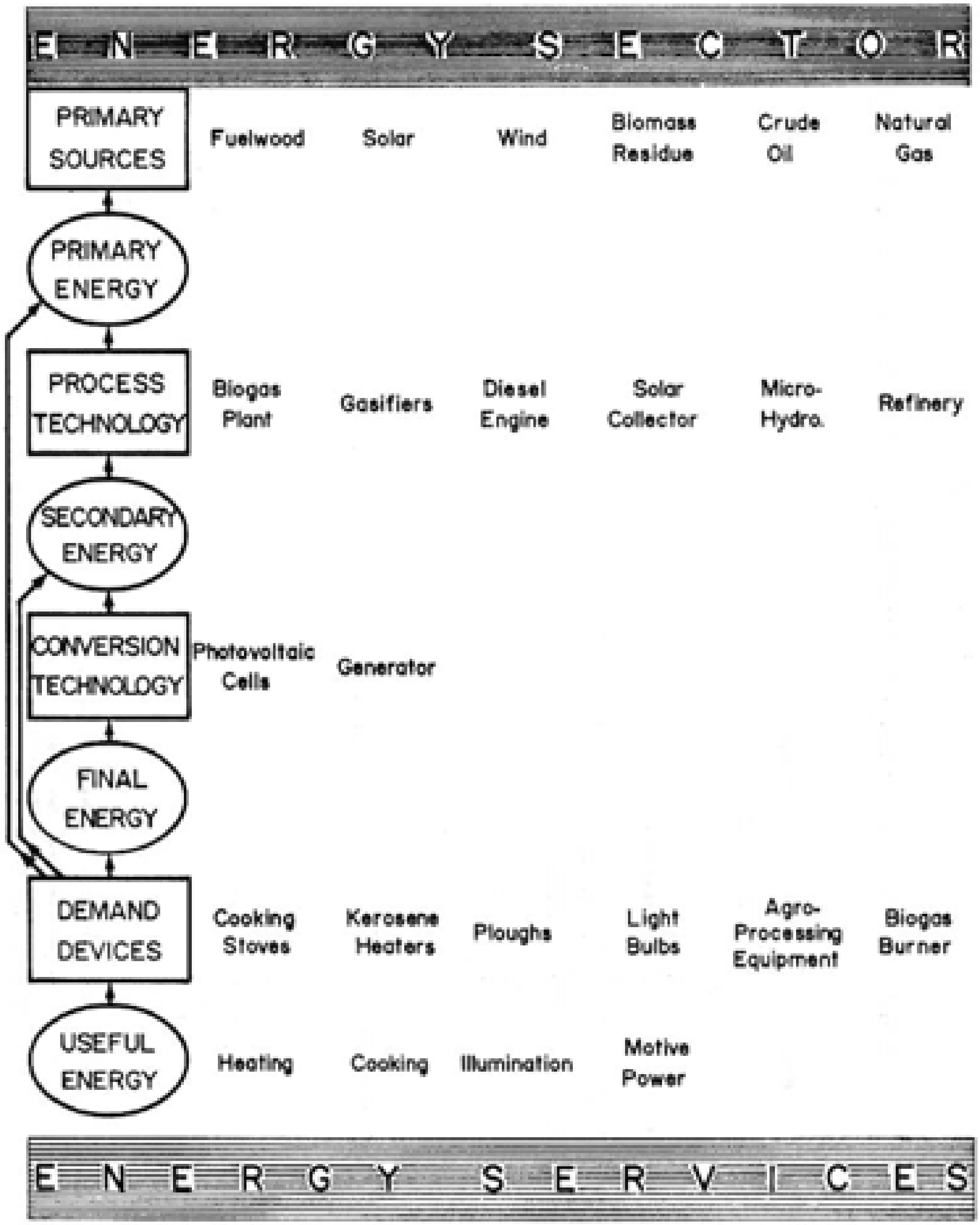
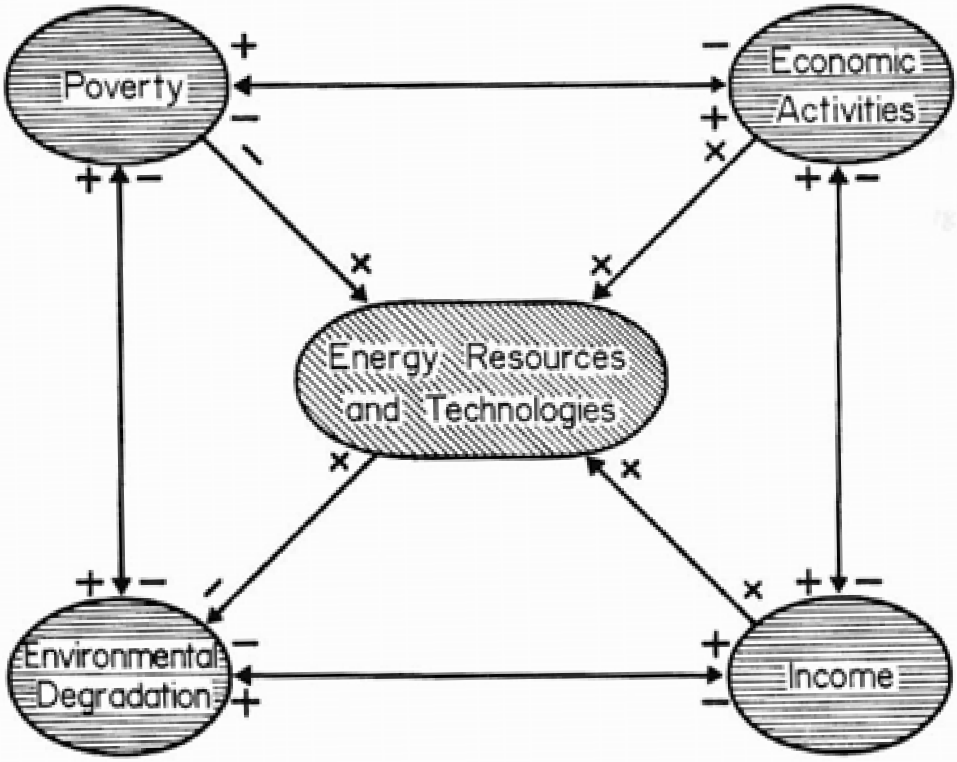


