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STRATEGY, POLICIES, AND PROGRAMMES IN THE ENERGY SECTOR

Energy Development Strategies and Policies

Principally it is the Government that manages the energy sector in Nepal. The institutions involved, at various levels for different tasks, operate under general government guidelines. The energy development strategies for general and rural energy (the latter in particular) are not explicitly articulated even though elements of strategies appear in periodic plans. Hydropower development is a major element in government strategies. Consequently, the hydropower sector has received high priority. The Seventh Plan document notes *Development of the power sector has consistently received high priority in the periodic plans as this sector occupies a prominent place amongst the infrastructures essential for the overall development of the country* (NPC, Seventh Plan, 1985). However, the progress to date has not been satisfactory and this has been noted in the Seventh Plan document as well. *Thus though power generation, especially [the] hydroelectric power generation capacity of the country has increased substantially, it has to be admitted that achievement in this area has always lagged far behind the power generation targets specified by the periodic plans .... both external and internal factors have been identified as being responsible for big gap between specified targets and actual achievements.*

An evaluation of the energy development approach shows a lack of clear and articulated strategies for the energy sector. Plan documents that are supposed to expound on strategies are silent on this subject. Consequently, one has to fall back on stated policies to see whether they form the basis for a strategy. A close examination of the basic features of energy policies in Nepal shows a concentration of policies in the following areas.

(a) The promotion of water resource development projects which, in addition to providing hydropower, also provide benefits such as irrigation, drinking water, and flood control.

(b) The investment in the expansion of transmission lines, electrification, and systems' improvement.

(c) The investment in small hydropower projects and district level projects under decentralisation schemes.

(d) Exploration for and propagation of alternative energy technologies such as 'biogas', improved cooking-stoves (ICS), turbines, improved water mills, and solar and wind energy, as well as R and D and training.

The forestry sector, which has a predominant energy implication, has so far not been considered explicitly within the energy policy framework. Nevertheless there are programmes, such as afforestation and community forestry, which include energy as a part of their focus.

Policies for fossil fuel import are basically seen as import management rather than energy planning and management.

The above policies are pursued through various institutions that are not yet well integrated. Because multiple institutions are involved, a coordinating agency called the Water and Energy Commission was established with a mandate to coordinate energy development and policy planning. The commission has a secretariat called the Water and Energy Commission Secretariat (WECS) as its executing body. It is linked with the Ministry of Water Resources.

Table 7 gives the percentage distribution of investments in the energy sector from the Fifth to the Seventh Plan; i.e., from 1975-80 to 1985-90.

Table 7: Percentage Distribution of Investment Planned for Different Activities in the Plan Periods

	Fifth Plan Period (1975-80)	Sixth Plan Period (1980-85)	Seventh Plan Period (1985-90)
1. Large hydropower projects	88.7	69.2	56.8
2. Small hydropower projects	1.5	4.2	5.3
3. Transmission lines	2.4	13.2	10.1
4. Electrification and systems' improvement	1.7	9.7	9.5
5. Survey and feasibility studies	2.7	2.1	4.9
6. District level projects under decentralisation	-	-	13.5
7. 'Others' not specified above	2.8	1.6	
8. Total amount allocated (million Rs)	737.2	3800	4757.1
9. Amount allocated for alternative energy (million Rs)			50.0
10. (9) as % of (8)			1.1

Source: HMG/Nepal, The Fifth Plan (1975), The Sixth Plan (1980), and The Seventh Plan (1985), NPC. Ram Shah Path. Kathmandu.

Table 7 shows that large power projects (they are large in the Nepalese context and not in an absolute sense) account for a sizeable proportion of the money allocated for this sector. A comparison of the allocations made in this sector with those made for alternative energy development shows the latter to be only about one per cent of the former. It is thus apparent that in spite of what is written in the plan document, the development of alternative technology receives least priority in the energy development scheme.

