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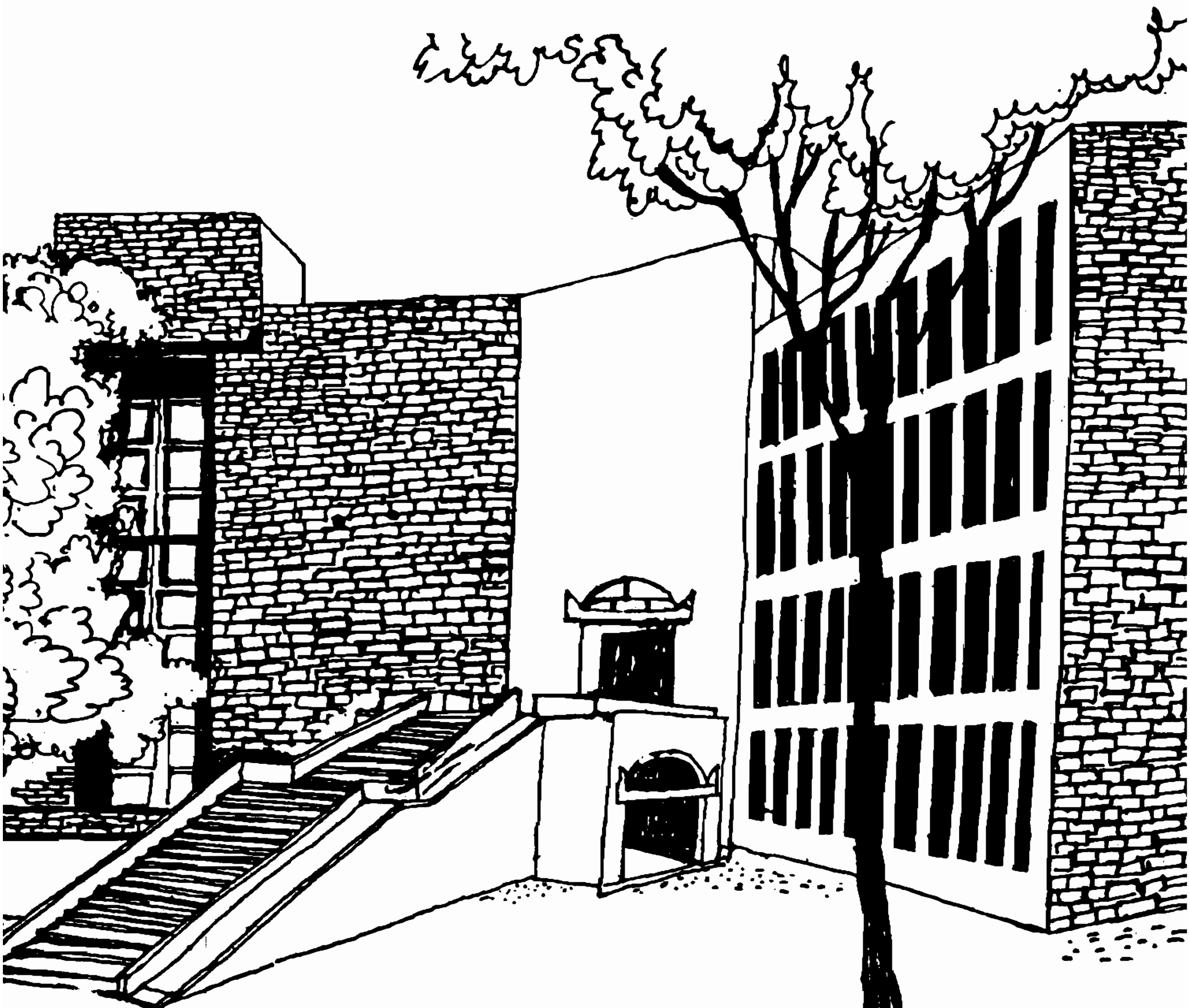

ENERGY-ENVIRONMENT DYNAMICS IN A MEDIUM SIZED TOWN

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ENERGY-ENVIRONMENT DYNAMICS

IN A MEDIUM SIZED TOWN

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1. INTRODUCTION

1.1 Energy, Environment and Development

Energy is required to supply us with the basic human needs of food, water and shelter and for improving the overall quality of life. A number of activities that require energy are central to improving the quality of life thus enabling economic and industrial growth and encouraging development[1]. In recent years, it has been realised that energy, environment and development are more intimately related than we realized only a few years ago. While development clearly depends upon energy, the availability of energy by no means guarantees sustainable development. Further, energy produced in such a way as to degrade the environment can retard development[2].

Brooke *et al*[3] have rightly pointed out that although advances have been made in the awareness of the relationship between energy, environment and development, the bulk of policy research does not yet reflect a clear understanding of this relationship; nor is it directly relevant to the problems of developing countries. They further go on to say:

- Most energy environment research has a technical or techno-economic focus. Such information is useful in identifying potential but only indicative in providing a basis for designing programs, making policy choices or projecting rates of implementation.
- Many studies look at data for whole countries or regions and jump to conclusions about appropriate policies and interventions. The real gap lies in the absence of studies that start from given target populations, examine the hierarchy of problems from their point of view, and only then select interventions (which may or may not be energy related).

Shukla and Modak[4] point out similar problems with the Integrated Rural Energy Program (IREP) in India : "... IREP will need reorientation in a number of areas. These are, viz. an organizational integration of the planning exercise with the execution aspects of the programs, its integration with the overall developmental planning programs at the block levels and the reconsideration of the role of the planning commission in the whole process."

It is these gaps that this study proposes to fill. In India, there have been a number of studies on energy, environment and the environmental impacts of energy use. This study goes a step further. The energy and environment scenario of a town has been studied so as to improve the *'quality of life'* of the people and ensure sustainable development. Quality of life in a town is determined by fulfillment of energy needs and satisfactory levels of sanitation, water supply, waste disposal, sewerage, health, etc. Institutional and organizational factors and social and cultural context have also been given due importance. The entire exercise has been carried out with the goal of sustainable development in mind. The essence of this idea is that the pattern of development should be such that it meets the needs of the present generation without compromising the ability of the future generations to meet their needs.

1.2 Need for Studying the Urban Areas

Urbanization is assuming increasing importance all over the world and particularly so in developing countries like India. Due to the considerable development which has been taking place in the industrial sector, there has been rapid growth in existing urban centers and also emergence of large new urban

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[1]Gregory Kats; The Earth Summit : Opportunity for Reform; Energy Policy, Vol. 20, No.6, June 1992.

[2]David B. Brooks and Harmut Krugmann; Energy, environment and development: Some directions for policy research: Energy Policy, Vol. 18, No.9, Nov1990.

[3]Ref. 2.

[4]P.R. Shukla and S. Modak; Rural Energy Planning Calls for Reorientation; The Economic Times.

settlements which, too, are developing rapidly. Also cultivation -- the mainstay of rural masses -- engages much larger number of people than it can gainfully employ. Thus, unable to be absorbed in the economic environment of rural areas and lured by better economic prospects in urban areas, some population is always on the move from rural to urban areas in a developing economy. Consequently, with passage of time, the proportion of population living in urban areas will increase.

In India, the urban population as a percentage of total population has increased from 19.91% in 1971 to 25.72% in 1991[5]. The number of urban agglomerations / towns was 2,270 in 1961 and 3,768 in 1991[6].

Table 1.1 :Trends in Urbanization

Population	No. of Towns/Cities/UA's		
	1971	1981	1991
Above 1,000,000	8	10	23
200,000 to 999,999	52	90	110
100,000 to 199,999	89	126	167
50,000 to 99,999	173	270	341
20,000 to 49,999	558	738	927
Below 20,000	1617	2021	2045

In the wake of urban growth come many benefits, not the least of which is improved access to services for large sections of the community. Urbanization also creates a range of problems which frequently widen existing inequalities between different groups[7]. The growth of urban population is paralleled by the growth of demand for a range of goods and services (including energy) to meet their basic consumption needs[8]. Essential needs such as shelter, water, food, transport, health and education must all be found in one way or the other. Many to these goods and services are free in rural areas, but in cities, these are commodities which must all be bought and paid for[9]. For the urban poor, meeting basic needs is a struggle which is as severe as, and different in nature from, that facing the rural poor.

In view of the consequential problems that are created by the process of urbanization there has been a growing concern amongst policy makers, administrators, planners and others about the trends, direction and dimensions of urban growth.

In developing countries, there are a large number of cities and towns. The only factor that makes us classify most of these towns as 'urban' is population. As regards infrastructure, education level and employment pattern, most of these towns are overgrown villages or at most semi-urbanized. In India there are over 4,000 towns / cities, of which 3,400 have a population below 50,000[10]. The growth rate of these towns is quite high and by the end of the century, a very large number of these towns will have a population above 100,000.

These towns are in the process of transition from predominantly rural to urban character. Agro-based and other industries are coming up. There is a shift in fuel-mix from biomass to LPG and electricity. Rickshaws are being replaced by petrol and diesel vehicles. Water supply has shifted from hand-pumps and wells to centralized water supply systems. This transition has repercussions on all fronts. There is an increase in the per capita energy consumption and shift from the locally available energy sources to centralized sources like LPG, electricity, diesel, etc. On the environmental front, there is general deterioration due to waste

[5]Census of India 1991, Paper II.

[6]Ref. 5.

[7]M. Lipton; "Why poor people stay poor: Urban bliss in world Development"; in Gugler, "*The Urbanisation of the Third World.*" Oxford University Press.

[8] H. Richardson ; "*Spatial straregies, the settlement patterns, and the shelter and services policies* " in L. Rodwin *ed.* " Shelter, Settlement and Development", Allen and Unwin, Boston,USA.

[9]G. Leach and R. Mearns; " Beyond the fuelwood crisis : People, trees and land in Africa."; Earthscan,London,UK,1989.

[10] Ref. 5.

water disposal, solid waste disposal and industrial effluents, as most of these are being disposed in an untreated and uncontrolled manner.

It is important to study such towns for the following reasons:

- A lot of research effort has gone into studying the rural energy scenario[11] and the large urban settlements[12]. But these towns in transition have been neglected by both policy makers and energy / environment researchers.
- These towns are growing in an unplanned manner and, if this continues, the quality of life in these towns will soon be quite miserable.
- These towns are still at a stage of development where suitable interventions can not only avoid future problems, but can also uplift and maintain the quality of life in the long run.
- In India and other developing countries, there are a large number of such towns. Thus it is useful and necessary to study them and develop a general methodology. If few case studies of small and medium sized towns were to be undertaken, the particular results would have the potential for much larger application.

2. ENERGY-ENVIRONMENT DYNAMICS IN A MEDIUM SIZED TOWN

Conservation of energy and protection of environmental resources are two of the biggest challenges in planning for a higher quality of life in our communities and sustainable economic development for the society at large.

