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Issues and Options in Energy Conservations in Nepal

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Introduction

The conservation of energy and waste elimination play a vital role in the supply and demand of energy, particularly at a time when energy resources have become scarce and the cost of supply is increasing. Both consumers and producers could contribute towards these factors to a great extent.

Conservation of energy embraces quite a vast area in the industrial, commercial, and domestic fronts. Energy saving possibilities exist in all the sectors of economy. Various studies show that in industry and the commercial sector 15 to 20% of the energy can be saved by simple measures and better technologies. Similarly, diesel oil use in the transport sector can be reduced by 6 to 10% with simple fuel economy measures. In the agriculture sector too the case is similar. It has been repeatedly demonstrated that conservation measures can reduce energy use by 15 to 30%, or more with justifying cost savings. Further, fuelwood consumption in the domestic sector could be reduced to half with the use of the Improved Cooking Stove (ICS) instead of the traditional open fire stove. Likewise, the amount of fuelwood used can be reduced by the drying of fuelwood and utilizing proper cooking appliances.

That it is possible to save energy by purposeful strategies is exemplified by the case of USA. Conservation means have helped reduce its oil import from about 8.5 million barrels per day in 1973 to 2.5 million per day in 1983. Further, figures from the Department of Energy's (DOE) office of Industrial Programmes show that the ten most energy–intensive U. S. industries achieved overall efficiency improvements of 15.4% between 1972–1979. A series of energy economizing measures in the U. K. has resulted in over 10% saving in energy consumption. Studies in West Germany indicate that the country can manage its industrial growth in the year 2000 A. D., with the same amount of energy that it consumed in the 1970s.

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Unlike the highly centralised energy supply,energy conservation is a decentralised issue. Decision and action in energy conservation largely depend on the individual-the housewife, the car driver, the boiler operator, and every individual who consumes energy in one form or the other. Hence, it is obvious that the imparting of the concept of energy conservation to every level is essential.

Certain aspects of energy conservation do, however, require strong and purposeful policies at the national level in order to make structural system changes that favour conservation. Developing countries like Nepal, in particular, need to conserve energy, because the efficiency of our energy use in every sector of economy is low.

Consumption Sector and Conservation Possibilities

The total energy consumption of Nepal was about 4 million tons of oil equivalent in 1983–84, out of which domestic sector consumed 94%, industry and commercial 3.8%, and transport 1.8% as shown in Table 1. The purveyors of energy are fuelwood (83.7%), agricultural waste (9.2%), animal dung (1.6%), petroleum fuels (3.5%), coal (1.5%), and electricity (0.5%).

Domestic Sector

The domestic sector consumed about 3.8 million tons of oil equivalent in 1983-84, i.e., 94% of the total energy consumption. All in all, it consumed 98% of the total fuelwood, 100% of agricultural waste and animal dung, 25.9% of petroleum fuels, and 50.7% of electricity. 98.7% of the supply of energy in this sector was met by traditional sources and 1.3% by commercial sources. The traditional sources of energy include fuelwood (87.3%), agricultural waste (9.7%),and animal waste(1.7%),whereas the commercial sources of energy include kerosene, LPG, and electricity. The conservation possibilities in this sector are discussed as follows:

The traditional wood burning stove or *chulo* has a thermal efficiency of about 92.1%, compared to the 3% of an open fire. The improved *chulo* has a thermal efficiency of about 22–30%. Widespread installation of improved stoves has, therefore, the theoretical potential to half the fuelwood consumption. The impact of a large scale Improved Cooking Stove Programme (ICSP) can be considerable. Not only would the programme reduce the current demand on the existing forests but also significantly reduce the planting requirements of the reforestation/afforestation programme. It is estimated that, on an average, each improved stove installed reduces fuelwood consumption by i m^3 per year per household. Thus ten stoves would reduce plantation/protection requirement by 1 ha.

Similarly, the consumption of kerosene can be reduced to 10–15% using the efficient kerosene stoves. In Bangladesh, the consumption of kerosene for lighting reduced by almost 50% with the use of improved kerosene lamp instead of rudimentary lamps "Traditional Cuppy" (per. Comm.).

