ENERGY MANAGEMENT IN GHAZIABAD CITY

A DISSERTATION

Submitted in partial fulfilment of the requirements for the award of the degree of

MASTER OF URBAN AND RURAL PLANNING

By

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CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the dissertation entitled **ENERGY MANAGEMENT IN GHAZIABAD CITY** in partial fulfillment of the requirement for the award of the Degree of **MASTER OF URBAN AND RURAL PLANNING** submitted in the **Department of Architecture and Planning** of University of Roorkee is an authentic record of my own work carried out during the period from **July 2000 to May 2001** under the supervision of **Dr.V.Devadas**

The matter embodied in this dissertation has not been submitted by me for the award of any other degree.

Place: Roorkee

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This is certified that the above statement made by the candidate is correct to the best of my knowledge.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Energy is the basic element for the development of any country. It has a major economic and political role, as an important raw material traded worldwide. The energy sector activities include extraction, conversion, transportation and consumption, and conservation of energy.

A quarter century ago hardly anyone imagined that energy would become virtually overnight a major nemesis in the worlds affair. The availability, type, use, abuse and price of energy touch nearly all the dimensions of human life more or less. The prosperity and stability of industrial state, the economic and social aspiration of developing countries, food production, population and economic growth, environmental balance, the promise and limits of technology, the growing militrization of the world economics. The alternatives to a conscious search for solution are quite simply drift, periodic "crisis storm" and chaos as E.F Schumacher has put the case for energy it is impossible to over emphasis its certainty. It might be said that energy is for the mechanical world and no consciousness to human world. **IF ENERGY FAILS, EVERYTHING FAILS** [7].

Energy resources vitally affect the socioeconomic development of any nation. The rising price of oil, growing uneasiness about depletion of fossil fuel, the consequent shortage of fertilizers and, therefore, of food; pressure from environmentalists about pollution from both conventional energy resources and nuclear power plants, all of these serve to focus attention upon energy problems especially as they affect the developing countries. It is thus imperative that considerable research be undertaken in order to study the energy resources, demand and consumption patterns. Equal importance should have a study on exploring new energy resources, and to catalogue steps necessary for energy conservation.

1.2 ENERGY CONSERVATION

There is significant scope for energy conservation. This not only calls for continuation and reinforcement of the conservation measures already introduced by various Governmental agencies but also for adoption of new and innovative approaches. Several energy conservation studies have revealed that our energy, use efficiency is very low, as compared to that achieved by the industrially advanced Countries. The Inter Ministerial Working Group has estimated the energy conservation potential of 20-30 percent in all sectors of Indian economy [18].

In recent years, the energy sector in India has been the center of many debates. The energy requirements in various sectors of the economy are met through a combination of commercial energy i.e. *electricity, coal, oil, gas, etc. and also non-commercial sources of* energy in various forms. In India, commercial energy consumption is concentrated in the urban and semi-urban areas for Industrial, Transport, Commercial and domestic uses. The non-commercial energies are widely dispersed primarily in rural areas in the form of firewood, agricultural residues, animal waste, and human and animal power.

The energy scenario in India is rather complex and needs systematic evaluation. Nearly 30 percent of the total outlay, of the Government of India is earmarked for the energy sector. In spite of such a huge Investment in the development of Oil, Gas, Coal, and

Power, the gap between energy availability and demand has not declined [18].

Considering limited financial and energy resources and the substantial scope in improving energy efficiency, the following major challenges emerge:

1. Efficient use of energy leading to conservation and environmental protection,
2. Strict energy management,
3. Reduced dependence of oil by inter-fuel substitution,
4. Development of alternate and renewable sources of energy, etc.

Above-mentioned issues are interrelated and need collective efforts to achieve the desired goals.

India's per capita consumption of commercial energy is only $1/8^{th}$ of the world. Industrial sector consumes about 59 percent of the total power produced in India. Agricultural sector consumes about 5 percent, domestic sector about 10 percent, transportation sector 22 percent and other 3.1 percent, as shown in ***Fig: 1.1*** [18]. In terms of the total power generated, Indian scenario can be compared with that of Germany, France, and Britain. But, the per capita consumption of power, about 300 kWh per person/annum is among the lowest in the world [1].

1.3 ENERGY ECONOMIC LINKAGES

In India, economic growth, based on rapid structural change increased urbanization, is an important factor, which contributed to the increase in energy consumption. During 1980-95, the commercial energy use increased it an average annual growth rate of 6.5 percent [18]. Although past experience shows that availability considerations rather than price levels are important determinants of energy demands the energy-gross domestic product elasticity is often used as an indicator for studying energy consumption response. The declining trend of energy gross domestic product elasticity during 1953-95 is partly due to structural changes in the economy, the changing pattern of demand, and also the penetration of efficient technology. This elasticity is, however, very high when compared to developed countries, reflecting the fact that India's per capita commercial energy consumption levels are still very low, and commercial energy forms are still substituting the use of traditional fuels. India covers an area of

328 million hectares, with an estimated population of over 965 million in 1997. Over 25 percent of the population live in urban areas [18].