Not only are the levels of energy consumption in urban communities likely to be higher than in rural areas, but also energy is obtained from a greater variety of sources and consumed in more diverse end-uses. Without a clear understanding of these patterns of energy consumption, it is difficult to plan for greater energy efficiency and resource conservation. It becomes even more difficult to respond to escalating prices, supply uncertainties and inevitable exhaustion of non-renewable sources of energy. Also, patterns of domestic energy consumption in urban areas are far more complex and dynamic than in rural areas. First, in the urban households multiple fuel use is common[13]. Second, type of fuels and appliances used in urban areas vary greatly across different income groups. Third, patterns of urban energy consumption change over time as fuel prices, incomes and the availability of different fuels change

As cities grow, environmental degradation sets in. In the first place, a city grows to cover a large area posing increasing threat to natural resources. Since the availability of land is limited, intense competition develops for the limited space. The most common growth pattern is the sprawl that converts prime agricultural and pastoral land to urban use. Secondly, there is an impact on the surrounding region by the growing demand for energy, food and construction materials. Rapid urban growth leads to accelerated and exploitative draw on the resource base. Large areas around cities are dug up for making bricks and forests are destroyed to provide building materials and firewood. These leave the soil in an unusable condition and various forms of vegetation, insects, animal life and even birds are destroyed. What is of concern is that resources are converted into products which are not biologically degradable and hence cannot be recycled at the end of their utility. Third the metabolism of the city increases resulting in higher generation of harmful byproducts such as waste waters, solid wastes, air pollution and noise[14].

The quality of life in an urban community is closely tied to the nature of production processes, consumption activities and the methods of disposing wastes. Through the creation of public infrastructure, provision of

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[11] See, Shukla *et al, "Decentralised Energy Planning"*, Oxford IBH; Jacob George, *"Household Energy Use Pattern with levels of development"*, National Institute of Rural Development,Hyderabad, India.

[12]Soussan *et al; " Urban fuelwood: Challenges and dilemas"*; Energy Policy,Vol.18.,No.6, July/ Aug. 1990

[13]Ref 12

[14]B.S.Padmanabhan;Urbanisation: Growing Problems; The Hindu Survey of the Environment, 1991.

municipal services and regulation of private activities, the local urban governments try to manage the living environment of their communities.

In India, the rate and pattern of growth in cities of all sizes has been such that traditional planning approaches have failed to provide the appropriate basis for managing the quality of urban life. This study deals with the problem of managing the urban environment. An alternative approach based on examining the energy-environment dynamics in these communities may provide new solutions for some of the most pressing problems of urban life and could serve as a framework for managing growth.

3. SCOPE AND OBJECTIVES

This study attempts to model the pattern of energy consumption in all sectors of the community in a medium-sized town in north India. The environmental impacts of energy consumption in human activities - domestic, commercial and industrial - are assessed. Public systems for providing municipal services are evaluated both in terms of energy requirements and their effectiveness in providing desired levels of service.

Being focused on energy-environment interface, it would be unrealistic to expect the proposed model to serve as a basis of comprehensive planning for the community. It is not the purpose of this study to develop such a tool. However, it is expected that the insights gained from this study would indicate how a community might manage its resources efficiently by devising appropriate strategies for energy conservation and environmental protection.

The specific objectives of this study are:

a). To assess energy consumption in all sectors and to relate this pattern to environmental impacts of the activities in which energy is consumed.

b) To assess the present state of the environment and to study the adequacy of the present level of services being provided.

c) To identify and evaluate policy options for strategic interventions in each major sector in order to:

   - improve the efficiency of energy use in the community and to minimize the negative impact on the environment.
   - improve the level of the municipal services (waste disposal, sewage, etc.) and reduce the environmental hazards due to commercial and industrial activities.

d) To assess the capacity of the local government to mobilize resources for implementing some of the recommended strategies and generate ideas for methods of financing.

e) To evolve a general methodology for application of this model to address issues at the energy-environment interface in other similar communities.

4. PLANNING METHODOLOGY

4.1 Energy Model, Reference Energy System (RES)[15]

A reference energy system (RES) depicts estimated demand, energy conversion technologies, fuel mixes and the resources required to satisfy those demands. The pictorial format of the RES is a network diagram

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[15]P.R. Shukla, Pramod Deo, S. Modak; *"Decentralised Energy Planning"*; Oxford & IBH; P.R. Shukla *et al*; *"Regional Energy Demand Model and Analysis"*; Oxford & IBH.

which shows the energy flow from various sources through conversion devices to the end-uses (final demand). This RES approach allows one to carry out detailed energy demand analysis.

The RES network has three basic components - energy sources, energy conversion devices and energy end use/demand. It helps in deriving the effect on the sources if the demand pattern changes. Once the energy flows are known, it is also possible to derive the effect of changes in device efficiencies and resource availability. An RES is made as is shown in figure 4.1.

The first step in the RES analysis is to create in as much detail as possible energy supply, demand and the flow relationship based on existing data. Energy consumption in medium sized towns in developing countries can be broadly classified as consisting of the consumption in household, industry, transportation, municipal services and those agricultural activities in the hinterland for which energy is supplied from the town. Among domestic activities, the energy requirements are broadly for four end-uses: cooking, water heating during winter, lighting and operating household electrical appliances. In the transport sector, diesel and petrol vehicles are typically used for inter-city movement but rickshaws and horse-pulled tongas are used along with two-wheelers for transport within the city. In the municipal services sector, the two main functions for which energy is consumed are street lighting and public works. In the commercial sector the pattern of energy consumption is use of electricity and kerosene for lighting; LPG, Kerosene and coal for cooking in restaurants, electricity for appliances such as fans, etc. In the industrial sector, energy is mostly used for electric drives or for process heat requirements.

4.2 Environmental Impact Assessment System (EIAS)

Environment impact assessment is an activity designed to identify and predict the impact on the bio-geophysical environment and on the health and well-being of humans and to interpret and communicate information about these impacts[16].

The EIAS for the present study estimates the nature and magnitude of the likely environmental changes due to energy use and generation and disposal of wastes and sewage. The criteria for measuring the significance of environmental change are human health, ambient air quality, effects on land and water and irreversibility of environmental change. Based on the above criteria, the impact of environmental change is estimated. Finally, recommendations are made for remedial action. A schematic representation is shown in Figure 4.2.

Air Quality : Managing air quality involves the following:

1. The identification of the sources of pollutants.
2. Deciding the major pollutants to be monitored.
3. Estimation of the quantity of pollutant emission.
4. The impact of the pollution level on human health.
5. Possible mitigation measures and implementation plans.

For the present study the sources considered are vehicles, industrial processes, fuel use in domestic sector, fuel combustion in stationary sources (diesel generators). The emissions of four critical pollutants - sulphur dioxide (SO_2), nitrogen oxides (NO_x), solid particulates (SPM), and carbon dioxide (CO_2) - have been studied. The emission model calculates the quantity of these air pollutants released as a result of energy use. The calculations are performed on an annual basis. As input to the emission model, the annual energy consumption is given for each fuel type. These data come from the energy demand model (RES). Once the quantity of the pollutants has been estimated, the resulting ambient air quality can be assessed. The possible impact of the pollution level on human health is studied. Finally, mitigation measures have been suggested. The structure of the sub-model is shown in Figure 4.3.

Managing of Wastes : The overall objective of waste management is to minimize the adverse environmental effects caused by the indiscriminate disposal of wastes. To assess the management possibilities, it is important to consider:

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[16] R.E. Munn; *"Environmental Impact assesment"*; John Wiley & Sons.

Resource(i)	*Device(j)*	*End Uses(k)*
Firewood	Chulha	Cooking
Dung	Chulha	Cooking
Coal	Chulha	Cooking
Kerosene	Ker. stove	Cooking
	Ker. lamp	Lighting
LPG	LPG stove	Cooking
Diesel	Vehicles	Transport
	Generators	Elec. gen.
Petrol	Vehicles	Transport
Electricity	Bulb	Lighting
	Tube light	Lighting
	Mercury lamp	Lighting
	Sodium lamp	Lighting
	Elec. appl.	House hold
	Elec. drives	Industry
	Motor/pump	Water pumping

Figure 4.1 : Reference Energy System.

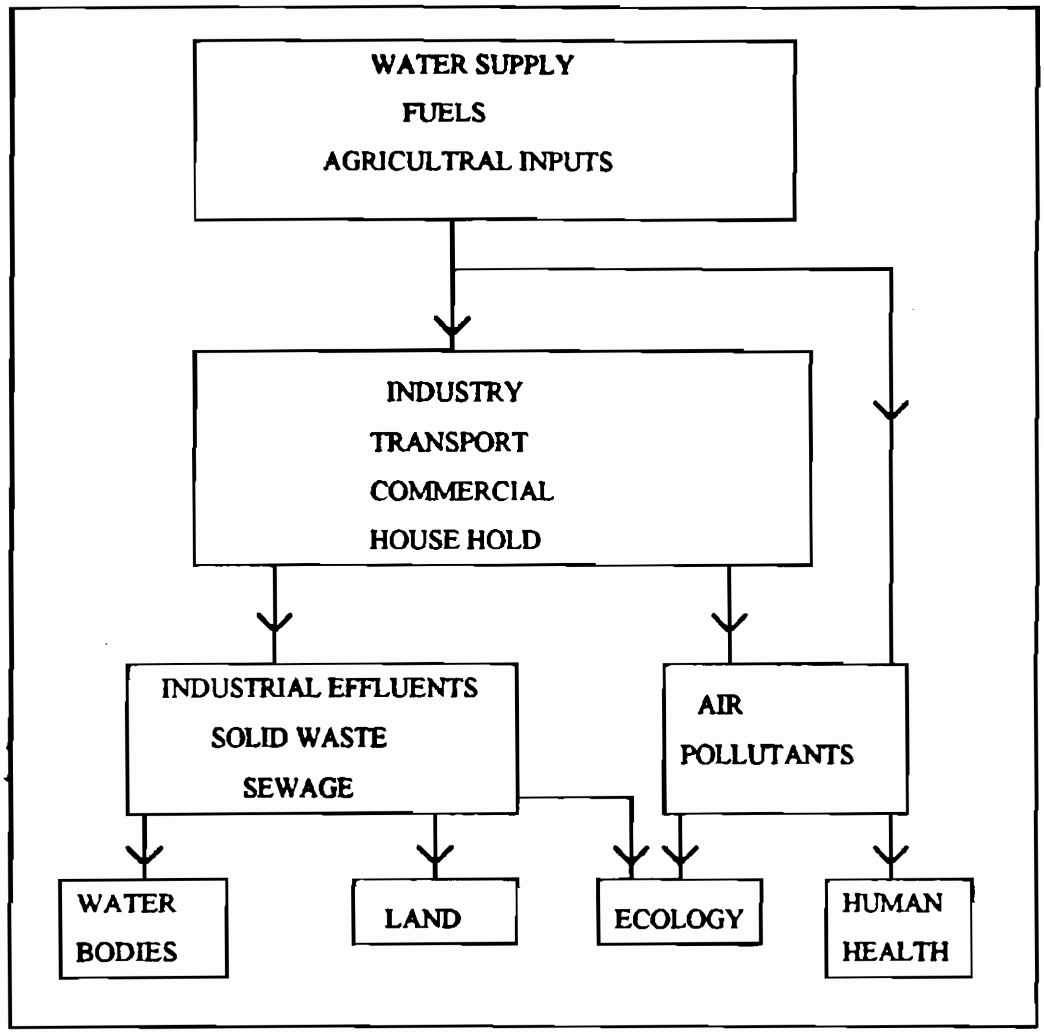

Figure 4.2 : Environmental Impact Assessment System (EIAS)