FIGURE 17

Poverty, Environmental Degradation and Energy Resource and Technology Linkages



\+ Indicates increase

— Indicates decrease

SELECTED REFERENCES

ADB and ICIMOD, 1992. *Nepal: Economic Policies for Sustainable Development*. Kathmandu: ICIMOD.

Asian Development Bank (ADB), 1992. *Energy Indicators of Developing Member Countries of ADB*. Manila: Energy and Industry Department.

Bajracharya, D. 1986. *Decentralized Energy Planning and Management*. ICIMOD Occasional Paper No. 4. Kathmandu: ICIMOD.

Codoni, R.; Park, H.; and Ramani, K.V. (eds.), 1985. *Integrated Energy Planning: A Manual* Vol. 1 to 4. Kuala Lumpur: Asia Pacific Development Centre (APDC).

deLucia, J.R. 1994. *Alternative Paradigms for Rural Energy Development*. Cambridge, MA: deLucia and Associates Inc.

deLucia and Associates Inc., 1993. 'The Equitable and Efficient Energy Pricing Study' prepared for the Asian Development Bank, Cambridge, MA.

ESCAP, 1990. *Linking Rural Electrification with Rural Development in Asia*. New York: United Nations.

FAO, 1993. *Wood Energy Development: Planning, Policies and Strategies* Vols. 1 to 3. Bangkok: FAO.

Goldemberg, J.; Johansson, T.B.; Reddy, A.K.N.; and Williams, R.H., 1988. *Energy for a Sustainable World*. New Delhi: Wiley Eastern Limited.

ICIMOD, 1986. *Energy for Mountain Districts, Report of the International Workshop on District Energy Planning and Management for Integrated Mountain Development*. Kathmandu: ICIMOD.

ICIMOD, 1989-94. *Annual Report*. Kathmandu: ICMOD.

ICIMOD, 1991. *Rural Energy and Related Technologies, Report of the Seminar on Rural Energy and Related Technologies in Nepal*. Kathmandu: ICIMOD.

ICIMOD, 1993. *Economic and Environmental Development: Planning for Bagmati Zone*. Kathmandu: ICIMOD.

ICIMOD, 1995. *Regional Collaborative Programme for the Sustainable Development of the Hindu-Kush Himalayas*. Kathmandu: ICIMOD.

ILO, 1987. *Linking Energy with Survival*. Geneva: ILO.

Jodha, N.S. and Shrestha, S., 1994. *Sustainable and More Productive Mountain Agriculture: Problems and Prospects, International Symposium on Mountain Environment and Development*. Kathmandu: ICIMOD.

Junejo, A.A. and Sharma, S., 1994. 'Role of Energy and Related Technologies in Mountain Development', International Symposium on Mountain Environment and Development. Kathmandu: ICIMOD.

Keating, M., 1993. 'Earth Summits' Agenda for Change.' SRO-Kuding S. A., Geneva: Centre for Our Common Future.

Khator, R., 1989. *Forests: The People and the Government*. New Delhi: National Book Organisation.

Monga, P. and Lakhanpal, T.N., (eds), 1988. *Rural Energy Alternatives in the Hilly Areas*. New Delhi: Today & Tomorrow's Printers and Publishers.