India's economy grew at an average rate of 6.8 percent during- the Eighth five-year Plan period (1992-1997). During the terminal year of the Plan, gross domestic product growth touched a phenomenal 7.5 percent. There has been a certain deceleration to 5 percent in 1997-98. The economy recovered to an estimated growth of 5.8 percent in 1998-99 (estimated for the period April - December 1998). Agriculture and allied sectors have registered a growth rate of 5.7 percent electricity, gas and water supply 6.3 percent. Trade, hotels and transport and communication accelerated to a growth rate of 6.8 percent. Inflation rate rose sharply during 1998-99 because of an exceptional spurt in prices of a handful of agricultural commodity touching- a peak of 8.8 percent in late September 1998, and then dropping to 5 percent in early January 1999 [18].

India's energy intensity' (kilograms of oil equivalent per Rs 1000 of gross domestic product at 1980 price) has increased from the year 1980 level [1]. This is the result of:

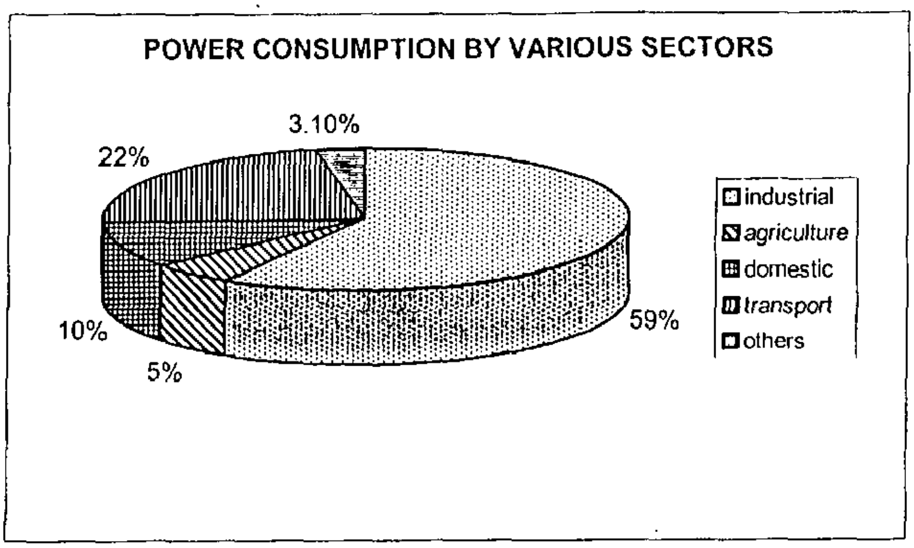
1. The growth of economy,
2. Increasing per capita income,

3. The continued shift from noncommercial forms of energy to commercial sources of energy
4. Structural change towards more energy-intensive industries,
5. Increased urbanization.

The consumption of commercial energy has gone up. The share *of commercial energy consumption,* was in India about 40 percent in 1960-1961, is expected to go further to 80 percent by the year 2004-2005 due to:

1. POPULATON INCREASE.
2. URBANISATION.
3. INDUSTRIALISATION.
4. INCREASE IN ECONOMIC GROWTH RATE.

Fig: 1.1 Power consumption of various sctors



Source: TERI handbook 1998-99

1.4 Distribution of Energy Resources

1.4.1 Principle Energy, Resources and Regional Distribution:

Coal and hydroelectric resources is the mainstay for India's primary resource support for secondary energy purposes. Oil and natural gas resources of the country are limited. Nuclear resources, on the other hand, are modest. The availability of coal resources is considerably good, but it has higher quantity of ash content, which is of poor quality. Besides, the distribution of the primary resources in the various regions is rather skewed. While the eastern region accounts for 70 percent of the total coal resources, the western region accounts for over 70 percent of the hydrocarbon reserves, and over 70 percent of the total hydro potential of the country are concentrated in the northern and northeastern region. The southern region, which has only 6 percent [18].

Although India is relatively well endowed with both renewable and non-renewable energy resources, it has to satisfy about 16 percent of the world's population as shown in ***Table: 1.1***. Coal, oil, and natural gas are the primary commercial energy sources. Of which coal is the major non-renewable resource of the country and has a life expectancy of over 240 years [18].

The reserve to production ratio for natural gas, though it has declined over the years, is still at a higher level than that for crude oil [18]. This clearly brings out the possibility of a somewhat higher rate of production of natural gas than at present. The reserves to production ratio for crude oil have remained by and large the same during the last few years. Significant increases in oil production in the years to come will, therefore, depend upon the rate of accretion. Some options have been suggested for improving the rate of reserve accretion. These are:

(1) Reprioritization of exploratory efforts,

(2) Greater application of close grid seismic surveys, and

(3) Interpretation of data on priority in areas with relatively higher potential for extension/new discoveries.

Apart, from coal, oil and natural gas, India has assured uranium resources of 34,000 tonnes, of which 15,000 tonnes is economically exploitable. The total lignite reserves now stand at 26,000 million tonnes. Further, the Central Electricity Authority has assessed the hydro potential in the country to the tune of 84,000 Mw [1]. In India, renewable energy sources are also expected to play an important role in solving the energy problems in the decentralized locations and in some remote areas, where the extension of the grid system may be comparatively uneconomical.