The policy of promoting large power projects has its positive and negative aspects. On the positive side, the multiple benefits of power exports, irrigation, drinking water, flood control, and river navigation are attractive. So are the savings made on fuelwood as a result of the expanded use of electricity in areas where currently fuelwood is being used, for example, domestic use in urban areas and industrial use in industries that have a natural resource base such as cement, bricks, and bakeries. The ecological and environmental costs that necessarily accompany such projects are also evident and this issue has received insufficient focus in policy planning. Furthermore, given the huge resource and capital intensive technologies needed for such projects, an evaluation in terms of the impact of this investment in income generation, employment, and equity must be made. Investment may be attractive, in terms of its benefits vis-a-vis the cost, but if it increases social inequality then it is no longer sustainable. This question assumes a great deal of importance in Nepal, as investment decisions , based on 'trickle-down' theories, have totally failed to increase the well-being of a majority of the people. This is attested by indications that income inequalities have increased over time.

Energy Pricing Policy

The policy of promoting alternative energy, although absolutely necessary, has not produced tangible results. Has there been a problem in implementation? Or is it not seriously pursued at all? When only 30 per cent of distributed ICS in urban areas and 10 per cent in rural areas are in operation, the programme is far from achieving its goal of reduction in fuel consumption through increased end use efficiency. Similarly, the biogas programme has hardly made any progress. Is the lack of demand for biogas plants an indication of social resistance due to cultural practices or does it rather reflect insufficient attention given to design sensitivities and operational problems arising out of local resource conditions? Further enquiry concerning these aspects should be undertaken in future.

The institutional arrangements of the central coordinating body, however attractive on paper, still fail to address the crux of the problem, that is, that 'energy' is not an exclusive sectoral concern. However, present practices are purely sectoral in reality. Petroleum pricing comes under the authority of the Ministry of Supply, fuelwood pricing under the Ministry of Forests, and electricity pricing under the NEA. The revenue considerations of the Ministry of Finance are reflected in the tax and duty structure for petroleum products.

The market prices of important energy forms - such as fuelwood, petroleum products, and electricity - are not indicative of their true economic costs. Neither are their relative prices reflective of their scarcity/abundance. For example, during 1975 to 1985, percentage increases (per Kcal) indicated that fuelwood prices increased the least (38%) when the forests were depleting at a high rate. The price increases were mostly in diesel, followed by kerosene, electricity, and petrol, and they were 275 per cent, 195 per cent, 125 per cent, and 90 per cent respectively. During this period, the relative prices, in fact, moved in the opposite direction from that warranted by the resource endowment. Also, the domestic prices of petroleum products did not reflect the decrease in international prices during the 1980s. The conclusion was that *energy pricing policy at present is basically form-specific and does not take into account the total effect of the pricing of the individual forms. Consequently the relative price structure does not reflect true scarcity value. Non-economic considerations are somewhat narrowly defined and have a bias towards short-run perspective. The net effect has been implicit encouragement for the use of scarce resources* (Sharma 1988). There has been no real change in relative prices since then (WECS 1989). However, in the last two years, petroleum prices have increased significantly. Petroleum products in general, and motor spirit, in particular, show a high margin between the actual cost of imports and their selling prices.

The real price of <u>fuelwood</u> shows a significant divergence from nominal prices. So do the real prices of most other energy forms. The short-run, real economic cost of fuelwood ranged between NR 459/m^3 to NR 903/m^3 for 1987 (Devkota 1987). The real cost showed an increasing trend during 1977 to 1987, as indicated by the estimated figure of NR 148/m^3 in 1977 compared to the above-mentioned figure (Devkota 1987). The long-run, real cost, on the other hand, was lower than the short-run cost and was estimated at NR 325/m^3. The price of fuelwood prevailing then was about NR 0.55/kg (public corporation price) or NR 385/m^3;while the long-run, real cost was lower than the market price of fuelwood, the short-run, real cost (more relevant to fuelwood pricing) was at a much higher level.