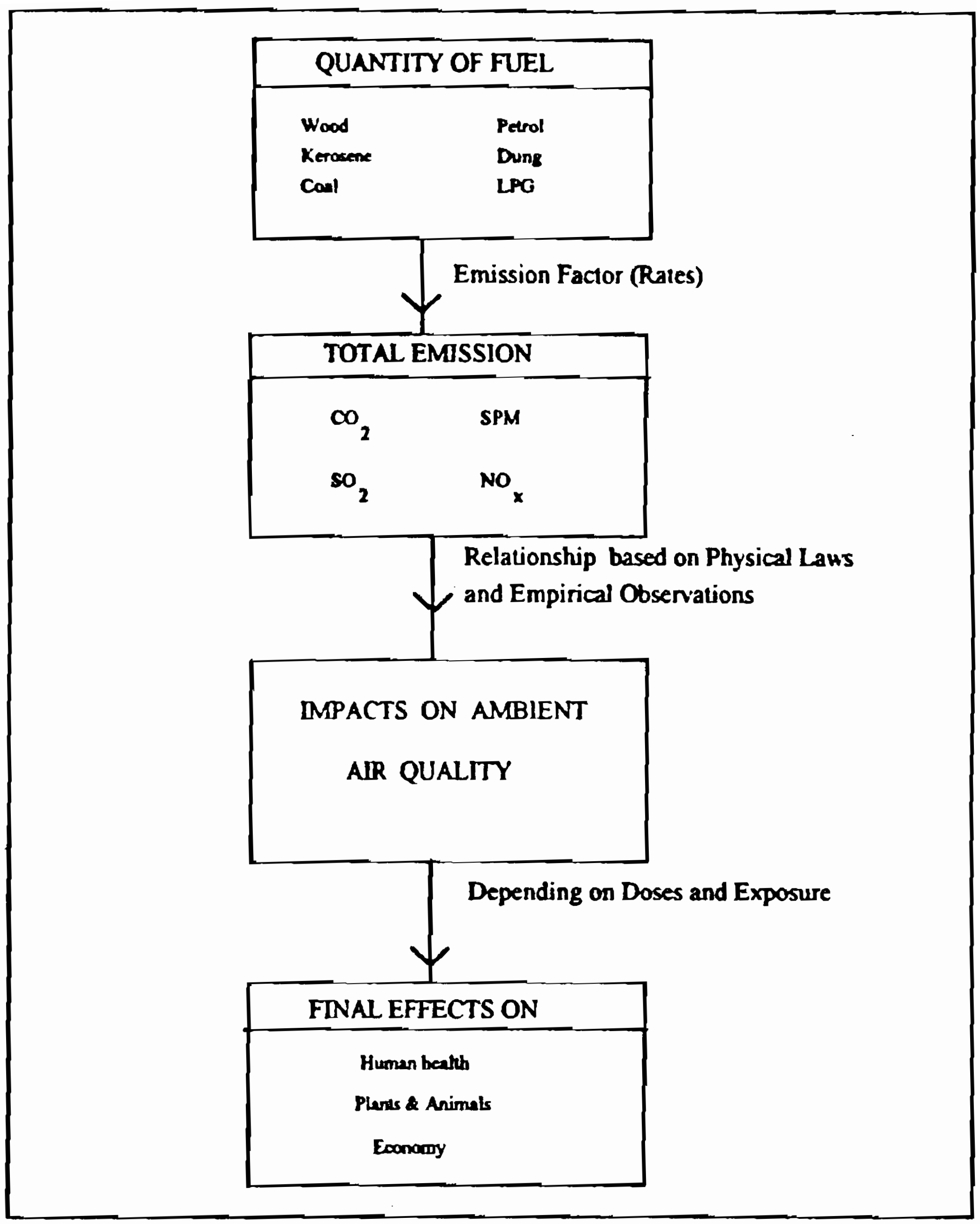

Figure 4.3 : Emission Model

1. The material flow and the generation of wastes in society.

2. The assessment of day-to-day waste management methods.

3. The impacts of waste disposal methods.

4. The mitigation measures - reduction in raw material usage, re-use of materials, material recovery, energy recovery, improvement in treatment and disposal methods.

The material flow and waste generation in society is shown in Figure 4.4. For the present study, the municipal wastes (primarily domestic and commercial) and industrial wastes have been studied. Solid wastes and waste water (sewage and industrial effluents) have been studied separately.

Waste water Management : For the present study, the quantity of effluent and waste water discharged by all sectors has been estimated from the amount of water used. The adequacy of treatment methods has been judged keeping in view the standards for disposal. The quality of waste water disposed has been estimated from the records of U.P.P.C.B. (Uttar Pradesh Pollution Control Board). The possible environmental impacts of waste water disposal on human health and agriculture have been assessed and mitigation measures and implementation plans have been suggested.

Solid Waste Management : The functional elements comprising the solid waste management system are shown in the Figure 4.5.

For the present study, the total solid wastes produced in the town (the domestic and industrial sector) have been estimated from the survey. The composition and quantities generated are assumed to be similar to the averages reported in the literature, for such towns in India. The amount of waste disposed by the municipal body and the adequacy of the collection and disposal system have also been assessed. Finally the environmental impacts of the present system of management have been assessed and alternatives have been suggested.

5. DATA COLLECTION

The basic requirement of any planning exercise is relevant and accurate information. A careful audit of data requirement was done before starting the process of collection. The RES and EIAS were useful for this purpose also. A preliminary sketch of the systems was made to understand the energy, pollutants and wastes flows. Thus, influencing factors were identified and relevant energy and environment data collected. Past and present data of population, industrial growth and other socio-economic factors were also collected.

Appropriate survey methodology, explained later, has been used to collect primary data from household and industrial units. Secondary data were available from a number of published and unpublished sources such as Census of India, Municipal Board records, District Supply Office records, etc.

5.1 Primary Data Collection

The process of primary data collection involved identifying the units of inquiry, developing an appropriate questionnaire, drawing out a sample which is representative of the town and carrying out the survey.

Two surveys need to be carried out for a complete estimation of energy demand and generation of solid wastes and waste water. The units of inquiry were individual households and industries. The respondents social background, awareness level, education and understanding of the exercise, were kept in mind while designing the questionnaire. Also, the questionnaires were filled by the face to face interview method so that the questions could be asked in a manner to evoke correct responses. For example, a question like "How much wood do you consume in a year?" may not get the correct information. Instead, the same information could be sought by asking "How much wood do you buy at a time?" followed by "How long does this amount of wood last?".

5.2 Secondary Data Sources

The secondary data for this study were obtained from a variety of sources.