The total potential of small hydro (up to 15 Mw) and wind in the country is estimated at 10,000 Mw and 65,578 Mw respectively [1].

Table: 1.1
Proven Reserves of Fossils Fuels

Types of Fuel	India	World
Coal (billion tones)	70.00	1032.00
Crude oil (billion tonnes)	0.70	137.30
Natural Gas (billion cubic meters)	0.70	139.00

Source: TERI Handbook 1998- 1999

Assuming that the growth rate in the above areas remains at the present level, it is estimated that the energy requirements would quadruplicate in the next 20 years. This also assumes that no additional incremental effort input in for energy conservation. In case concerted efforts are made by various agencies, the energy requirements would reduce considerably as it has happened in several developed countries after the 70's oil crises. This will also reduce the incremental investment. Hence, implementation of well thought – out policies and programs on energy conservation is essential. Installed power generation capacity of India was 1,362 Mw. In 1997, it was 79,187 Mw. In the IX Five Year Plan (1997-98 to 2001- 02), an incremental capacity addition of 57,000 Mw has been planned [18].

1.4.2 Trends in Energy Production, Supply and Consumption: Indigenous Primary Energy Production

India's energy requirements are met from traditional as well as modern forms of energy. The share of traditional forms of fuel is diminishing and in 1996-97 these contributed to only 34 percent of the annual energy consumption. The usage is largely restricted to domestic fuels in semi-urban and rural areas at very low efficiency [1].

Total power generation capacity installed on March 31, 1998 was 89,090 MW. (Capacity addition of 6,324 MW is estimated for the period April 1, 1998 to March 31, 1999). These plants generated a total of 420.6 bkwh of electricity in 1997-98 comprising of thermal 336.1 bkwh, hydro 4.5 bkwh and nuclear 9.0 bkwh. Thermal plants account for 79.9 percent, hydroelectric plants for 17.7 percent and nuclear plants for 2.4 percent of power generation. This recorded a growth of 6.6 percent over the previous year [1].

1.5 ENERGY IMPORTS

Energy imports are largely in the form of crude oil and oil products. The import/export of other commercial energy forms, viz., coal and Secondary electricity has been rather limited and restricted. The import of crude oil and oil products in the year 1997-98 has been 4.49 mt and 19.5 mt (crude 'equivalent) respectively. Import of coal in the year 1997-98 has been 17 mt [18].

India continues to be the net importer of energy. In 1994, nearly 20 percent of the energy supply was through import in the form of coking coal, crude oil, and petroleum products. Increasing dependence on oil import has become a serious cause of concern. In 1994, the import of oil and oil products was 41.3 Mt, which was 60 percent of the total oil consumption.

1.6 ENERGY SUPPLY

1.6.1 Primary Energy Supply

Total supply of energy (both commercial and non-commercial forms excluding draught animal power) increased from

89.6 mtoe in 1953-54 to about 377 mtoe in 1996-97. Share of non-commercial fuels declined from 74 percent in 1950-51 to about 34 percent in 1996-97. Fuelwood continues to maintain its supremacy in the non-commercial energy supply (largely in the household sector). (The break-up for 1997-98 has still to be worked out as the figures for energy production and supply are still provisional) [18].

Supply (also considered consumption) of non-commercial fuels in the year 1996-97 is estimated at 173 Mt of fuel wood, 95 Mt of dung cakes and 53 Mt of agro waste [18].

There has been a significant change in the pattern of energy supplies with the share of commercial fuel increasing from 26 percent in 1951-51 to about 60 percent in 1994-95. The overall supply of commercial fuels has grown from 121.5 million tones of oil equivalent in 1984-85 to 223.7 m. tons in 1994-95, with an annual growth rate of 6.3 percent. Coal is being a cheaper and abundantly available, dominates the total energy supply. Its increase in supply, over the years is due to the increase in mining and the application of new mining practices.

1.7 ENERGY CONSUMPTION

The growth in consumption of energy is, inter alia, a function of the growth in the economy, and changes in the lifestyle of households, and as a result of changes in the income levels enjoyed by them. In India, energy consumption, however, reflects the energy demand to the extent it is constrained by supply shortages. India's final commercial energy consumption was 148.6mtoe in 1994, and has grown at the rate of 5.6 percent annually during 1984-94. Per capita primary energy consumption has also grown from 163 kilograms of oil equivalent in 1984 to 244 kilograms of oil equivalent in 1994, registering a growth rate of 4.1 percent during the same period. In spite of a higher economic growth rate, the per capita commercial energy consumption is very low as compared to the world average of 1471 kilograms of oil equivalent [18].