Similarly, the real, economic cost of <u>electricity</u> ranged widely between seasons and between peak hours and off-peak hours. The average systems' cost for the rural and the urban sector varied as well. While recent figures on such costs are not available, a tariff study made during 1982 indicated that the annual average systems' cost per kWh ranged between NR 2.09 to NR 2.61 (Nepal Electricity Corporation 1982). The lowest cost per unit was NR 0.57 for off-peak hours for wet seasons in the urban system and the highest was NR 6.54 during peak hours for dry seasons in the rural electricity supply system. This indicates that there is scope for promoting electricity consumption during low load periods, i.e., wet season off-peak hours. For 1984, the Long-range Marginal Cost (LRMC) of electricity generation in Nepal was estimated to range between NR 0.76 to NR 1.22 per kWh in the case of firm energy and to be stable at NR 0.21 per kWh in the case of incremental secondary energy. The LRMP figures are for generation (i.e., at high voltage level) and have to be complemented with distribution (at low voltage) cost. The unit cost of electricity from micro-hydro plants was estimated at NR 3.6.

The real cost of <u>fossil fuel</u> estimated by using a shadow exchange rate for 1983, indicates that the economic cost is lower than the market price for diesel and petrol and higher for kerosene and LPG (Devkota 1987). There was a bigger discrepancy in the case of petrol (NR 5.93 economic cost, NR 9.3 market price) than in the case of other fuels.

The above real costs, although for the earlier 1980s, sufficiently indicate a persistent issue for energy planning - to what extent should prices reflect the economic cost? An intimately related issue, regarding electricity pricing, is that the real cost reflects part of the inefficiency cost arising out of a low load factor and that increases in the load factor will significantly reduce the costs.

Discrepancies between costs and prices will lead to misallocation of resources and encourage inefficient resource use, and this is an element of unsustainability. Suitable policy responses in the form of price and non-price variables are, therefore, required to correct this distortion.

The distributional impact of failure on the allocative front should be the next consideration. Because misallocation leads to an overall welfare loss, its incidence across various strata needs to be properly understood. A scenario analysis of the impact on consumer welfare, due to price changes in fuelwood, electricity, and kerosene, shows that low income households are affected most by fuelwood price increases and upper income households most by electricity price changes (Sharma 1988). Any pricing policy attempting to correct the price distortions by a change in administered prices, should also look for ways to safeguard the interest of the weaker members of society. The safeguards could range from outright grants (or subsidies) to the concentration of conservation efforts with the poor as a target group.

The above discussion, digressing somewhat from rural energy policy, is nevertheless important to highlight policy gaps/failures because these policies do have an indirect but powerful impact on the rural energy situation. Take, for instance, the fuelwood pricing policy. By keeping it below its social cost, there is not only an implicit encouragement of its consumption but it is also diverted to an area where its substitutes are available. Furthermore, such diversions take it away from areas where it is needed most, i.e., rural areas. It is indeed ironic to note that the urban hills are supplied with fuelwood from the *Terai*; which itself is facing a deficit (APROSC 1983 and Shaik, et al. 1989). Similarly, the pre-occupation with large-sized hydropower projects has drained the energy away from the crucial issue at hand. This is that in spite of a somewhat higher estimated cost per unit of smaller hydroprojects they have more potential for substituting fuelwood; at least in commercial activities in the rural townships. Even more important, they exhibit the ability to encourage economic activities in rural areas. When micro/mini-hydroprojects are integrated with economic activities, they are seen to be profitable (Cromwell and Wishart 1989).

The kerosene distribution cost is high in rural areas but there has been no systematic attempt to examine whether kerosene could still be competitive if the social cost of energy use is considered.

While pricing and related policies are important they have limited applicability in the rural sectors. Here the emphasis has to be on energy generation and conservation programmes. A look at the government programmes shows a strong emphasis on management of the commercial energy sector. Details of such policies and programmes are provided in the Annexes.

The Energy Conservation Policy

Energy conservation, especially in the context of rural energy demand management, assumes added significance because the scope of other policy tools is fairly limited. Since fuelwood is the major energy source, emphasis on sustainable fuelwood use is the prime requirement. Propagation of, and programmes on, distribution of improved cooking-stoves (ICS) have been launched in an attempt to facilitate fuelwood conservation.

Estimates of the number of ICS distributed, and in actual use, vary considerably according to different sources. WECS reports that out of a total of 40,000 ICS distributed, only 20 per cent or 8,000 are in operation. MPFS reports 16,000 units distributed, out of which 70 per cent or 11,200 are in use. The latter estimate most likely includes only those distributed through Community Forestry Development Programmes (CFDPs) and Integrated Rural Development Projects (IRDPs). There are other institutions involved in this programme such as UNICEF, Agricultural Development Bank/Nepal (ADB/N), and other bilateral donors.