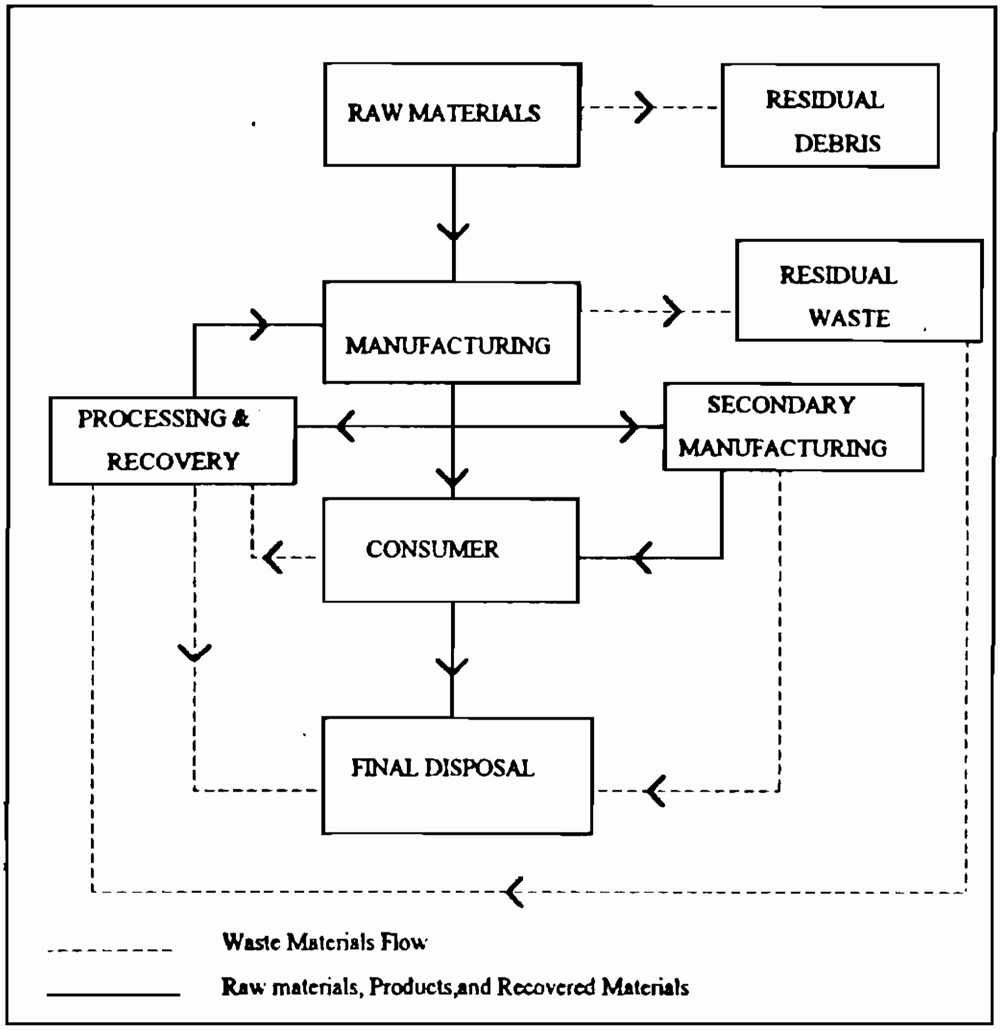

Figure 4.4 : Generalised Flow of Material and Generation of Waste

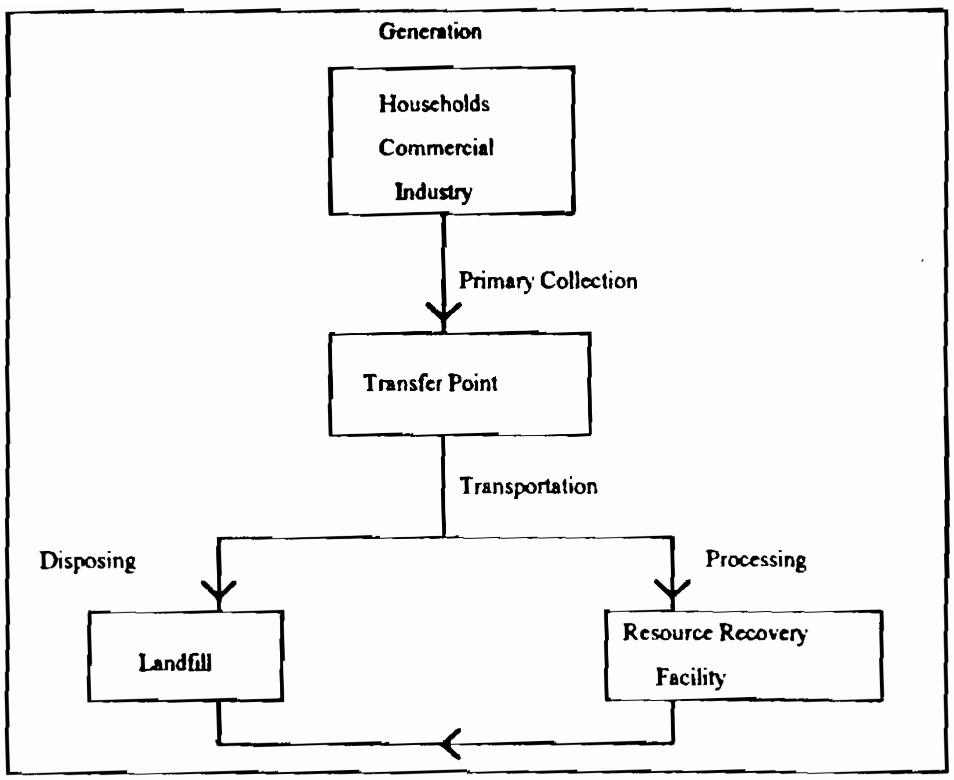

Figure 4.5 : Functional Elements of a Solid Waste Management System

a) Census of India, Town Directory.

Since the 1971 Census, a state level town directory is brought out as a source of basic data in respect of all towns of the state. Some very useful information is available in the town directory. Statements I to VI of the town directory provide range of demographic, social and economic data. Information relevant to energy/environment planning available is: location, land use map, system of sewerage, water supply, electrification, trends in urbanization, climate, etc. But as a census is carried out every ten years, the data may be outdated in many respects at the time of the planning exercise. Yet the town directory may provide a good town profile which is very useful before going in for detailed data collection.

b) Municipal Board Records.

The Municipal Board records are a very valuable source of detailed information regarding services being provided, municipal finance, maps, etc. Both the latest and the past information is available, which is useful to study trends. Also, since the municipal board is responsible for sanitation, waste disposal, water supply and other services, it is important to know about its structure and resources to be able to make any meaningful suggestions.

c) State Electricity Board Records.

From the divisional or sub-divisional office of the state electricity board, it is possible to get data on the load utilization pattern for different connected loads in the town. From the billing section, it is possible to get data on the connected load and the total units consumed annually by domestic, commercial, institutional, street-lighting and industrial consumers in the town. The local electrical sub-station has meters connected to the feeders supplying the town. A daily record of the meter readings is maintained at this station. These would give the actual annual electricity consumption. If the historical series is available, it could be used to make future projections of the electricity consumption. For this purpose the historical data of the number of connections given per annum and the connected load would also be required; where the staff is cooperative this information can be taken from the billing section at the subdivisional office.

d) Petrol pumps and Oil Companies Records.

Data regarding supply of diesel, petrol and LPG to the town is available from the various oil companies (IOC, IBP, HP) or from the petrol pumps in the town. A fairly accurate estimate of the amount of petrol or diesel sold to consumers outside the town (mostly, people from villages around the town), can be made by talking to the owners of the petrol pumps.

e) District Supply Office.

The supply of a number of commodities is controlled by the government. Reliable supply data about these commodities can be taken from the District Supply Office (DSO), for example, the amount of kerosene or coal supplied to the towns.

6. ANALYSIS

The data regarding the energy consumption in all activities of the town have been organized on the basis of the RES and EIAS. But, before discussing the tabulation of the data, it is important to understand that there are two measures of energy consumption, potential energy and end-use energy.

6.1 Measures of Energy Consumption

On the supply side, the physical quantity of energy supply source has certain energy embodied in it. This can be labeled as ***"Potential Energy"*** available from source[17]. This total energy contained in a fuel is not available for use. The amount of energy that a user can avail for his needs depends on the efficiency of the end-use device used. At the same time since the user's energy needs for a particular activity can be met

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[17]Shukla *et al*; *"Decetralised Energy Planning"*; Oxford IBH.

from different fuels by using different devices, the potential energy consumption can be thought of as being variable with respect to device and fuels in use.

The amount of energy finally used for any particular activity in accounting for the conversion efficiency of devices, is termed as ***"End-Use Energy"***. The end-use energy per unit of any particular activity remains the same irrespective of the energy source and the device. The end-use energy is a planning parameter and the ultimate focus of the energy planning exercise must be to meet these needs. In doing so, the exercise must lead to the least cost option in the economic sense. All energy conservation options have, therefore, to be related to their overall economic feasibility vis-a-vis the current available options[18].

The end-use energy is the true energy demand at the user's end. The potential energy gives the fuel required from the supply side for a particular fuel and device system.

6.2 Cost Analysis

The aim of the planning exercise is to meet the demand at a minimum cost. Thus, the cost has to be estimated per unit of end-use energy. The following example explains these concepts:

If one kg. of kerosene is used for cooking, then the potential energy is equal to 11,000 KCal; if the kerosene-stove efficiency is 55% , then the end-use energy is equal to 0.55 x 11,000 = 6,050 KCal. Further, if the price of kerosene is Rs. 5.00 per kg, the price of end-use energy from this link equals 5/6050 Rs per KCal.

Once we have all the data from the sample survey and secondary sources, a convenient way of organizing the data is:

Firstly, a graphical representation of the RES and EIAS, then the tabulation of data on the basis of the RES and EIAS. Data have been tabulated in the format shown in the Annexure III and in the case study using a spreadsheet software (Micro Soft Excel).

Tabulating data in this format is very useful for identifying inefficient links in the RES and the places for suitable interventions. Also, once such a table is ready, the energy consumption on the sectional basis or end-use basis can be calculated. This has been used as an input for the EIAS emission model.

6.3 Scenario Building

It is quite difficult to predict the future with regard to energy and environment because of the intricate manner in which energy use and environmental effects are related to human activities. What will be the future energy demand if things go on as they are?. If certain interventions are made how will the energy consumption pattern be influenced? What will be the environmental implications of these interventions?.

The writing of alternative futures often referred to as scenario building, is a convenient tool for studying interventions of complex uncertain factors. Broadly described, scenarios are hypothetical sequences of events constructed for the purpose of focusing attention on casual processes and crucial times for decisions. Scenario building is a detailed examination of the possible futures and the consequences of the assumptions made about them. This set of futures may provide a better view of what is to be avoided or facilitated, the type of decisions that are important, and the points in time after which various decision branches will have been passed.[19]

In the present study, three scenarios have been built. First is a short-run scenario for the year 1995. Second is a medium-term scenario and the third is a long term scenario for the year 2020. These have been discussed in detail in Section 12.

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[18]Ref. 16.

[19] Management of Energy/Environment Systes; IIASA.

7. CASE STUDY: ENERGY ENVIRONMENT DYNAMICS OF "Baheri"

From 1971 to 1991 there was a 45% increase in the number of urban settlements in India. The number of towns/cities/UA's[20] was 2,497 in 1971 and 3,613 in 1991. The largest growth in the number of towns was in Uttar Pradesh (U.P.) with an increase of 116.6%. UP has a growing economy and it is expected that the pace of urbanization in the state will continue. Therefore, 'Baheri' a town with a population of 46,000 (Census of India, 1991) and a few industries has been chosen for the study. The population and growth rate in Baheri for the last few decades is shown in the table below:

Table 7.0 :Population and Growth Rate

Year	Population	Growth Rate (%)	
		Decadal	Annual
1941	9,994		
1951	10,891	8.98	0.86
1961	15,406	41.96	3.53
1971	21,094	36.92	3.19
1981	29,680	40.70	3.47
1991	46,000	62.14	4.95

8. TOWN PROFILE

Baheri is a tahsil in Bareilly district, Uttar Pradesh. The Tahsil consists of Baheri town area and adjoining villages and agricultural land. For the present study the Baheri town area has been considered. The town is 50 kms from Bareilly, 250 kms from Delhi and 333 kms from Lucknow. The location has been shown on Map 1.

The town of Baheri has an area of 3.58 sq. kms and a population density of 8,291 persons per sq. kms. The growth pattern over the last one decade is shown in Table 8.0. Map 2 shows the town of Baheri. To the north of the town flows the Kicha river. The river is about 4 kms from the town and is not shown in the map.

Table 8.0 : Town Profile : Basic Data

	1981	1991
Area (Sq. Km.)	3.58	3.58
Population Density A	8,291	12,849
No. of Households #	4,538	8,500
A Persons per Sq. Km. # Including houseless households		

8.1 Civic and other amenities:

8.1.1 Water Supply

Water for all domestic and commercial activities is supplied by the municipality. The average supply is 75 litres per person per day. There are two tanks of capacity 2,500 kl and 100 kl respectively and three pumps of 25 HP, 28 HP and 30 HP respectively. The water is supplied during the following hours: 5-9 a.m., 12-2

[20]UA: Urban Agglomerations.

p.m., 5-9 p.m. (i.e. total 10 hours daily). At present, the water is chlorinated before supply, using bleaching powder. The water quality is checked by the CMO (Chief Medical Office, District Hospital) of Bareilly. There is a plan to lay a 21 km line and install two new tube wells in the near future. The estimated cost is Rs. 44 lakhs.

8.1.2 Solid Waste Disposal

The Sanitary Inspector is in charge of the solid waste disposal. There are 57 employees in all who use 31 hand carts and 2 tractors with trolleys. A trolley can carry 30-35 quintals of waste and 3-4 such loads are disposed in a day. All the solid wastes are disposed through land filling.