Monga, P. and Ramana, P.V. (eds), 1992. *Energy, Environment, and Sustainable Development in the Himalayas*, TERI. New Delhi: Indus Publishing Company.

Munasinghe, M. and Saunders, R.J., 1992. 'Energy Issues in the Developing World', Working Papers - Energy Development. Washington D.C.: World Bank.

Omvedt, G. and Kelkar, G., 1995. 'Gender and Technology: Emerging Visions from Asia', Gender Studies Monograph 4, Gender and Development Studies, Bangkok: AIT. Asian Institute of Technology (AIT).

Overholt, C.; Cloud, M.; Anderson, M.B.; and Austin J., 1995. 'Gender and Development: A Framework for Project Analysis'. USA: Harvard Institute for International Development Case Study and Training Project, and USAID.

Paul, S., 1985. *Energising Indian Agriculture, Indian House Developments*. New Delhi: Government of India (GOI).

PEP Project, 1995. 'Perspective Energy Plan for Nepal', submitted to the National Planning Commission, Kathmandu.

Philips, R.; Goldemberg, J.; and Johansson, T.B., 1995. *Energy as an Instrument for Socio-Economic Development*. N.Y.: UNDP.

Ramani, K.V.; Reddy, A.K.N.; and Islam, M.N., (eds), 1995. *Rural Energy Planning: A Government-Enabled Market-Based Approach*. Kuala Lumpur: APDC and GTZ, SP-Muda Printing Sdn. Bhd.

Rijal, K.; Manandhar, A.; Kharel, T.; and Bajracharya, D., 1987. 'Participatory Action Research for Rural Energy Planning in Nepal: Experiences in Hill and Terai Panchayats'. In *Village Voices in Rural Development and Energy Planning*. Hawaii: Chulalongkorn University/East-West Centre.

Rijal, K., 1991. Technology Assessment, Planning and Modelling of Decentralised Rural Energy Systems', Ph.D. Dissertation, Centre for Energy Studies, IIT, Delhi.

Rijal, K., 1994, 'Economical and Environmentally Sustainable Biomass Strategy'. In *Proceedings of Sustainable Infrastructure Development*. Kathmandu: Nepal Engineers' Association.

Sharma, P. and Banskota, M., 1992. 'Population Dynamics and Sustainable Agricultural Development in Mountain Areas', In Jodha et. al. (eds), *Sustainable Mountain Agriculture*. Volume 1. New Delhi: Oxford and IBH Publishing Co. and ICIMOD.

Sharma, P., 1994a. 'Population and Employment Challenges in the Mountains . *International Symposium on Mountain Environment and Development: Constraints and Opportunities.* Kathmandu: ICIMOD.

Sharma, P., 1994b. 'Urban and Industrial Development: Processes and Opportunities in the Mountains', paper presented at the Regional Conference on *Sustainable Development of Fragile Mountain Areas of Asia*. Kathmandu: ICIMOD.

Shrestha, S., 1992. *Mountain Agriculture: Indicators of Unsustainability and Options for Reversal*. Mountain Farming Systems' Discussion Paper Series No. 32. Kathmandu: ICIMOD.

UN, 1989. *New and Renewable Sources of Energy for Development*. Energy Resources Development Series No. 30. Bangkok: UN.

UNDP, 1993. *Human Development Report*. Bombay: Oxford University Press and UNDP.

UNDP, 1994. *Human Development Report*. New Delhi: Rekha Printers, UNDP.

UNDP, 1995. *Human Development Report*. N.Y.: Oxford University Press, UNDP.

Vinod Kumar, T.M. and Ahuja, D.R., 1987. *Rural Energy Planning for The Indian Himalaya*. TERI and ICIMOD. New Delhi: Wiley Eastern Limited.

Water and Energy Commission Secretariat (WECS), 1988. 'Report of the Task Force on Rural Electrification Impacts in Nepal'. Kathmandu: WECS.

WECS and CIDA, 1991. *Women in Water and Energy Development in Nepal*. Kathmandu: WECS.

WECS, 1995. 'Energy Sector Synopsis Report', Perspective Energy Plan (PEP), Supporting Document No. 1. Kathmandu: His Majesty's Government of Nepal (HMG/N).

World Bank, 1993. *Energy Efficiency and Conservation in the Developing World*, A World Bank Policy Paper. Washington D.C.: World Bank.

World Bank, World Development Report 1994, Infrastructure for Development, Oxford University Press, N.Y.: The International Bank for Reconstruction and Development.

World Commission on Environment and Development (WECD), 1987. *Our Common Future*. New Delhi: Oxford University Press.

ICIMOD

ICIMOD is the first international centre in the field of mountain development. Founded out of widespread recognition of environmental degradation of mountain habitats and the increasing poverty of mountain communities, ICIMOD is concerned with the search for more effective development responses to promote the sustained well being of mountain people.