The exact number of ICS distributed and in actual use, apart, it is beyond debate that this programme has failed to fulfill its potential. The reasons are many and are within the ambit of social and technical considerations. Enough attention has also not been given to the differences in adoption rates across different ecological regions.

In spite of poor performance, the technology in itself has potential. Estimates show that, if the ICS programme fulfills its potential, it could result in a saving of as much as six per cent in fuelwood demand in the middle mountains, Siwaliks, and the *Terai* by 2010 (HMG/N, FINNIDA, and ADB 1988). This would require a significant increase in the programme and implementation capabilities of concerned institutions. There will hardly be any ground for optimism if the existing arrangement continues. Therefore, this indicates the need to articulate the expected role of ICS and institutions involved in their distribution under an overall strategy for rural energy planning and management. Only then can one expect a meaningful realisation of the theoretical potential of ICS technology.

Conservation policies that directly affect other sectors, the effects of which would also be felt by the rural domestic sector, are provided in the Annexes.

Biogas Development Programme

A total of 4,351 biogas units were estimated to have been installed by 1988/89 (WECS). The installation rate has increased since 1985/86 and 2,462 of the total units have been installed since then. The Seventh Plan target was for the installation of 4,000 units during the plan period. Two main designs, the fixed dome type and the floating gas holder type, are in vogue; the former being greater in number. Private and community biogas units are in operation. *The community biogas plants are used mostly to run agro-processing and other small-scale industries. while the family type plants are used mainly for household cooking and lighting* (Shrestha and Bajracharya 1989).

Compared to the present situation, biogas use can be significantly increased in Nepal. The livestock population is quite large and is expected to increase to 11.6 million livestock units (LSU) by 2000 AD. This offers a lot of potential for the use of dung to produce energy. At present dried dung is directly burned, but using it to produce biogas would leave its fertiliser value intact after providing energy. A rough calculation shows that, theoretically, almost 500,000 biogas plants can be in place by the turn of the century if the full potential is exploited; financial and technical impediments are unlikely to allow for such a massive increase in capacity.

Because of its favourable conditions, the *Terai* is the ideal place for the expansion of biogas technology. To facilitate this, R & D for cost reduction, managerial efficiency in programme expansion, and an explicit policy of financial incentives/subsidies are required. Again, this points to the need for incorporating biogas development programmes as an essential component of the energy development strategy.

Solar and Wind Power Development Programmes

Although relatively unimportant from the current rural energy supply point of view, these technologies cannot be left out of the overall energy strategy. They exhibit potential, they are renewable, and are seen to flourish under the right conditions. For example, solar energy, in spite of its high cost is being used in urban areas for water-heating. Water-heating is the main energy consuming activity in cooking activities, and cooking activities account for almost 80 per cent of all energy used. Thus the right conditions seem to be there for this technology, provided it can compete with the other options that may be available to a rural household. Clearly, the need is for a reduction in cost in the use of solar energy, and this can only be made possible by an increased R & D programme for solar energy use.

Similarly, wind energy is largely untapped. Isolated instances of use are reported, but efforts are inadequate and need to be strengthened. The database is weak and needs to be improved.

Integrated Approach to Energy Planning and Management

As discussed earlier, a clear strategy on rural energy is missing. Components of the rural energy sector have been dealt with in an isolated and perfunctory manner. They will continue to be treated in the same fashion unless the objective of rural energy planning and management is established.

Evaluation of the approach to energy planning in Nepal shows that it is still to be integrated into the overall socioeconomic planning strategies. The practice of looking only at a particular energy form in the planning process has been the basic problem. There have been no systematic attempts to look at energy in terms of a sector, let alone in terms of integrating that sector with other sectors of the economy.

The first step in the move towards integrated planning is to define the goals of energy planning. These goals have to be consistent with the overall socioeconomic goals of development planning, i.e., improvement in the quality of the life of the people. In pursuing this goal, energy planning must be within the framework of the overall economic and policy analysis to meet interrelated and often conflicting national objectives.