Table 1
Energy Consumption Pattern, 1983/84

Consumption Sector	Traditional Eenergy			Commercial Energy			
	Fuel Wood	Agric Waste	Animal Dung	Petroleum	Coal	Electricity	Total
Natural Units ('000)	(tonnes)			(toe)	(tonnes)	(Gwh)	
Domestic	8507.0	1279.0	257.0	37.1	0.5	124.0	
Industry/Commerce	170.0	0.0	0.0	22.7	98.7	106.4	
Transport	0.0	0.0	0.0	70.5	1.8	1.5	
Agriculture	0.0	0.0	0.0	11.6	0.0	6.2	
Others	0.0	0.0	0.0	1.3	0.0	6.5	
Total —	8677.0	1279.0	257.0	143.2	101.0	244.6	
UNIT ('000(TOE							
Domestic	3317.7	370.9	64.2	37.1	0.0	10.4	3800.3
Industry/Commerce	66.2	0.0	0.0	22.7	58.2	8.9	156.0
Transport	0.0	0.0	0.0	70.5	1.1	0.1	71.7
Agriculture	0.0	0.0	0.0	11.6	0.0	0.5	12.1
Others	0.0	0.0	0.0	1.3	0.0	0.6	1.9
Total	3383.9	370.9	64.2	143.2	59.3	20.5	4042.0

Source: *Energy Sector – Synopsis Report, Revised and Updated 1983–84, WECS, Nepal (1985).*

The drying of fuelwood is another measure of conservation. Fuelwood with a high moisture content has less energy available per unit weight than wood with a low moisture content. The difference created is due to the energy needed to vaporize the contained water. For example, a given volume of green wood at 100% moisture content weighs 200 kg. (100 kg wood + 100 kg. water). At this moisture content the total energy available is 402,800 kcal (2015 kcal/kg). If the wood is air dried to 15% moisture, the volume is basically unchanged though the weight of fuelwood is now 115 kg and the total energy available (at 4000 kcal/kg) is 460,000 kcal. There is a 15% increase in available energy. Dry wood burns more efficiently than wet wood as there is less water to be vaporized However, the advance collection and stock-piling of sufficient fuelwood should be organized carefully to ensure a consistent supply of dried wood.

As far as animal waste is concerned it is desirable to use it in a bio-gas plant insteaed of making dry dung cakes to be used as cooking fuel. Power generation from bio-gas will not only yield power for lift irrigation, lighting and cooking, but will also produce a rich soil nutrient in the form of slurry which will help the farmer to cut down on chemical fertilizer inputs.

Industry and Commercial Sector

The Industry and commercial sector consumed about 150,004 tons of oil equivalent (3.8% of the total energy consumption) in 1983-84. It amounted to the consumption of 2% of the total fuelwood, 15.8% of petroleum fuels, 98.2% of coal, 43.4% of electricity. The main contributors of energy in this sector were fuelwood (42.2%), coal (37.3%), petroleum fuels (14.6%), and electricity (5.7%). The possibilities of energy conservation in this sector are discussed as follows:

After 1973, concerted efforts have been made the world over in developing a wide array of energy conservation technologies in this sector. Some of the noteworthy developments in the field of combustion are low-excess air burners, water-in-oil emulsion burners and recuperative burners. The low-excess air burner increases the thermal efficiency ranging from 45-85%, with stack heat loss of 10-15%. The emulsion burner is another technique by which fuel oil combustion can be improved by about 8-12%.

It has been noticed that the use of rice husk instead of fuelwood in the industrial boiler has reduced the annual energy cost by almost 60% (per. comm.).

In the field of heat transfer, several heat recovery equipments using different principles and materials have been developed. The conventional shell and tube heat-exchanges, if replaced by ceramic recuperators, plate heat exchangers, heat pipe and the heat wheel will improve the efficiency in the heat transfer process.

Interesting developments have been reported abroad and in India in the area of low-temperature heat recovery – that is, recovery of waste heat at temperature ranges between 70° and 400°C. For example, waste gases leaving the boilers in a rice mill are in the tempe-

rature range of 100°–150°C, and if a system could be devised to recover and use this heat, it would help conserve energy. Similarly heat is carried away by the engine cooling jacket at a temperature of 60°–70°C and if we conceive a heat recovery system for such an application, it would also help to conserve energy.