It is a fact that the power shortage continues to persist. To merely keep pace with the current shortages, India needs an additional capacity of 1,40,000 Mw in the next 15 years, according to the 15th Electric power Survey, the energy and peak demands are expected to be about 570 billion units and 95,757 Mw respectively, by the year

2001- 02 [18]. The electricity consumption pattern from various utilities is shown in ***Table: 1.2.***

A comparison with some of the developed countries reveals that India's per capita energy consumption is only three per cent of the per capita consumption in the US, and about nine per cent of that of Korea. The sectoral energy consumption pattern shows that the industrial sector is the largest consumer of energy, followed by the transport sector. Energy consumption in the industrial sector has grown at a rate of 5.2 percent per annum during 1984-99, however, during this period, the share of this sector in total energy consumption has declined from 61.5 percent to 59 percent. Energy consumption in the agricultural sector tripled during 1984-94 and registered an average growth rate of nearly 14 percent per annum [1]. Of the total quantity of coal and natural gas consumption, the industrial sector alone consume about 99 percent of coal and natural gas which is used in the industrial sector.

Table: 1.2

Pattern of Electricity Consumption (from utilities) (1997-98)

S no.	Sector	Percentage consumption
1	Domestic	19.8 percent
2	Commercial	6.2 percent
3	Industry	37.8 percent
4	Traction	2.3 percent
5	Agriculture	29.6 percent
6	Others	4.5 percent

Source: Indian Economic Survey 1998-99 (1999)

The transport sector is the largest consumer of petroleum products, and accounts for nearly 50 percent of the total consumption, followed by the industrial sector 27 percent. The industrial sector is the largest consumer of electricity too with a share of 38 percent in the total consumption. Coal is the dominant source of fuel in Indian industries with a share of about 62 percent. In the total energy consumption share of commercial energy in the form of final energy consumption increased from 28.4 percent to 65.9 percent during this period, while that of non-commercial energy sources has declined from 71.6 percent (in 1950 to 54) to 34.1 percent (in 1996-97). The final commercial energy consumption by various sectors is shown in ***Table: 1.3.***

Table: 1.3

Percentage Share in Final

Commercial Energy Consumption by Different Sectors

S no.	Sectors	1953-54 (percentage)	1960-61 (percentage)	1970-71 (percentage)	1980-81 (percentage)	1990-91 (percentage)	1994-95 (percentage)
1	Industry	39.9	41.5	49.6	49.6	44.7	42.1
2	Transport	43.7	40.2	28.2	23.5	19.8	20.8
3	Household	9.6	9.7	12.2	9.7	11.8	12.3
4	Commercial	0.5	0.3	1.2	0.9	1.1	1.2
5	Agriculture	1.4	1.6	2.7	6.3	8.2	9.3
6	Feed stocks	0.5	0.3	4.2	5.6	10.4	10.3
7	Non-energy use	2.9	4.7	1.5	4.0	3.1	3.0
8	Others	1.5	1.7	0.4	0.4	0.9	1.0
9	Total	100	100	100	100	100	100

Source: Planning Commission, Government of India (1998).

The total consumption of petroleum and petroleum products during 1997-98 is reported to 84.5 Mt (80.1 Mt from the public sector units and 4.4 Mt imported by the private parties).

1.8 ENERGY SECTOR REFORMS

India's economic growth in the past has been plagued by deficient energy supply, both in terms of quality and quantity. The perpetual race to narrow the demand-supply gap in energy resulted in sub optimal decision-making in almost all energy sectors: hydro power development lost to the shorter gestation thermal power plants; generation capacity took precedence over proper maintenance and reduction of losses in the transmission and distribution network; and the focus of energy planning was on supply enhancement with little or no attention being given to demand management.

In order to correct these distortions, a series of reforms were initiated in the energy sectors. In the hydrocarbon sector, the latest reforms include new exploration licensing policy, revision of prices of natural gas, and steps for phased dismantling of administered pricing mechanism over the period 1998 -2001. In the coal sector, apart from encouraging private sector investments, steps have been taken to liberalize the pricing and distribution of coal. In the power sector, the government recognized that inefficiencies in this sector are largely due to state electricity boards lack of commercial and managerial autonomy. State electricity boards generally have inadequate capital structure, low tariff, and poor bill collections. The improvement of supply efficiency, the consumption pattern, and rational pricing of electricity are only possible through reforming power sector management and financing at state levels. Restructuring state electricity boards is high on the agenda of the government. In order to rationalize the tariff and other allied matters, the government has already set up a Central Electricity Regulatory Commission at the Center for regulating, among others, the tariff of generating companies owned and controlled by the Union Government, the integrated power transmission, and the tariff of the transmission entities.

1.9 FUTURE AGENDA

India has opened up its power generation, oil exploration, and refining to private sectors. However modalities of inviting private capital into other sectors like transmission and distribution are yet to be fully worked out . Given the availability of finite amount of private capital along with competing claims by different sectors, India must identify the resource-effective areas in meeting future energy demands. It is essential that the private capital inflow be smoothened in all energy sectors through adequate fuel supply and adequate evacuation of power. Increasing the pace of reforms in state electricity boards will remove certain irritants affecting the inflow of private capital into the power sector. In addition, demand-side reforms should be taken up as a part of the long-term strategy for efficient energy use. There is perhaps need for an integrated energy policy in the context of sustainable development in India.