If the goal of rural development planning in Nepal is to improve the socioeconomic standards of rural people, then energy planning too must contribute towards this goal. This is possible only when the energy sector has strong links with the production structures of the rural economy. In other words, the primary requirement of this integrated approach is that energy in the rural area should not be seen as an item of final consumption, e.g., lighting or cooking, but as an input into the rural economy which will lead to the attainment of a higher level of output. The rural economy in Nepal is predominantly agricultural and improvements in living standards are inconceivable without a growing agricultural sector. Energy can play a vital role in this respect. Enhanced energy supply, for example, for irrigation-lift or surface, could go a long way to improving rural agriculture. This in turn could lead to a higher demand for energy by the agro-processing and small-scale industrial sector. Choice of appropriate energy technology becomes important in the promotion of such an approach.

Planning must ensure that scarce resources are used in the best possible manner. Rural energy planning must also be guided by the same consideration even though some of the resources may not be commanding a market price. Fuelwood, for instance, falls outside the scope of pricing intervention in most of rural Nepal but is a scarce resource. The need, therefore, is to conserve it. The potential of ICS in biomass conservation is attractive and it should be exploited fully. Side by side promotion of energy sources which have the same end use, such as that of fuelwood, is essential to reduce pressure on fuelwood. In Nepal this means promoting biogas. Electric power and other non-conventional energy sources, where such technologies are feasible, will also contribute to saving fuelwood even though the savings may not be as great as those brought about by an increased use of biogas. Planning at this stage must address the issue of social as well as financial costs and benefits of various energy options and technologies.

Coordinated energy planning and pricing require detailed analysis of the interrelationships among the various economic sectors and their potential energy requirements, on the one hand, and of the capabilities and advantages and disadvantages of the various forms of energy used to satisfy these requirements on the other. Non-conventional sources, which could play an especially effective role in remote areas where they turn out to be viable alternatives, must also be fitted into this framework (Kumar 1987).

Such a coordinated approach requires investment policies that are not only based on energy sector investment priorities but which also take into account investments to be made in other interrelated sectors. For instance, transport sector investments, in the form of road construction, resulting in the linking of rural area to the widemarket, may bring about additional demand for local agricultural produce and cottage industry products, and this in turn will lead to an increased demand for energy for intermediate use. The degree of such demands depends of course on the energy intensity of these sectors. Similarly, tracing the effects of other policy decisions, such as the pricing of a particular energy form, is necessary to promote an integrated approach.

The next level of integration is intra- and sub-sectoral. A detailed analysis of each sector is required to assess the extent of interaction among different energy sub-sectors, substitution possibilities, and for the resolution of resulting policy conflicts. For instance, it may seem attractive to promote hydropower in a particular rural region but one may encounter conflicts of different types once the scale of plant is taken into consideration. Similarly, it may be necessary to make judgments and trade-offs on equity vs. efficiency basis.

Organisational and institutional requirements for the promotion of integrated energy planning for rural Nepal assumes as much significance as matching aggregate demand and supply or intra-sectoral integration of different energy sub-sectors.

On a macro-scale, specialised energy planning agencies can make technical decisions but, once planning reaches micro-level, then these institutions are seen to be inadequate to the task on hand. The insensitivity of macro-level institutions to micro-level conditions has strongly emerged as one of the key lessons from past development experiences.

It is becoming more and more evident that poverty eradication and resource conservation measures are location-specific activities. Pressures on natural resources are strongly interlinked with local production systems; poverty eradication requires a clear understanding of local environment and socioeconomic characteristics and of opportunities and constraints in order to identify appropriate programme interventions. Obviously there are serious limitations in the technical capacities of local organisations; also many so-called local institutions are only agents of central level institutions. The important point being emphasised is that programmes designed at the Centre and implemented by the Centre have not succeeded in the fields of poverty eradication and resource conservation. What is needed is to provide greater opportunities for local people to organise their own management systems (ADB 1990).