8.1.3 Sewerage and Disposal of Night Soil

There are no underground sewer lines. Throughout the city there are open surface drains. About 5% of the houses have septic tanks. From the rest of the houses, the jamadars collect the night soil and dump it outside the city. The decomposed night soil is bought by villagers at about Rs. 100 per ton to be used as fertilizer.

A World Bank aided plan is to be implemented. Two tanks will be made in all houses. The latrines of the house will be connected to these tanks. Each tank will be large enough to last two years. Once a tank is full, it will be closed for composting and the other one would be opened.

8.1.4 Electrification

The trends in electrification of the town are shown in Table 8.2 The light and fan connections include both domestic and commercial sectors. The power connections include mainly industrial and two or three domestic sector consumers who are using air conditioners in their houses. The percentage of households having electrical connections was 20% in 1981 and 25% in 1991.

Table 8.2 : Electrification Trends : Number of Connections

Type of Connection	1981	1991
Light & Fan	1,310	2,100
Power	70	120
Street Light	417	776

Street Lighting

The electricity charge for street lighting is paid on the basis of connected load. The connected load is shown in the Table 8.3 below. The total road length is 71 kms. Thus, on an average, there is one street light per 15 metres. The bill for the year 1991-92 was Rs. 532,288.

Table 8.3 : Street Lighting : Connected Load (1991-92)

Fixture	Wattage	Number
Tube Light	40	127
Bulb	60	474
Mercury Lamp	125	120
Sodium Lamp	200	51
Sodium Lamp	400	4
Total Load (kW) = 60.32		

8.2 Local Administration

Municipality:

In Baheri, there is an elected body which consists of the Chairman, 16 elected members, 3 nominated members, 1 MLA and 1 MP. Further, there are a number of state government employees. An Executive Officer is the overall incharge of the administration. The other employees are: Tax Superintendent, Sanitary & Food Inspector, Water Works Engineer, Junior Engineer, few Clerks and a number of other employees for solid waste disposal, street sweeping, etc.

8.2.1 Municipal Finances

Table 8.4 : Municipal Finances ,1981.

S.No.		Amount (Rs)	% of Total
	Receipts		
1.	Revenue through taxes	865,000	66.35
2.	Revenue, other sources	41,700	3.20
3.	Government grant	142,800	10.95
4.	Loan	-	-
5.	Advance	32,100	2.46
6.	Other Sources	221,800	17.01
	Total	1,303,600	
	Expenditure		
1.	General Administration	158,500	16.97
2.	Public Safety	32,800	3.51
3.	Public Health and Conveniences	380,300	40.73
4.	Public Institutions	10,200	1.09
5.	Public Works	184,300	19.74
6.	Others	167,700	17.96
	Total	933,800	

8.3 Transport

The major modes of transport used for traveling within the city are private two-wheelers (scooters and motorcycles), pedal rickshaws and horse-pulled tongas. The people of the town travel a lot to Bareilly city (50 kms) by minibuses and jeeps which are being used as taxis.

Table 8.5 : Modes of Transport & Distances Traveled

Mode	Number	Distance #
Jeeps	30	2,737
Minibuses	34	2,073
Two Wheelers	500	3,650
# Distance traveled annually in 1000 person-kilometers (PKms)		

8.4 Industry

Messrs. Kesar Enterprises Ltd., Baheri, is a major industry in Baheri. It has a sugar division and a distillery. In the year 1991-92, 740,000 metric tones of sugarcane was crushed. Apart from this, there are 7 rice mills, 2 ice factories, approximately 20 flour mills and 20 oil mills. The flour mills, oil mills and two ice factories cater to the needs of the local people. The paddy for the rice mills comes from the rural areas around Baheri around and the rice, rice husk and bran are all sold outside the town.

9. ENERGY CONSUMPTION PATTERN

The annual consumption of fuels for various end-uses was estimated from the survey of 225 houses, 25 commercial establishments, 3 rice mills, and the sugar industry and distillery, and secondary data from a number of sources. Table 9.0 shows the annual consumption of various fuels in the town. The details of data collection for energy consumption in various sectors are given in Sections 9.1 to 9.3. The details of electricity consumption in various sectors are given separately in Section 9.4.

Table 9.0 : Annual Energy Consumption in Baheri (1991-92)

Resource	Amount	Price
Kerosene	1101 Kl	3.00 per litre
Diesel	743 Kl	5.50 per litre
Petrol	249 Kl	18.25 per litre
Soft Coke	45 tons	1350.00 per ton
Electricity	4383 Mwh	1.50 per Kwh
Firewood	11454 tons	1000.00 per ton
Dung	2545 tons	500.00 per ton
LPG	24166 cylinders	71.00 per cylinder

9.1 Consumption in the Domestic Sector

From the Indian Oil Corporation Office at Bareilly, it was found that the total number of LPG connections in Baheri was 2,537 and approx. 10% connections are double connections, i.e. more than one cylinder in one household. Thus, the actual number of households having LPG connections is 2,284. The total annual supply of LPG is 26,739 cylinders weighing 14.5 kg's each and of this 10% is consumed in the hinterland.

From the survey it was found that the households where LPG is used, wood and dung are not used and the average household size was the same in both the cases.

The number of households using wood or dung is estimated to be 6,216. From the survey it was also found that the daily wood and dung consumption of an average household is 5.59 kg's and 1.22 kg's respectively.

Kerosene is used both by the households using LPG and by those using wood/dung. The average monthly consumption is about 6.79 litres per household.

From the coal depots it was learnt that about 5 tons of coal is used annually for domestic purposes. The total annual energy consumption pattern is given in Table 9.1.

9.2 Consumption in the Transport Sector

An accurate estimate of the supply of diesel and petrol to the town was obtained from the records of the Indian Oil Corporation, Bareilly and from the petrol pumps. In the last financial year (1991-92), 550 Kl. of petrol and 7,035 Kl. of diesel were supplied to petrol pumps in Baheri.

By speaking to the owners of all the petrol pumps, it has been estimated that about 90% of the diesel is bought by villagers from nearby villages and is consumed for agricultural purposes. About 40 - 50% of the petrol is also consumed in the hinterland.

From the survey it was found that 481 kl of diesel is consumed by the jeeps and minibuses plying between Baheri and other towns and cities (Bareilly, Kicha etc.). Approximately 380 kl is consumed in various diesel generators in the town. Hence in 1991-92, the estimated annual diesel consumption in Baheri is 743 kl and the annual consumption of petrol is 249 kl. These figures match quite closely with the estimates given by the petrol pump owners.

9.3 Consumption in the Commercial Sector

From the data collected from 3 laundries and 5 restaurants (*'dhabas'*), it has been estimated that 40 tons of coal is consumed in the commercial sector. Kerosene consumption in the commercial sector is mostly for cooking and lighting in the small shops and roadside *"lorries"*[21]. From the survey and municipal office records, it is found that there are approximately 150 shops and *lorries* consuming, on an average, 5 litres of kerosene per day for cooking. About 500 shops use one litre each per day for lighting. About 20 restaurants also use LPG, each consumes 25 cylinders per year.

9.4 Electricity Consumption

From the records of the electrical sub-station and the billing section of the Electricity Board's Divisional Office the data regarding total units of electricity supplied in the last financial year to the town were obtained. According to these, the total electricity consumption in Baheri was 5,496 MWh, of which Messrs. Kesar Enterprises accounted for 1,716 MWh.

The electricity consumption on a sectoral basis is given in Table 9.6 at the end of this section.

9.4.1. Domestic and Commercial Sector

There are a total of 2,108 light and fan connections. These include domestic and commercial connections. Out of these, 10% are commercial connections and the rest are domestic connections. The average consumption of domestic connections, estimated from the records of the billing office of the Electricity Board, is 104 units (kWh) per month. The annual consumption in domestic and commercial sectors as estimated from the survey is shown in Table 9.6.

9.4.2 Industrial Sector

There are 120 power connections. These include 7 rice mills, 2 ice factories, flour mills, oil mills and welding shops, etc. The consumption was estimated from the bills available at the billing office of the Electricity Board. The consumption for 3 rice mills, 1 ice factory, 2 flour mills and 2 oil mills were used to estimate the total consumption. The ice factories operate for 8 hours a day for 3 months with a connected load of 20 kW. The data for the other power connections was estimated from the survey and Electricity Board records. This is shown in Table 9.5. Annual consumption in Kesar Enterprises was taken directly from the monthly meter reading.

Table 9.5 : Electricity Consumption Pattern in the Industry

Connected Load (HP)	Number of Consumers	Hours of Operation	Days	Consumption (MWh)
5	90	4	365	468
20.	10	4	365	216
25.	7	9	365	425
20.	2	8	90	21
			Consumption In Kesar Enterprise	1716
			Total Consumption	2865

9.4.3 Consumption in Street Lighting

The total connected load for street lighting is 60.20 kW. The number and type of fixtures are given in Table 8.3. It is found that all the fixtures work for approx. 10 hours a day. Thus, the total consumption is estimated to be 602 kWh per day or 219 MWh per year. Last year (1991-92), the municipality paid Rs. 532,288 for electricity consumption in street lighting.

9.4.4. Consumption in Water Supply

For supplying water to the town of Baheri, three pumps with power rating of 25 HP, 28 HP and 30 HP respectively are used. These are operated during the following hours: 5 - 9 a.m., 12 - 2 p.m., 5 - 9 p.m. Thus, electricity consumption for water supply is estimated to be 614 kWh per day or 224 MWh per year. At the time of the surveys, the meters for the pumps had not been working for a few months. The payment to the electricity department was being made on the basis that each pump consumes 8,500 units per month.

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[21]"Lorries" here refers to small roadside stalls serving tea/or other eatables.

Table 9.6 : Sectoral Electricity Consumption Pattern

Sector	Annual Consumption (MWh)
Domestic	1,071
Commercial	195
Industry	2,865
Street Lighting	219
Water Supply	224
Total	4,574

10. BIOMASS PRODUCED AS BYPRODUCT OF INDUSTRIAL ACTIVITIES

Rice Husk

In the town there are 7 rice mills with an average capacity of about 1 ton per hour for dehusking of paddy. On average, the mills operate for 9 hours per day over a year. On dehusking, the output is: 65% rice, 5% rice bran and 30% of rice husk. Thus the mills of Baheri produce 6,898 tons of husk in a year.

Baggase

In the process of crushing, one-third of the weight of sugarcane is left as baggase. In Kesar Enterprises, 740,000 MT of sugarcane was crushed during 1991-92 producing 211,902 MT of baggase. Of this, 210,074 MT was used in the industry itself for the production of steam, and 1,827 MT was sold.

11. ENVIRONMENTAL QUALITY

The environmental quality has been examined under the heads of air pollution, solid waste disposal and water pollution in Sections 11.1 to 11.3. The Tables 11.1, 11.2 and 11.3 are derived from the EIAS. The EIAS for the town is shown in Section 4.2.