1.10 OBJECTIVES

The following objectives have been framed for the present investigation. They are:

1. To assess the available energy resources.
2. To assess the energy consumption pattern.
3. To investigate the dynamics of changing intensity of energy use and changes in the energy consumption pattern.
4. To identify a set of control parameters, which decide the functions of the system.
5. To evolve a set of policy guidelines for rational use of energy resources.

1.11 SCOPE

The present study aims at preparing a set of policy guidelines and making plausible recommendations. So that the energy resource can be managed in Ghaziabad City in a proper way. If the proposed sets of policy guidelines are implemented successfully, by commensurating the present and future needs and aspirations of the people, scarcity of energy resource would be minimized on one hand, and better environment can be achieved on the other hand.

The practice of energy management observed reflects a narrow definition of the concept. Management is defined as the judicious use of means to achieve goals. It is process, which includes the function of planning, execution, and control. Recognizing energy as a resource to be managed in parallel with land, labor, capital, and raw materials suggests that the elements involved in the management of other resources. The several elements that must be present in a successful energy management program are grouped under the three basic functions of management. They are:

1. Planning.
2. Execution.
3. Control.

1.11.1 PLANNING

The planning process begins with the realization that energy is a resource to be managed and the decision to see that adequate management practice is indeed applied. Programs necessary to achieve the goals should be defined, and procedures should be established for systematic monitoring of results. This can only be done after information on energy flows and cost has been obtained. Energy management requires successive phases of planning, execution, and control, so that information obtained in each phase provides a basis for planning the next one.

1.11.2 EXECUTION

The execution of the program involves most importantly, a commitment on the part of the management within the company. This commitment must flow from the highest level of management and must include a commitment of the necessary personnel, time, and funding to carry out a successful program.

1.11.3 CONTROL

During each phase of an energy management program, goals are established and action plan are developed and implemented. Then the results will be measured and evaluated in relation to the goals, which are set and corrective action may be taken if it never reach the target. These constitute managerial control.

The interaction of the three components of management is evident as the implementation of the program proceeds and results are evaluated; plans for saving energy are often modified, new goals may be set, and additional monitoring may be required. A successful energy management program requires continuos planning, execution, and control.

1.12 CONCEPT

Any system (urban or rural) functions with energy interaction. In an urban system, almost all the subsystems such as, household, industries, transport, trade and commerce, and other infrastructure services are consuming more quantity of energy rather than they produce.

More quantity of energy is required to satisfy the requirement of human wants since energy is the basic element for any development and development is a continuing process. The present investigation aims at to investigate energy consumption. At various sub systems level in the urban system and to evolve a feasible energy management system for Ghaziabad City.

1.13 RESERCH AND DESIGN

Survey research methods are employed for the present investigation.

1.13.1 METHODOLOGY:

Proper research methods have been followed to take up this investigation at the grassroots level with the use of proper tools and techniques, and it is presented in ***Fig no.1.2***.