Thus, to base rural energy planning on realities, efforts have to be initiated to follow a decentralised approach, and this should be based on two major factors. Firstly, population settlements in rural Nepal are scattered. This makes it extremely costly to execute any strategy that aims at covering a fairly large geographical area for supply of abundant domestic energy; hydropower. Secondly, because of spatial diversity, no single energy technology can possibly be viable across the whole country. Climatic conditions, resource endowments, and resource potentials vary across three major ecological belts. It is therefore obvious that energy technology choices have to vary as well.

For example, take the case of the hills and mountains. The Forestry Sector Master Plan estimates that the high hills and high mountains are fuelwood sufficiency areas whereas the middle mountains are not. The deficit of fuelwood is estimated to reach 23 per cent of the sustainable fuelwood supply in the area in 2000/01 and 19 per cent in 2010/11. But this is an area where other forms of energy are also not available. Because of the physical features as well as the difficulty in management, large-scale importation of POL products to meet energy needs may not be feasible. But the natural conditions here are suitable for the exploitation of numerous rivers and streams. Traditionally, these rivers have been used to generate mechanical power through *ghattas*.

Can the rivers be exploited to produce electric energy for domestic use as well? ADB/N's experience has shown that this can indeed be done if planned and executed properly. The demand for micro-hydro technology in the private sector points to its viability in hill conditions. This technology has integrated energy and economy in the sense that the demands for electric and mechanical power form the basis of the demand for this technology. Yet this experience has remained largely within the confines of ADB/N and no real efforts are being made to make it a part of the rural energy development strategy. This is not to say that micro-hydro technology does not face any problems; it does, but the problems can be better addressed if the 'technology' becomes a component of overall strategy. It is only then that sufficient resources and technical skills can be channelled so as to take advantage of this technology.

In the case of the *Terai* there is already a fuelwood deficit in some areas, and the deficit can be expected to grow in the future. The *Terai* abounds with livestock and agricultural residue. If livestock waste and the residue can be turned into energy, without detracting from their traditional uses as manure, then energy and economy will be integrated. The apparent attractiveness of biogas technology in such a situation cannot be ignored. Again this calls for a strategy that internalises the issues involved and identifies programmes and investment options commensurate to the need.

The Chinese have demonstrated that energy technologies can be combined within a certain spatial unit to provide energy to the rural population. This is achieved in what is called an Energy Village. Such villages are being promoted by the Chinese Academy of Science. The basis element of the strategy was to reach a higher consumption of energy through a series of demand and supply management activities. They are:

o reforestation of fast growing species for fuelwood supply,

o conservation of fuelwood by adoption of energy-saving stoves,

o extensive application of biogass and other appropriate technologies such an ICS, and

o a change in animal husbandry practices.

A brief description of the Chinese Energy Village is provided below.

Illustration of the Chinese Energy Village Experiences

During 1982, six villages in Sichuan Province in China were included in a rural energy experimentation project. These villages were characterised by acute shortages of energy. Increasing population pressure encouraged conversion of forests into agricultural land. Forest-based energy sources were in short supply. There was a heavy dependence on the use of agricultural residue in meeting the energy needs. However, the situation was such that even if farmers were to burn all the available crop residues they would still not have sufficient fuel; they would face a deficit for three months. Also the environmental consequences of the practice of burning straw and other biomass, instead of recycling it into the land, affected the agro-ecological balance. It also reduced the fertility of the land.

One of the villages included in the programme was Changle. This village lies to the south of Chengdu. It had 71 households with 301 persons in all. The cultivated land consisted of little more than 20 hectares and the main crops were rice, wheat, and rape seeds. The climate in the area is relatively mild with an annual mean temperate of above 15 °C. The annual precipitation is more than 1,000m.

When the programme was initiated, there were 124 biogas digesters in the village with many households having two units. All of them were wet fermentation types and were round, small, and shallow. The annual mean biogas yield rate was about $0.1m^3/m^3$ diameter. The total production was $21{,}000m^3$ which was only enough to cook three meals a day for 6 months in a year.

Crop straws were used as kitchen fuel with traditional stoves having a 10% calorific efficiency. About 82,000kg of straw were burned annually. Further, approximately 25,000kg of coal was brought into the village annually for use mainly in cooking pigs' feed.