11.1 Air Pollution

The main cause of air pollution is energy use in various sectors. Emission of four major pollutants due to energy use in various sectors are given in Table 11.1.

Transport Sector: Diesel vehicles are not used for transport within the city. Thus, the emissions due to diesel combustion have not been taken into account. The main source of emissions in the transport sector is petrol.

Domestic Sector: In the domestic sector, combustion of wood and dung is the major source of air pollutants.

Industrial Sector: The only industry contributing significantly to air pollution is Kesar Enterprises. In this industry annually, 210,074 MT of baggase is burnt in the boilers for generating steam. Thus apart from other emissions, there is a major problem of fly ash. The height of the chimney is 30 metres and a cyclone collector has been installed. But still the problem of fly ash is very acute. *According to the people in the town, a 1 cm thick layer of ash is deposited on the roofs of their houses every night.*

Table 11.1 : Emissions due to Energy Use on a Sectoral Basis

Sector	CO_2	SO_2	SPM	NO_x
Domestic	17528	38	179	30
Commercial	908	5	2	4
Transport	635	0	1	0
Industry (Kesar)	169215	105	2374	315

11.2 Solid Waste and Night Soil produced

Solid Waste

The amount of solid wastes produced was estimated from the survey data. The amount of wastes disposed was obtained from the municipality.

According to the Sanitary Inspector of the municipality, 3 or 4 trolleys of waste are disposed daily. Each trolley carries 3,000 to 3,500 kg. of wastes. Thus, approx. 4,152 tons of wastes are disposed annually by land filling in an uncontrolled manner.

Assuming waste generation at the rate of 0 .3 kg per capita per day, total quantity of solid wastes generated in Baheri is estimated to be 5,270 tons annually. Since total collection is only 3,500 kg, it can be concluded that the collection and disposal facilities are not adequate.

Night Soil

According to average standards, night soil is produced at the rate of 0.25 kg per capita per day. Thus, annually approx. 4,391 tons of night soil need to be disposed in Baheri.

About 5% houses in the town have septic tanks. From the rest of the houses sweepers collect the night soil and dump it at a location outside the populated area. Here composting is done and farmers from nearby villages buy the compost at a price of about Rs. 100 to Rs. 150 per ton.

11.3 Water Pollution

Domestic and Commercial Sector

The supply of water is approx., 75 litres per capita per day for domestic and commercial activities. Thus, approximately 1,260 million litres of waste water is produced annually. This is disposed into the Kicha river without any treatment.

Industrial Sector (Kesar Enterprises)

The only industries which contribute significantly to water pollution are the sugar mill and distillery of Kesar Enterprises. The quantity of water used and quality of effluent after treatment are given in Table 11.3.

Effluent Treatment: In the sugar division only primary treatment is done. But, in the distillery, there is a primary effluent treatment plant and a digestor. The effluent before treatment has BOD of 50,000 - 60,000 and after treatment BOD is 4,500 - 6,000. Gas from the digestor is used for combustion in the boiler.

Effluent Disposal: After treatment the effluent is released into the nearby Kicha river.

Table 11.3 : Effluent from Kesar Enterprises

	Sugar Division	Distillery
Water Used	7000 lit. / day	2000 Kl / day
Colour	Grey	Brown
pH	6.91	5.56
BOD	200	6000
COD	480	12800
Suspended Solids	197	1900
Dissolved Solids	432	4202
Oil And Grease	9	18

12. SCENARIOS

In the present study, three scenarios have been built. The first is a Short-Run scenario for the year 1995, the second a Medium-Term scenario for the year 2000 and the third is a Long-Term scenario for the year 2020. These scenarios are driven by a set of assumptions related to two factors:

a). Growth of energy demand in relation to population growth and constraints on availability of certain fuels particularly biomass and kerosene.

b). Possible technological interventions that are realistically feasible and anticipated to be adopted.

It is assumed that generally energy demand would grow in proportion to population growth. However, since no increase in biomass (firewood, dung) is assumed, additional fuel needed for cooking to meet the needs of new population is obtained either from kerosene, coal or LPG.

In the Short-Run scenario i.e. by 1995 it is assumed that LPG connections will be in short supply and only hundred new connections will be given each year. The cooking fuel shortage due to non availability of extra biomass will be met by kerosene. For lighting kerosene lamps and bulbs will be replaced by tubelights. All the traditional chulhas will be replaced by improved cook stoves.

In the Medium-Term scenario, i.e. by the year 2000 in addition to the above, it has been assumed that Kesar Enterprises will go in for co-generation of power and process heat and that the amount of power generated will be 25 KWh per ton of baggase.

In the Long-Term scenario, i.e. by the year 2020, kerosene will not be available, the amount of biomass available will remain same as in 1992, LPG connections will be freely available and the shortage arising due to non-availability of kerosene and biomasss will be met by LPG and coal. All tube lights will be replaced by 9 watt CFTs (compact fluorescent tubes). The power generation by cogeneration at Kesar Enterprises will increase to 100 KWh per ton of baggase, due to availability of better technology.

Figure 12.1 gives the assumptions driving the scenarios.

Assumptions	Scenario A **Short-Run** (1995)	Scenario B **Medium-Term** (2000)	Scenario C **Long-Term** (2020)
1. Energy demand in all sections	Growth proportional to population growth		
2. Solid waste and sewage generation	Growth proportional to population growth		
3. Biomass supply	No increase after 1991-92		
4. Cook stove design	All traditional chulhas are replaced with improved cook stoves		
5. LPG Connections	Hundred new connections per year		No limit
6. Biomass Substitution	Kerosene		Coal
7. Kerosene availability	No limit		Zero (shortage met by LPG)
8. Lighting devices	Only tube lights		Only CFTs
9. Co-generation in industry	None	Full utilisation of baggase in Kesar Sugar Works for co-generation	

Figure 12.1 : Scenario Specifications

13. RESULTS

13.1 Base Year 1992

The total energy consumption is 88910 MkCal, and the per capita energy consumption is 1.86 MkCal. Firewood accounts for the largest share (61 %) of the total consumption.

The total CO_2 emitted as result of fuel use is 19070 tons per annum. The amount of solid waste to be disposed is 9604 tons.

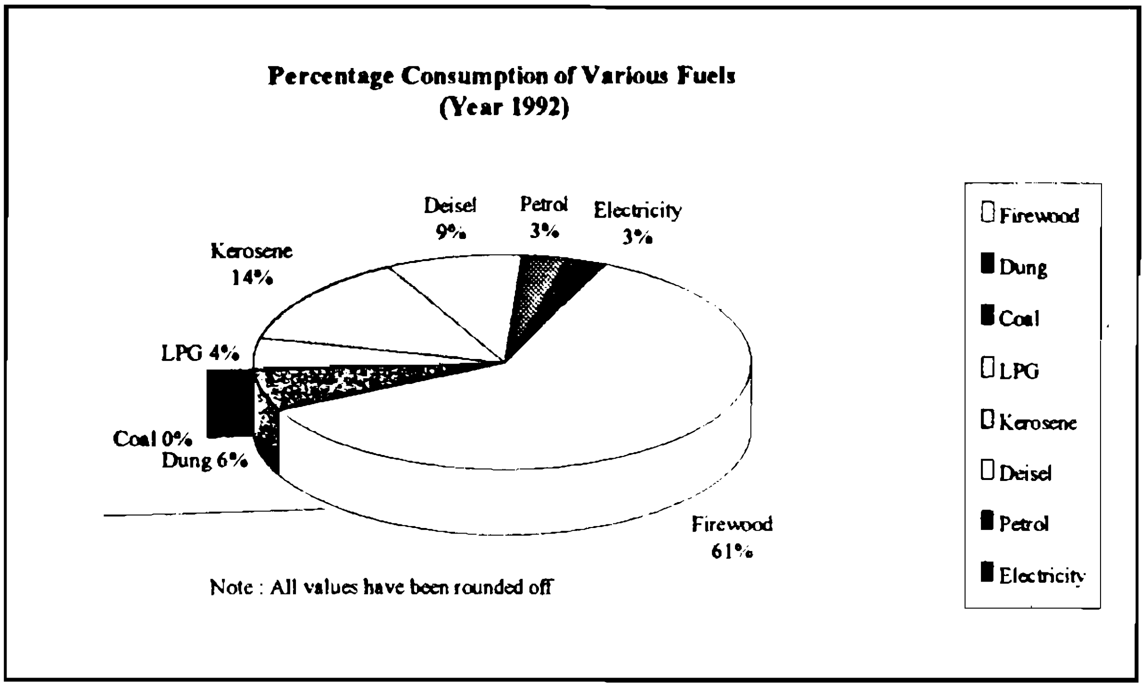


Figure 13.1 : Percentage Consumption of Fuels in Base Year

13.2 Short-Run Scenario (Year 1995)

a). The total energy consumption will be 83514 MkCal - a decrease of 6 % over 1992. The per capita energy consumption will be 1.55 MkCal - a decrease of 17 % over 1992.

b). The maximum increase will be in the consumption of LPG - an increase of 26 %. The maximum decrease will be in the consumption of kerosene - a decrease of 8 %.

c). The maximum increase in the contribution of any one fuel to the total energy consumption will be for firewood, an increase of 3.9 %; and the maximum decrease that for kerosene, 7.7 %.

d). The savings due to the replacement of traditional chulhas (efficiency = 10 %) by improved chulhas (efficiency = 15 %). will be 2981 MkCal. There will be a significant decrease in the consumption of kerosene due to substitution of kerosene lamps by tube lights. The total energy consumption will also decrease due to substitution of all the bulbs by tube lights. The overall saving due to change in lighting device will be 2980 MkCal.

e). Although there will be a increase in emissions due to fuel use in commercial and transport sector, a significant decrease in emission level in domestic sector will lead to overall decrease in emission.

f). The solid waste to be disposed will be 10803 tons. The waste water to be disposed will be 2.37 Mkl.