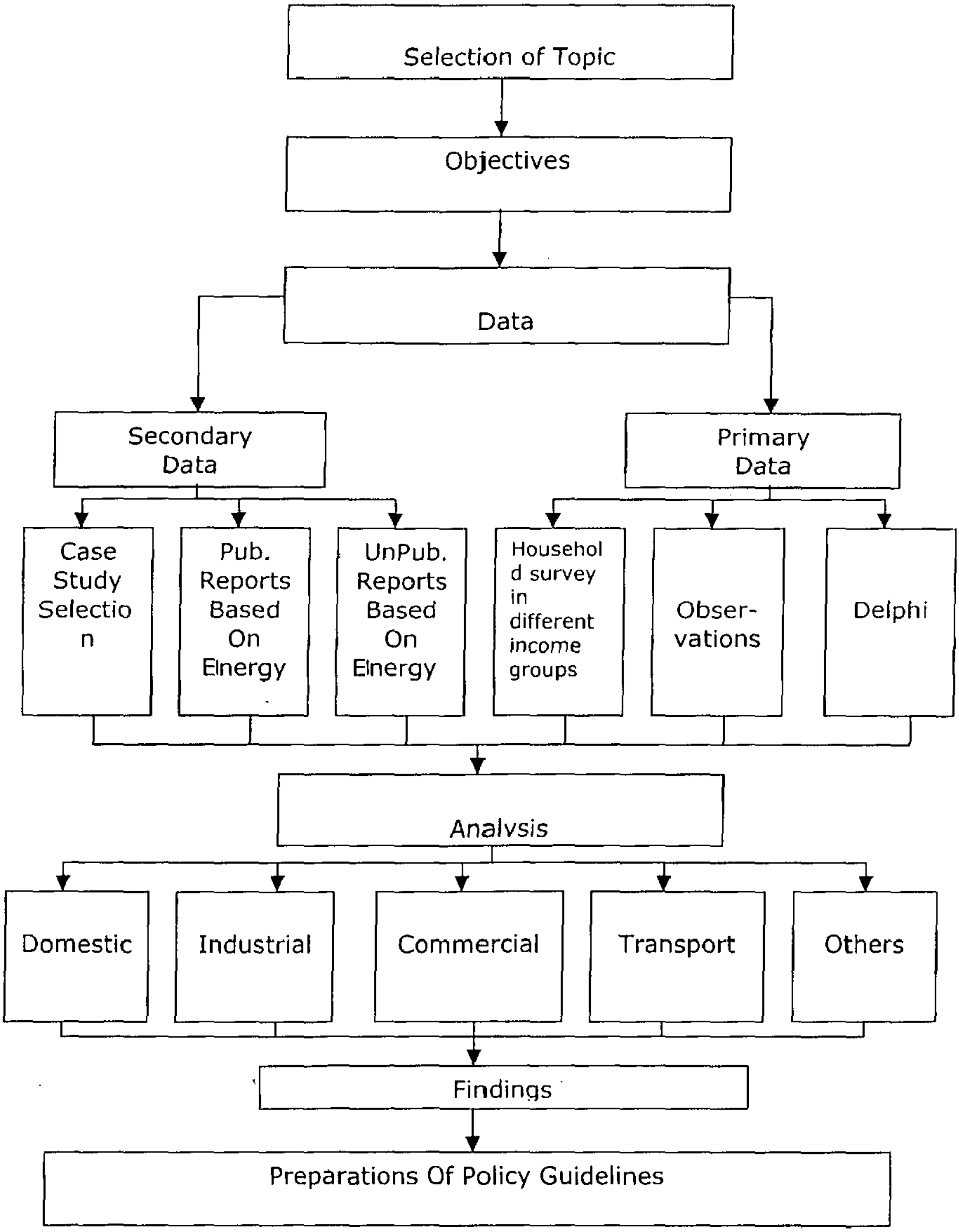


Fig no. 1.2 METHODOLOGY OF THE STUDY

1.13.2 DATA

Two sources of data are collected. They are:

1. **Secondary Sources:** Both published and unpublished literature in this particular field of investigation is reviewed.
2. **Primary Sources:** Survey was conducted at the household level for obtaining the required data by using schedules and questionnaire.

1.14 TOOLS AND TECHNIQUES:

Schedules and questionnaire are prepared, and used for conducting survey at the household level.

1.14.1 Techniques:

Multistage random sampling technique has been used to identify the households to conduct the survey.

1.14.2 Analytical tools:

Relevant statistical tools and techniques were identified and employed to analyze the data based on their availability and reliability. Various software tools and packages are also used like stat graph, MS excel, MS word; and sampling, Correlation, Regression, projection, etc techniques are also used in the investigation.

1.15 RESULTS AND DISCUSSIONS

The findings of the analysis are discussed thoroughly to arrive at and evolve a set of plausible policy guidelines to have proper energy management system in Ghaziabad City.

1.16 LIMITATIONS

- The research is time bound and limited to six months. Hence the study is limited to Ghaziabad City.
- Since the study is limited to Ghaziabad City, the recommendations will only be applicable to this particular study.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Energy research has got more and more importance during the second half of the 20th century and that too immediate after the energy shock of 1970's. Various distinguished authors have done research in the particular field of learning and published literature. Though huge quantity of literature is available in the field of energy research, literature pertaining to energy management in the urban system is very limited. It is of interest, the investigator has done literature survey quite extensively related to this present investigation, and analyzed them. The available literature in the field are collected and segregated into the following broad headings for presentation. They are:

1. Energy management measures abroad.
2. National standards and energy conservation in India.
3. Energy technologies
4. Legislative framework

5. Energy management at the city level

The grouped literatures under the foresaid headings are presented in sequence.

2.2 ENERGY MANAGEMENT MEASURES IN ABROAD

1.Japan

Amongst the countries, which had worked on this problem, it can be said that Japan has one of the most comprehensive set of regulatory measures for energy management. The objective of this policy is to reduce to the maximum extent possible, the growth of energy demand without affecting development. The law pertaining to the rationalization in the use of energy provides for several measures that assist energy management as pertinent to factories, building machinery and apparatus. Mixtures of technical and penal regulations are in force together with appropriate Japanese Industrial Standards (JIS). The key roles are being played by several agencies, particularly the Energy Conservation Center (ECC) in the management of Japan's conservation program. It is also evident that the program is comprehensive which could serve as model case, and that can be introduced in India after having through investigation.

2.France

The main thrust of French policy ties has been on reducing oil consumption and increasing the use of nuclear energy and coal. A national plan approved by Parliament aims at achieving at least 50 Percent self-reliance by 1990. France has also established sectoral targets for energy conservation, a vital role played by the French agency for energy management [18].

3.United Kingdom

United Kingdom's energy management strategy is based mainly on motivated campaigns, demonstration schemes and support service. A fully comprehensive Organization named "Energy Efficiency Office" has been set up in 1983 to promote this strategy [18].

4.USA:

Industry in United States of America is responsible for a large percentage of energy used. Isolated legislation's have been enacted, such as, the Public Utility Regulatory Policy Act 1978 (PURPA) encouraging cogeneration. Certain tax benefits are also available for industry including energy measures qualifying for tax credit. The office of Technology. Assessment in United States of America has stated that energy need not be a constraint to economic growth in the, United States [18].