An initial enquiry revealed the energy flow pattern in the village to be as depicted in Figure 5.

In Changle village, one person on an average owned 1.2 pigs. There was enough manure for biogas fermentation. The favourable climatic situation of the area also conductive to biogas production. Therefore, special attention was given by the Chengdu Institute of Biology of the Chinese Academy of Sciences to popularising innovative designs of biogas digesters.

Biogas units with dry and wet fermentation digesters were built. The dry digesters were fed with crop straws only with a total solid concentration of 25 per cent. The wet ones were fed with animal manure and night soil. Fermentation processes in the old type of digesters improved. These improved digesters were fed with manure without the addition of straw. Mixed with water, this helped to maintain the proper concentration and fertility of the fermentative materials. Low-pressure biogas stoves, developed by the Chinese University of Science and Technology, were widely disseminated in the village. The calorific efficiency obtained was as high as 64 per cent under rated pressure conditions. Apart from biogas fermentation, improved stoves, designed by the Chinese University of Science and Technology, was widely popularised in the village. The stove provided a calorific efficiency as high as 35 per cent.

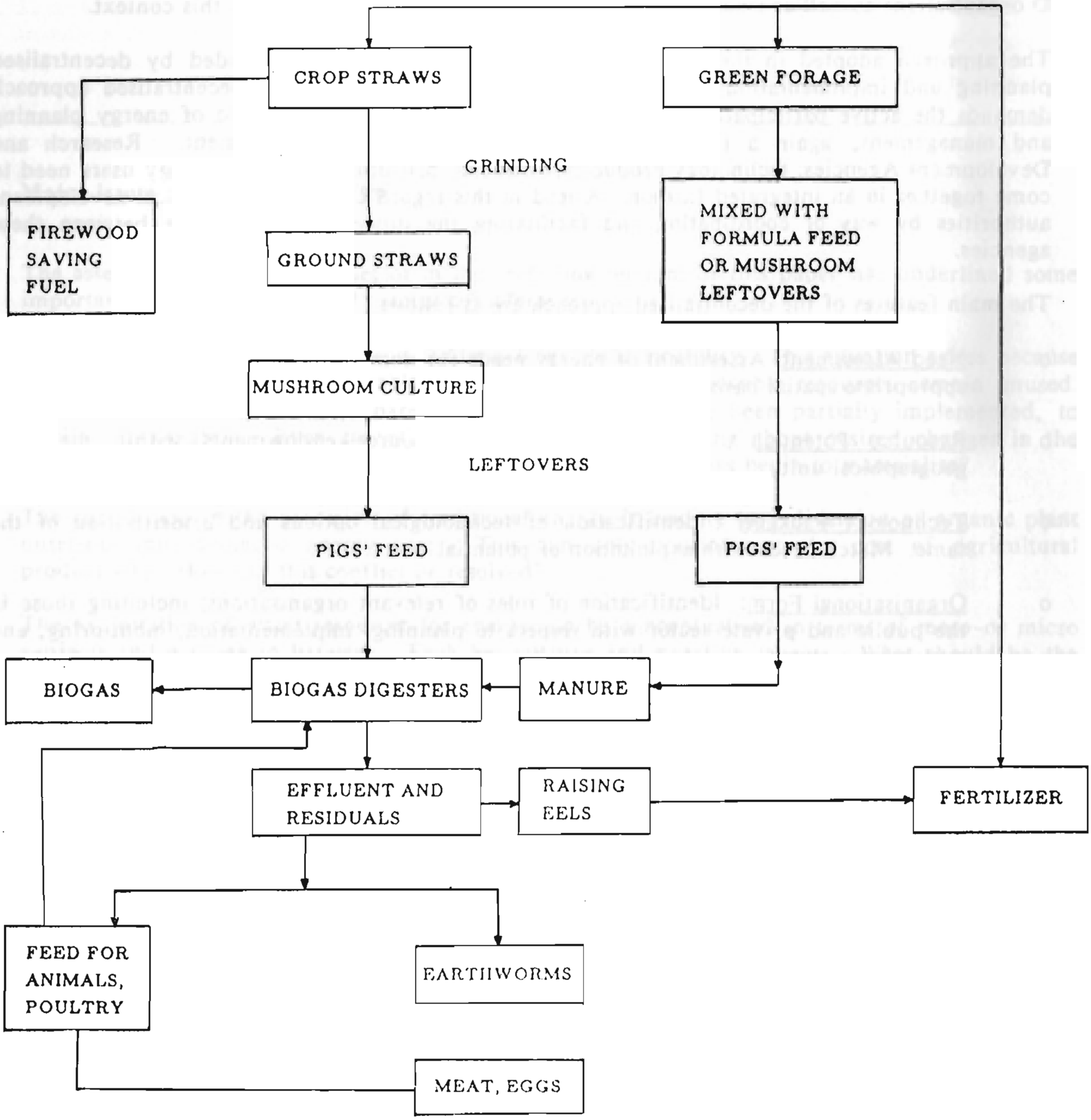
Fuel was saved in preparing pigs' feed. The energy consumption for cooking the feed used to account for about 50 per cent of the total domestic energy requirement. A new method of preparing feed was used by mixing green feed with formula feed. Left over mushrooms, mixed with crop straw and other agricultural waste, was used for this purpose.