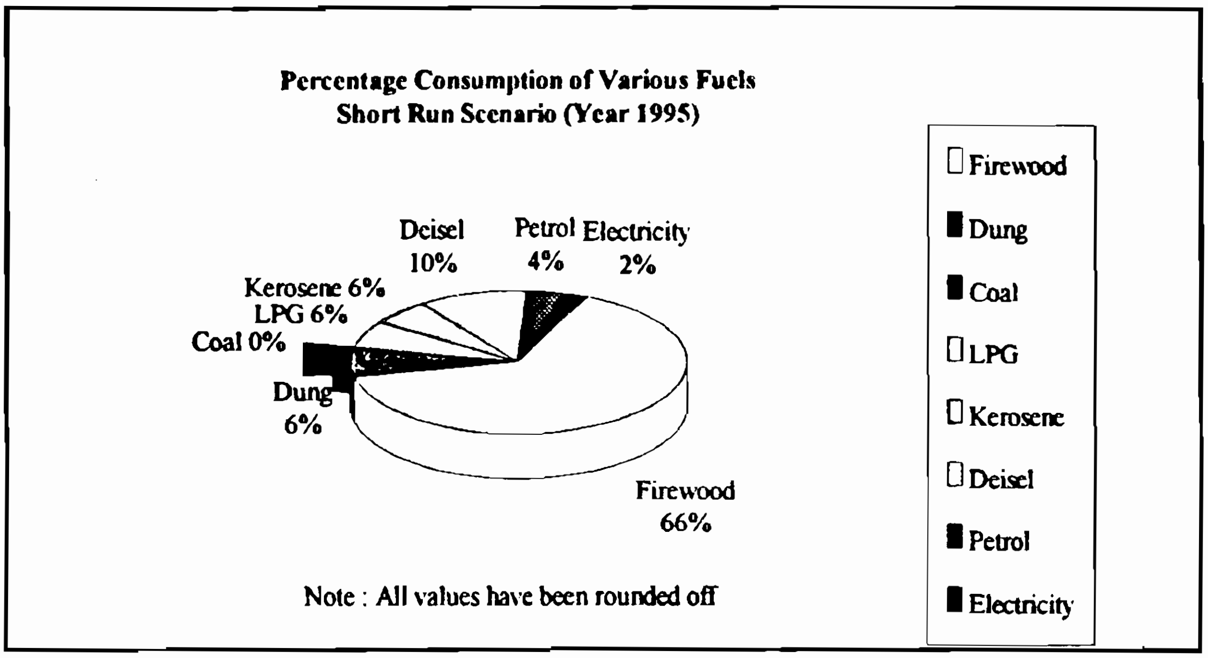


Figure 13.2 : Percentage Consumption of Fuels in Short Run Scenario

13.3 Medium-Term Scenario (Year 2000)

a) The total energy consumption will be 92035 MkCal - an increase of 4 % over 1992. The per capita energy consumption will be 1.41 MkCal -a decrease of 24 %.

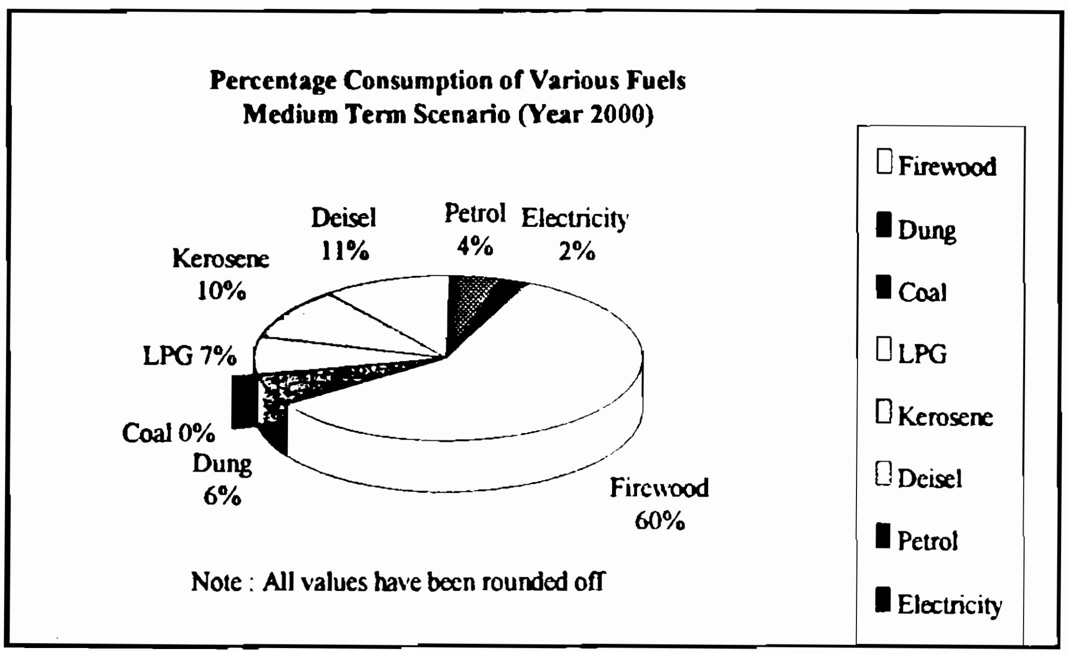
b) The maximum increase will be in the consumption of LPG - an increase of 69 %. The maximum decrease will be in the consumption of kerosene - a decrease of 21 %.

c) The maximum increase in the contribution of any one fuel to the total energy consumption will be for LPG, an increase of 2.85 %; and the maximum decrease that for firewood 3.28 %.

d) Kesar Enterprises will generate approximately 4200 MWh of electricity and will thus be able to meet their own power requirement and supply the extra power to the grid.

e) There will be a 4 % increase in the emission of CO_2 from all sectors.

f) The solid waste and waste water to be disposed will be 13143 tons and 2.69 Mkl respectively.



13.4 Long-term Scenario (Year 2020)

a) The total energy consumption will be 142723 MkCal - an increase of 61 % over 1992. The per capita consumption will be 0.90 MkCal - a decrease of 47 %.

b) The maximum increase will be in the consumption of LPG - a 1284 % increase.

c) The maximum increase in the contribution of any one fuel to the total energy consumption will be for LPG, an increase of 33 %; and the maximum decrease that for firewood 23 %.

d) Kesar Enterprises will generate about 16,000 MWh electricity by co-generation. The savings due to use of CFTs instead of tubes will be approximately 244 MkCal.

e) The total CO_2 released will be 30199 tons - an increase of 58 % over 1992 levels.

f) The amount of solid waste and waste water to be disposed will be 28800 tons and 4.83 Mkl respectively.

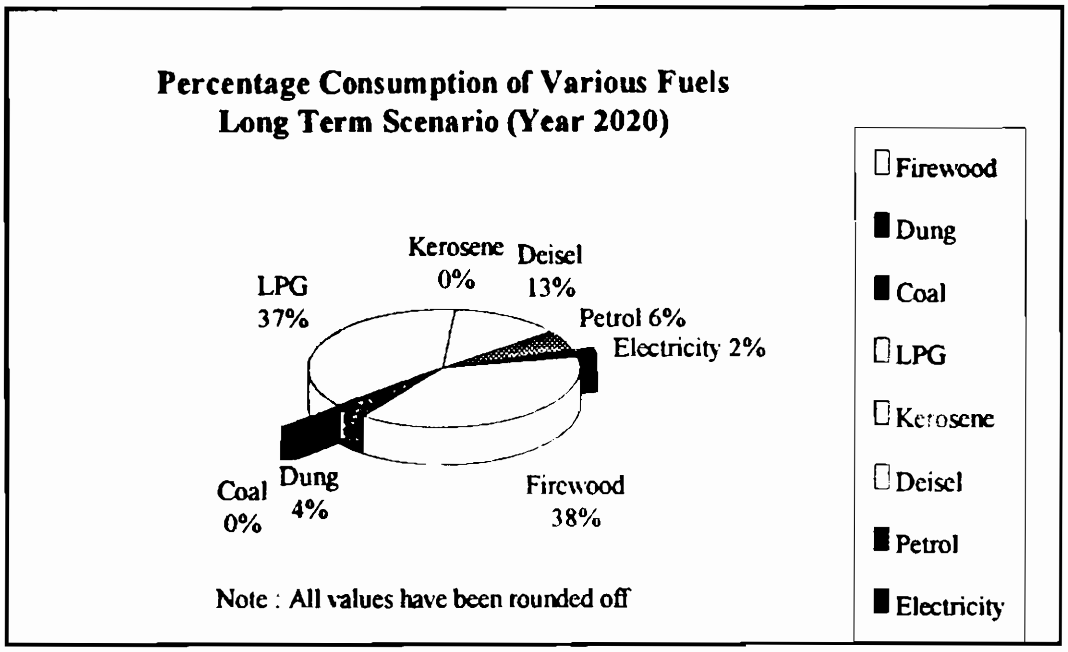


Figure 13.4 : Consumption of Fuels in Long Term Scenario

14. CONCLUSIONS AND IMPLICATIONS

In the short run, although the population grows at the rate of 4 % per annum, the energy demand decreases at the rate of 2% per annum. This is possible if inefficient traditional cook stoves are replaced by improved higher efficiency cook stoves and all lighting devices (kerosene lamps, bulbs) are replaced by tube lights. In the short run it is assumed that cooking fuel shortage due to non availability of biomass will be met by kerosene only as it is a cleaner fuel, easy to use and has higher efficiency.

In the medium term the energy demand grows at the rate of 0.4 % per annum although population grows at the rate of 4 % per year. The energy demand growth is kept down due to the conservation measures taken earlier. Kesar Enterprises produces about 4200 MWh of electricity along with meeting its process needs. This power is enough to meet the needs of the industry and the surplus can be supplied to the grid.

In the long term energy demand grows at the rate of 1.7 % per year. It is expected that by this time kerosene will not be available. The energy deficit due to the non availability larger quantity of biomass will be met by coal and kerosene related deficit will be met by LPG. The per capita energy consumption in lighting will drop by 244 % as the 36 watt tube lights will be replaced by 9 watt CFTs. Further, due to availability of better technology, Kesar Enterprises will produce approximately 16,000 MWh electricity by co-generation with the same amount of baggase.

Significant changes are expected in the energy consumption pattern due to the non availability of certain resources. Use of energy efficient devices can lead to significant changes in the per capita energy consumption. Thus, appropriate programs to promote adoption of efficient devices should be initiated. An important step could be to subsidise efficient devices rather than fuels. Kesar Enterprises should immediately go in for co-generation. In the long term disposal of solid waste by land filling might not be possible due to lack of land, thus waste recycling methods should be developed and put into practice. Also, the release of larger quantity of untreated sewage into the Kicha river will lead to number of health hazards as downstream water from this river is used extensively. Thus, primary treatment facilities for sewage should be planned. Kesar Enterprises should drop the present end of pipe effluent treatment method and reuse water after preliminary treatment wherever possible thus reducing not only the total effluent discharge but also the total water consumed.