5.Canada

A voluntary program devised by the industry leaders for implementing conservation is in vogue Canada through which industry commits itself to a program and seeks to promote off-the-job consciousness. The Federal Govt. provides assistance and support. Over 100 million dollars per year of federal if funds are currently allocated for such ventures [18].

6.Philippines

Energy supply, efficient uses of fuels and environmental protection form the basis of the energy program in Philippines. The Bureau of Energy Development (BED) and The Bureau of Energy Utilization (BEU) regulate energy business, monitor supply and demand and conservation [18].

7.Indonesia

The Indonesian Govt. has adopted a 'General Policy' on energy tc substitute oil with non-oil sources wherever possible. The conservatior policy includes public campaign and dissemination of information, technical guidance to the needy and regulations relating energy as presidential promulgation [18].

2.3 NATIONAL STANDARDS AND ENERGY CONSERVATION

2.3.1 PROGRESS OF CONSERVATION IN INDIA

At the apex of the energy management efforts in the country, is the Advisory Board on Energy (ABE) was constituted in 1983, with the following broad functions: continuously reviewing the energy situation in the country vis a vis global imperatives and advise the government on future options, formulating: a viable energy policy for commercial and non-commercial energy use and suggest operational arrangements for implementing and monitoring the same, periodic assessment of demand and supply of energy on a projected basis, suggest strategies for energy conservation, pricing policy and creating public awareness on energy issues. In pursuance of these functions, Advisory Board on Energy has thrown up adequate data on problem of energy as used in this country, which are pointers to the conservation movement in the country.

2.3.2 ROLE OF BUREAU OF INDIAN STANDARDS

In the field of energy conservation, the role of Bureau of Indian Standards the national standards body is basically catalytic. The role would basically include dissemination of practices of national and international standards organizations in the field of energy conservation, introducing such concepts in national standards whenever feasible, developing specific standards/design guides to promote optimum use of energy, aiding the efforts of other agencies in the country etc.

Indian Standards on equipment by and large stipulate one or more of the following aspects:

1) Maximum limit on energy consumption,
2) Minimum efficiency,
3) Maximum losses.

Besides product specifications, there are guides for achieving energy efficiency concerning selection, system design and codes for installation and maintenance. It will be noted that these cover many product groups and engineering disciplines. As such the formulation of these standards is distributed over a number of Technical Divisions.

Technical Divisions of Bureau of Indian Standards, through the many Sectional Committees functioning under them have developed several standards during the last three decades, which have implications on energy use.

2.3.3 CONCLUSION:

The case for energy conservation does not require to be labored. Conservation measures are cost effective and pay back in short gestation periods. Many countries have realized that the process of development could be sustained mainly by the efficiency with which scarce energy resources are managed. While it is necessary to take into account the local techno-economic imperatives and energy scenario much advantage can be gained by speedy and effective application of technologies introduced and proved successful elsewhere. It should be emphasized that the initial set back or the lack of initiative to proceed further owing possibly to the enormity of the tasks should not come in the way of continuing the valuable dialogue initiated. That has been created on this key issue should be taken advantage of and pursued. The lost time could be made up by, drawing upon the experience of other countries.

In the technological race it is not always that the most advanced innovations gain the most in techno-economic sense. Application of proven technologies ingenuously and adaption of time tested techniques to local conditions assist in bridging the gap that would for ever otherwise widening. This is especially valid in the area of energy conservation. Many countries, which have had contrary thoughts to the application of technology and had favored costly innovations in lieu of adaption, happened to be victim of the energy crunch.

2.3.4 A SET OF STANDARDS IN THE FIELD OF ENERGY CONSERVATION:

A) Product Standards

1) IS: 1342-1978 Specification for oil pressure stoves-Specifies thermal efficiency for different types of oil stoves.

2) IS: 4246-1984 Domestic gas stoves for use with LPG-Covers thermal efficiency requirements.

3) IS: 2418 tubular fluorescent lamps for general lighting service-Specifies minimum rated lumen and maximum consumption in watts.

4) IS: 374-1979 Electric ceiling type falls and regulators-Specifies minimum air delivery per unit watt consumption.

5) IS: 365-1983 Electric hot plates-Specifies Minimum value of thermal efficiency

6) IS: 325-1978 Three- phase induction motor- Covers minimum value of product of efficiency and Power factor maximum rated current, minimum torque at full load conditions.

B) Standards where Energy Stipulations are Periodically Upgraded:

1) IS: 10001 - 1981 Performance requirements for constant speed compression ignition (diesel) engines for general purposes-This specification envisages an improvement in the specified value of specific fuel consumption by 5percent on a periodic basis.

2.4 ENERGY TECHNOLOGIES

The energy needs of developing nations will grow at a faster rate than those of industrialized societies. Because 95 percent of the world's projected population growth will occur in these nations, economic development is essential for their survival. Yet, unless more cost-effective energy alternatives become available, wood, coal and oil will be the primary fuel used by developing nations, and traditional energy technologies will be the primary technologies for their economic growth.