After three years of experimentation in the integration of energy, agriculture, and animal husbandry, supported by the propagation of improved and innovative technologies, the village has undergone remarkable changes. These changes, are reflected in the following statistics.

- The annual net income per capita was raised by 94.1 per cent.
- Grain production increased by 25,000kg.
- Chemical fertiliser purchases decreased by 35,000kg.
- Use of coal was reduced by 22,000kg.
- Bio-energy accounted for 96.3 per cent of the total domestic energy (including 64 % from biogas).

The transformation brought about in the village by implementation of the Energy Village Concept is worthy of detailed examination. The attractiveness of the experiment is seen in terms of not only an increased energy consumption concomitant with increase in income but also in terms of the shift in the source of energy supply; from fossil fuel to biomass energy.

Figure 5: Ecological Circulation of Energy in the Village



Source: Chengdu Institute of Biology, Chinese Academy of Sciences.

Can such an approach work in Nepal? Afterall, the resource conditions are not radically different; a deficit of biomass fuel and pressure on marginal land for cultivation. There is also a need to increase energy consumption from its current low base. A pilot programme with cooperation from the Chinese Academy of Science, ICIMOD, and the active participation of R & D organisations as well as financial institutions in Nepal can be visualised in this context.

The approach adopted in the Chinese Energy Village experiment is guided by decentralised planning and implimentation as all such approaches should be. The decentralised approach demands the active participation of different agencies involved in the field of energy planning and management, again a fact attested by the Chinese village experiment. Research and Development Agencies, technology producers, financial institutions, and technology users need to come together in an integrated fashion. A lead in this regard can be taken by local development authorities by way of coordinating and facilitating the process of interaction between these agencies.

The main features of the decentralised approach are as follows.

- o <u>Need Assessment</u>: Assessment of energy needs for domestic as well as economic use on an appropriate spatial basis.
- o <u>Resource Potential</u>: Assessment of energy resource endowments within the same geographical unit.
- o <u>Technology Package</u>: Identification of technological options and prioritisation of the same. Match needs with exploitation of potential.
- o <u>Organisational Form</u>: Identification of roles of relevant organisations; including those in the public and private sector with respect to planning, implementation, monitoring, and evaluation aspects.
- o <u>Financial Support</u>: Assessment of financial support needed in terms of investment funds and credit lines.
- o <u>Project Planning and Implementation</u>: Planning and implementation of projects within the technological and financial options available.
- o <u>Evaluation</u>: Evaluation in terms of intended benefits relating to final consumption of energy in the domestic sector as well as its use as an intermediate input in the production sectors.

The above approach has the following advantages.

- o It draws upon the strengths of local people and organisations.
- o It is based upon the exact condition of local resources.
- o It interlinks promotional institutions with consumer groups.
- o It incorporates the elements of 'integration'.
- o It clarifies the expected role of each organisation /institution.
- o It allows sufficient flexibility for the mid-stream correction of courses if the need arises.