Table 14.1 : Summary Table for Projected Energy Consumption

Fuel	Consumption			
	1992	1995	2000	2020
Firewood{Tons}	11454	11454	11454	11454
Dung {Tons}	2545	2545	2545	2545
Coal {Tons}	45	51	62	136
LPG {Tons}	338	426	573	4516
Kerosene {Kl}	1102	448	866	0
Diesel {Kl}	743	803	921	1705
Petrol {Kl}	249	280	341	747
Elec. {MWh}	2667	2377	2641	3451

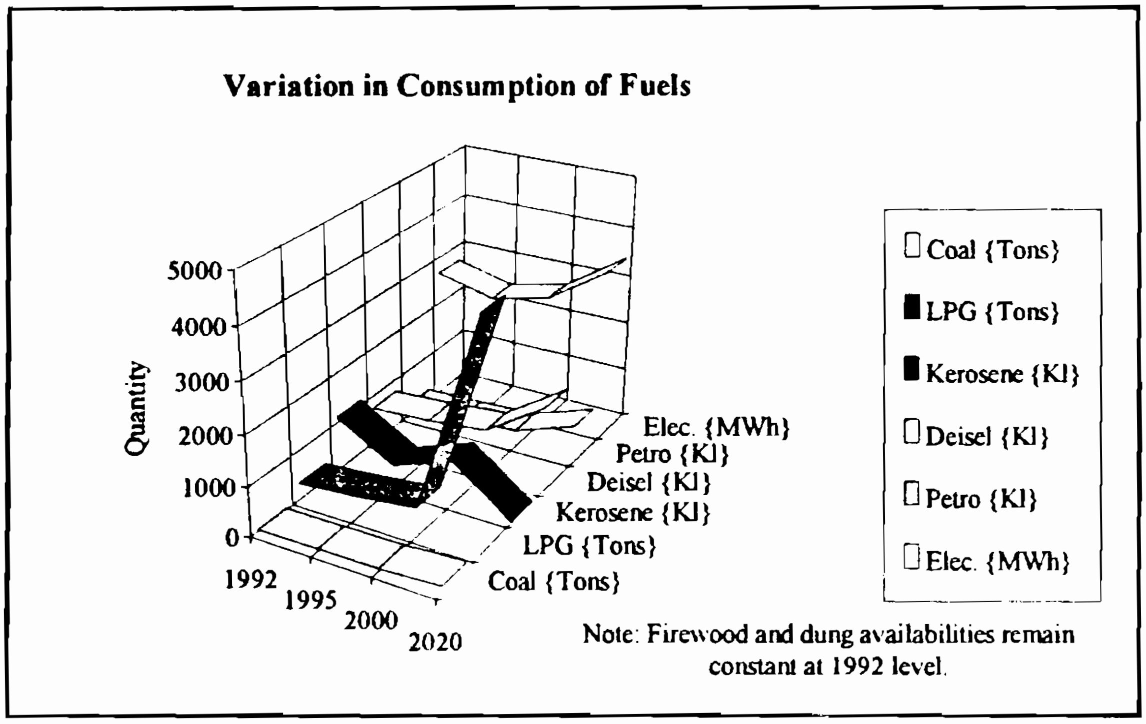


Figure 14.1 : Variation in Consumption of Fuels

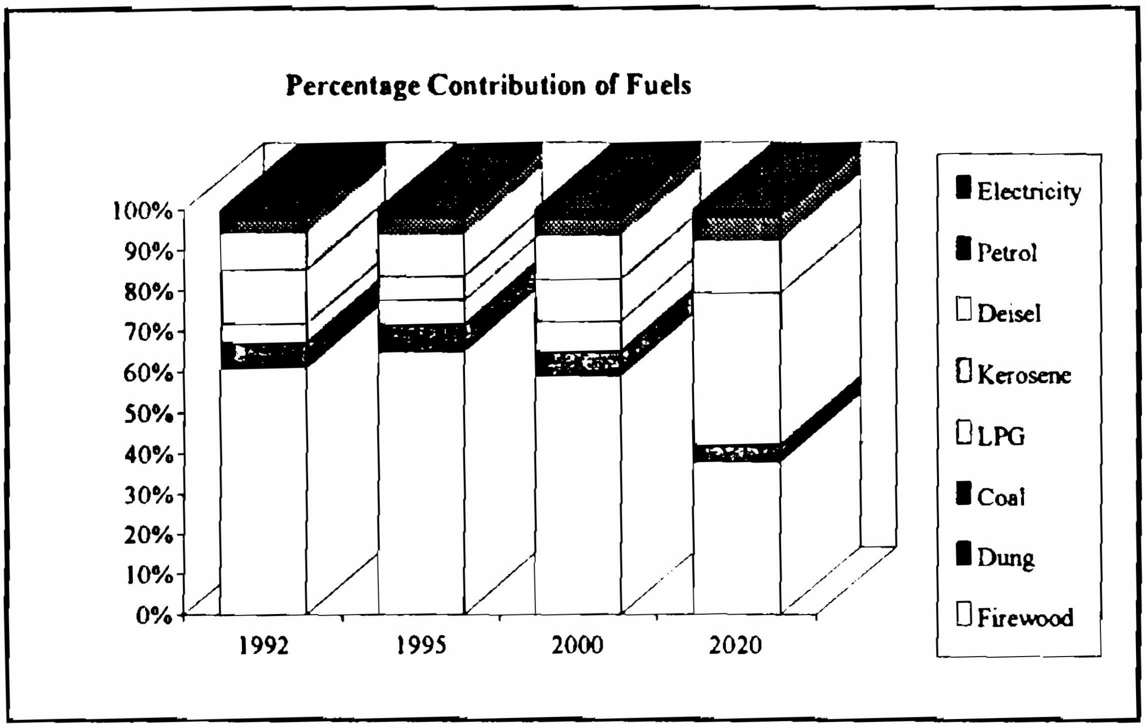


Figure 14.2 : Percentage Contribution of Fuels

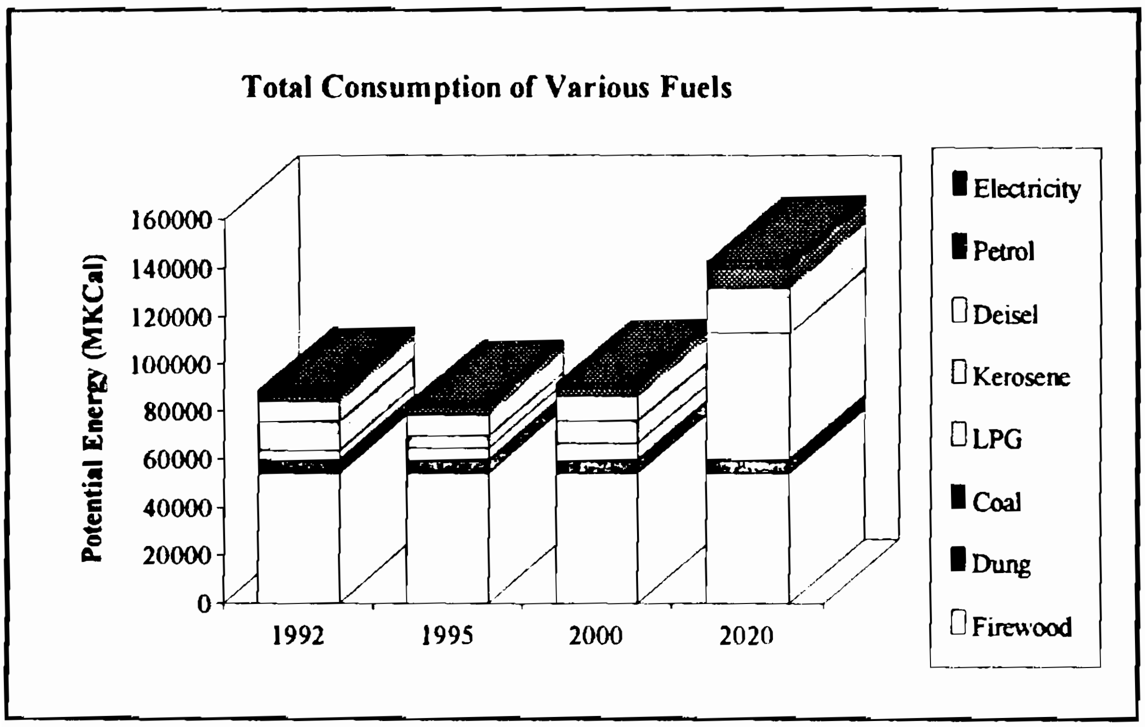


Figure 14.3 : Total Consumption of Various Fuels

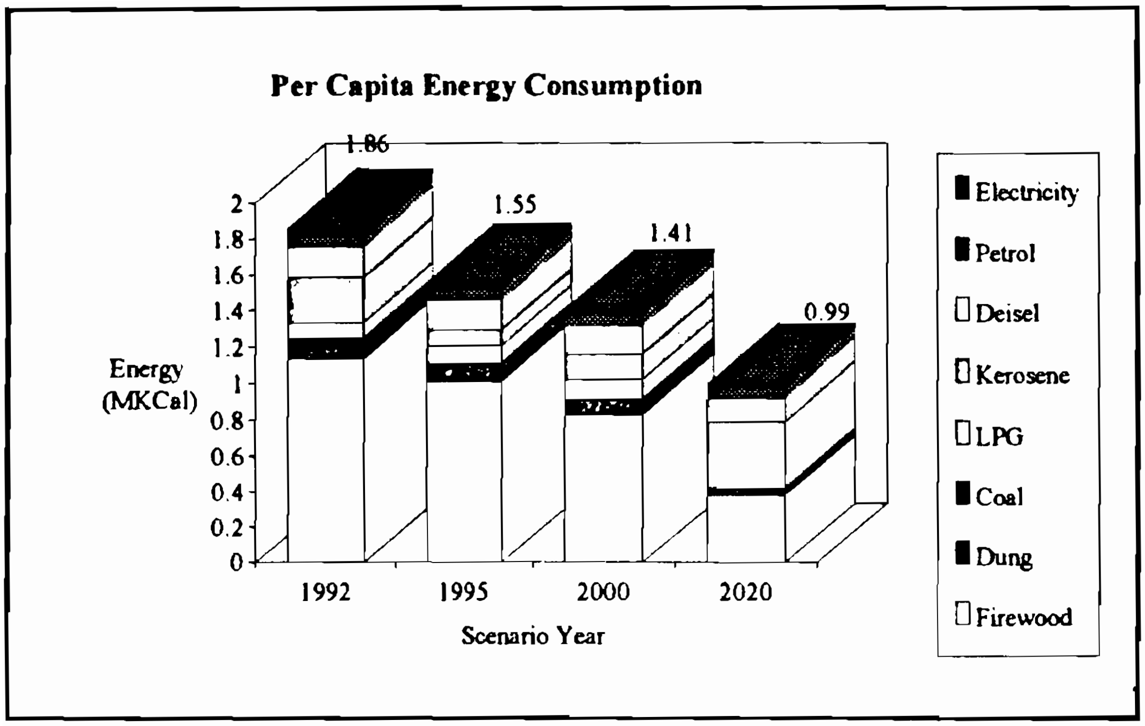


Figure 14.4 : Per Capita Energy Consumption

Table 14.2 : Emissions Due to Fuel Use

Year	Emission {in Tons}			
	CO_2	SO_2	*SPM*	NO_x
1992	19071	43	182	34
1995	17964	35	183	28
2000	19863	42	191	33
2020	30199	28	340	28

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