Transport Sector

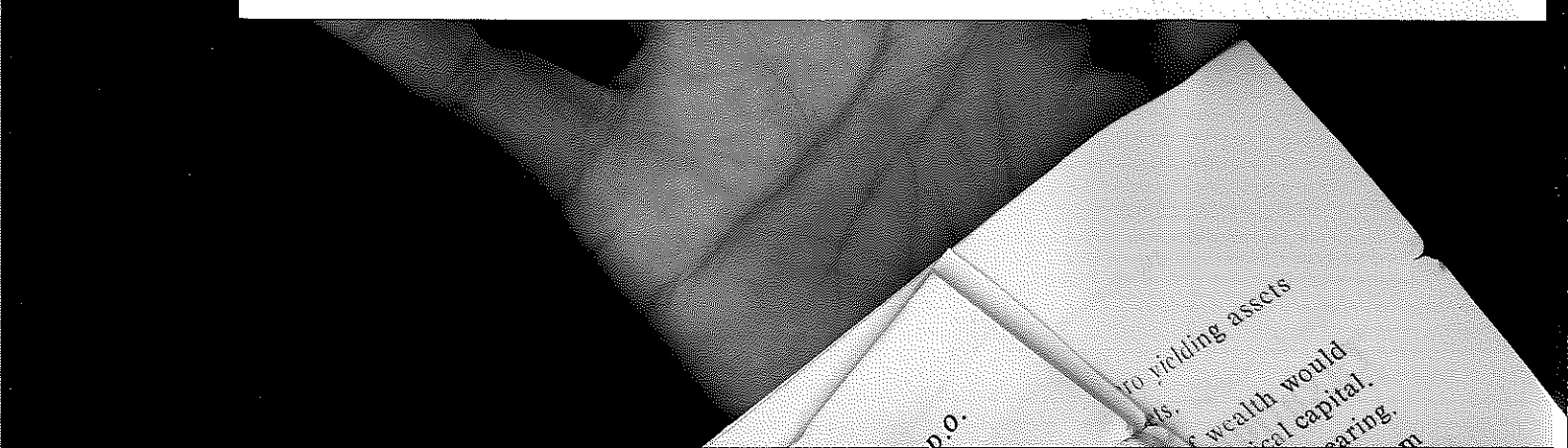
The transport sector consumed about 72,000 tons of oil equivalent in 1983/84 - about 1.8% of the total energy consumed. This sector consumed 49.2% of the total petroleum fuels, 1.8% of coal, and a negligible amount of electricity. The major contributors of energy in this sector were petroleum fuels (98.3%), coal (1.5%), and electricity (0.2%). Certain conservation techniques if applied will help to reduce the consumption of energy in this sector by 10-15%. The possibilities are discussed as follows:

Better fuelling systems and practices, upgrading driving and maintenance skills and sound management reporting and control helps to save diesel consumption by 6–11% as per the studies conducted by the Petroleum Conservation Research Association (PCRA), India. Buses and Trucks belching smoke are visible indicators of poor engine performance, a vehicle emitting visible smoke consumes nearly 10% more diesel. The black smoke mainly arises from defective injectors, defective fuel injection pumps and poor engine compression. Proper maintenance of the fuel injection system and top engine overhaul on schedule will practically eliminate smoke in all our vehicles.

Besides maintenance and good driving practices, engine and body design of the vehicles have much to do with fuel consumption. Fitting of turbo-chargers have better fuel economy and ensure that higher power is developed. Similarly, the reduction of drag or air resistance to the movement of the vehicle improves fuel economy. For instance, the extra board commonly carrying on the roof of a truck, is actually a drag on the movement of the truck, and can cause 13 lits. of extra fuel consumption on a 1,000 km run at 80 km/hr. The next important factor is the rolling resistance. Rolling resistance losses are actually a combination of the power required to overcome drive-line friction and to force the flexing and rolling of tyres. The radial tyres with steel belt offer 35% or greater reduction in rolling resistance and they are likely to bring down diesel consumption by 5 to 10%.

Agricultural Sector

Energy sources in agriculture are a mixture of human and animal power, petroleum fuels and electricity. The total energy consumed in this sector was 12,000 tons of oil equivalent in 1983/84, excluding human and animal energy (0.3% of total energy consumption). This sector consumed 8.1% of total petroleum fuels and 2.4% of electricity. The demand for energy in this sector was met by petroleum fuels (95.9%) and electricity (4.1%). As far as agricultural sector is concerned, the conservation of commercial energy is possible in lift irrigation pump sets, tractors, etc. The development and dissemination of labour saving devices will contribute a lot to save human and animal energy.



As the agricultural development situation of Nepal and India is somewhat similar, the case of India is exemplified in order to show the extent of the waste of energy in this sector. Studies conducted by Petroleum Conservation Research Association (PCRA), India and the Institute of Co-operation Management in Gujarat have shown that 30% of diesel consumed in 1983 could have been saved if the right types of pumps and engines had been used and foot values correctly choosen. About 80% of the pump sets being used in India are found to work at an efficiency of only 30%. Similarly, field studies conducted by PCRA have shown that it is possible to save about 15% of diesel consumed by tractors through good operating and maintenance practices.

The higher diesel consumption is not only due to poor efficiency of the engine but also due to poor installation of the entire pumping system. Hence care needs to be taken with regard to (i) Foot values (ii) Suction and delivery pipes (iii) Bend Fittings (iv) Transmission of power, and (v) Maintenance of engine.