The Centre was established in 1983 and commenced professional activities in 1984. Though international in its concerns, ICIMOD focusses on the specific, complex, and practical problems of the Hindu Kush-Himalayan Region which covers all or part of eight Sovereign States.

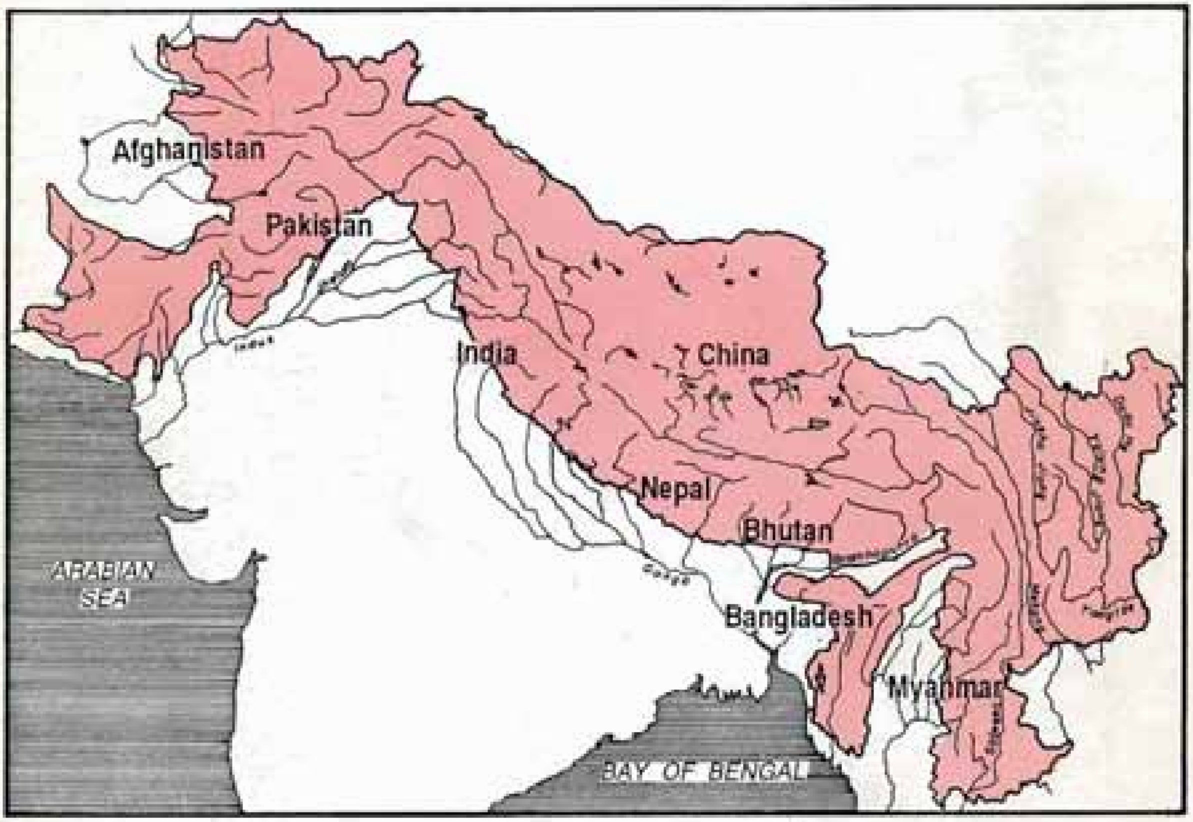
ICIMOD serves as a multidisciplinary documentation centre on integrated mountain development; a focal point for the mobilisation, conduct, and coordination of applied and problem-solving research activities; a focal point for training on integrated mountain development, with special emphasis on the assessment of training needs and the development of relevant training materials based directly on field case studies; and a consultative centre providing expert services on mountain development and resource management.

MOUNTAIN ENTERPRISES AND INFRASTRUCTURE DIVISION

Mountain Enterprises and Infrastructure constitutes one of the thematic research and development programmes at ICIMOD. The main goals of the programme include i) gainful enterprise development and income generation; ii) harnessing mountain specific advantages; iii) infrastructural development (social and physical); iv) sustainable energy resources for mountain development; and v) capacity building in integrated mountain development planning.

Participating Countries of the Hindu Kush-Himalayan Region

- Afghanistan
- Bhutan
- India
- Nepal
- Bangladesh
- China
- Myanmar
- Pakistan



INTERNATIONAL CENTRE FOR INTEGRATED MOUNTAIN DEVELOPMENT (ICIMOD)

4/80 Jawalakhel, G.P.O. Box 3226, Kathmandu, Nepal

Telex : 2439 ICIMOD, NP
Telephone : (977-1-525313)
e-mail : dits@icimod.org.np

Cable : ICIMOD, NEPAL
Fax : (977-1) 524509
(977-1) 524317