Discussions

The sectoral energy consumption pattern mirrors the rural agricultural nature of its economy, and the small size of its modern industrial and commercial sectors. The rural areas depend on traditional fuels for virtually all of their energy requirements. On the other hand, growing population and the demand for the expansion of agriculture land have placed the forest under heavy pressure which is leading to the use of more and more agricultural wastes and animal dung as cooking fuels. This reduces the productivity of the agricultural land resulting in its expansion which further reduces the forest cover and thus damages the environment.

Moreover, with the rise in the standard of living and modern sector of the country, commercial energy requirements in all sectors are bound to increase rapidly and, consequently, the pressure on petroleum fuels is also bound to increase. In Nepal, during the period 1970/71 to 1983/84, the average annual growth rate of commercial energies and petroleum fuels was about 6% and 7%, respectively. Although only about 3.5% of energy demand was met by petroleum fuels, about 53% and 40% of the country's export earning had to be diverted to import the petroleum fuels in 1982/83 and 1983/84. Hence, it is essential for Nepal to conserve energy as well as to develop its indigenous energy sources as far as applicable without further delay. In addition to that, due to the country's difficult geographical topography and the large investment required for large capacity hydro-generation, it is necessary to give higher priority to the development of decentralised energy systems such as; micro-hydro, bio-gas, etc., without forgetting the development of large power generation system, transmission and distribution network and exploring the possibility of power sales.

The investment required to save a unit of energy will be less than that required to produce the same unit of energy. For example, 1 unit of electricity can be saved by putting off electrical appliances, when not necessary, but the production of the same amount of electricity means some monetary investment. Conservation efforts therefore require strong

and purposeful commitment on the individual basis as well as on the national scale.

Recommendations

Keeping in view the above discussions, the following recommendations are suggested in order to conserve energy. This list is not exhaustive although it provides the guideline for further sectoral studies on conservation possibilities.

- The use of efficient cooking appliances such as Improved Cooking Stove (ICS), Efficient Kerosene Stoves, etc. should be promoted.
- Only the efficient kerosene stoves and LPG stoves should be promoted.
- The use of electric cooking and heating appliances should be discouraged.
- The use of the pressure Cooker should be encouraged.
- Only dried fuelwood should be marketed.
- Bio-gas utilization should be promoted.
- Densification of agricultural wastes should be encouraged with proper incentive programmes.
- The study of total energy concept in new industries should be made compulsory.
- The use of low excess air burner, water-in-oil emulsion burner and regenerative burner should be promoted.
- The conventional shell and tube heat-exchanger should be replaced by ceramic recuperators, plate heat-exchangers, heat pipes, etc.
- Use of low temperature heat recovery system in the existing and in new industries should be carried out.
- Replacement of fuelwood burning boiler with rice husk boiler should be encouraged providing necessary incentives.
- Every industry should make an energy audit which should be sent to government bodies on a regular basis.
- Only spare parts of high quality should be imported.
- Use of radial tyres should be made compulsory.
- Extra board or any obstruction on the roof of motor vehicles should be prohibited.
- The quality of existing petroleum supplies through a regular testing programme should be ensured.
- A mandatory vehicle maintenance and inspection programme as a part of an overall safety projects and upgrading driving and maintenance skills and sound management reporting and control should be instigated and a better fueling system and practices should be promoted.
- Only the import of efficient vehicles, available in the international markets, should be allowed.
- Existing road improvement programmes should be continued with particular emphasis on alignment changes which would reduce both distance and grade.

- The import of luxury vehicles should be discouraged.
- The mechanics who maintain the engines should be certified and every vehicle should possess a vehicle maintenance chart to be checked every now and then.
- Proper maintenance and proper installation of pumping system should be carried out by cretified mechanics.
- Efficient pumping systems should be imported.
- The research, manufacture, development and dessimination of labour saving technologies should be given higher priority.
- Substitution of imported petroleum fuels with indigenous hydro-power energy should be promoted as far as applicable.
- Decentralised energy resource development should be given priority.
- National level energy conservation planning and implementation should be carried out without delay.
- Periodic review of the energy pricing structure should be done in order to encourage conservation of energy.
- National policies should reward efforts at conservation of energy made by industries as well as individuals.
- Alternative energy users should be encouraged as far as praticable.
- Pamphlets, notes etc. such as; How to Trim Domestic Fuel Bills, Fuel Economy through Good Driving and Maintenance, etc., should be published and distributed to users level.
- Energy studies should be made compulsory in school and certificate courses.

Selected Referances

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