Energy extraction, processing and use represent what is arguably the single gravest environmental challenge of the coming decades. Worldwide economic reliance on the conversion of fossil-fuel sources is at the root of the environmental pollution problem. Among various energy technologies, those for producing and using non fossil-fuel energy sources offer the largest potential to reduce environmental pollution. Many non fossil fuels and renewable technologies, now in early stages of development, would yield large social returns from technical advances. Technological improvement to yield greater energy efficiency affects the extraction, processing and end use of energy; the potential for further gains is far greater on the demand side than on the supply side. To improve energy efficiency, which means -to reduces the wasteful use of energy, without necessarily entailing any cut in comfort or production. Much of the improvement has been realized by quite simple measures.

One of the greatest technological challenges for the future will be to develop less environmentally damaging sources of energy while simultaneously reducing total energy consumption through better energy efficiency in industry, agriculture, consumer products, the home and in almost every other sector of the economy. New energy technologies will give us a competitive edge as well as a healthier environment. The worldwide market for such technologies will continue to grow as the connections between environmental and economic well being become more apparent [18].

Of all the technological areas that need to be put on a sustainable basis, energy is the most critical. The generation and use of energy are responsible for a large percentage of almost all forms of pollution. For this reason alone, sustainable development will be impossible without new energy technologies. Energy demands to produce goods and services in industry and transportation and to meet daily needs in residential and commercial buildings have been increasing every year.

A pleased strategy is necessary to achieve an energy system for sustainable development. The first step in this strategy is greatly increased energy efficiency or conservation. The second step is the use of existing clean fuel technologies. The third and final step is the development and use of advanced, clean, cost effective energy technologies. The most important examples of such technologies will be discussed in later sections [18].

2.4.1 Fossil-Fuel

Fossil fuel, the dominant source of energy supply sustaining modern civilization, creates some of the most threatening environmental problems, ranging from global-scale changes in climate to regional effects of acid deposition to local urban air pollution problems and health and safety risks in mining and production. Much of the present technology for energy production will remain with us for at least another fifty years. This means that while working toward technical solutions for Sustainability, the most immediate actions relate to clean energy production.

Technologies for the reduction of fossil-fuel combustion emissions are already available and in use, but they are costly, and those emission control technologies for sulfur dioxide, nitrogen oxides and particulate create secondary pollution. A substance of rather recent concern is carbon dioxide, which causes the greenhouse effect, but there is no satisfactory Solution as yet. An increase in the energy efficiency of electricity production from fossil fuels, combined with a subsequent shift in fuel from coal to natural gas and later possibly towards Biomass, could be the first steps in a strategy aimed at halting the present alarming trends of excessive use of fossil fuels for energy production.

Integrated combined cycle Gasification (ICCG) processes offer potential for a substantial increase in electricity production from thermal power plants. Recent technological developments for high-temperature gas turbines have made them an attractive development alternative today. The main advantage of the processes provides a higher operating temperature, which gives a better thermodynamic efficiency for a heat engine. Employing an Integrated combined cycle Gasification process instead of a conventional coal-fired power plant results in much improved energy production efficiency together with reduced emissions.

2.4.2 Nuclear Energy

The biggest question mark in the energy picture over the next few decades is nuclear power. To date, the majority of the general public has opposed it. The difference between fossil fuels and nuclear power is a choice between pollution and the adverse health consequences of fossil-fuel generated power on one hand arid fear of a nuclear accident and consequences of nuclear waste disposal on the other. Two new technological developments could result in making nuclear power safer.

First, within the next decade, a new family of safer nuclear generators is likely to be developed. Second, fusion power may become commercially feasible. Nuclear fusion technology could potentially supply energy with few or no emissions. At the same time, the technology is highly controversial, plagued by problems of reactor safety, waste disposal, weapons proliferation, economic cost and technical reliability. New reactor designs, such as modular high-temperature, gas-cooled reactors, provide ultimately safe reactors; various liquid metal-cooled reactors. These developments, combined with concern over the inevitable emissions of fossil-fuel combustion, could make nuclear power a desirable energy option.

2.4.3 Photovoltics

Because photovoltaic relies on the virtually limitless and *nonpolluting solar resource, it offers enormous potential for* environmental pollution reduction. There are two basic designs of photovoltaic single-junction cells and multi-junction cells. The single-junction cell can only be optimized for a small portion of the solar spectrum, determined by the choice of the material. The multi-junction cell consists of several layers of semiconductors, active in different parts of the spectrum, stacked upon each other to yield a better total efficiency in terms of absorbed and converted sunlight. Today, photovoltaic is used in a variety of applications from Satellite power generation modules of a few militates to electric utility units as large as ARCO Solar's 6.6-MW power station in California.

Photovoltaic technology has progressed markedly in recent years, resulting in a cost decrease from $15 per kilowatt-hour (kWh) in 1973 to about $0.15 today. Nevertheless, significant technical advances will still be necessary to make Photovoltaics competitive with conventional fuel sources. These include new cell designs, Such as multi-junction cells that absorb greater portions of the solar spectrum, and new semiconductor materials for unproved efficiency and lower cost. Besides these generic developments, manufacturing process improvements, such as micro-fabrication and large-scale applications of thin films, are needed to make photovoltaic cells competitive in mass markets.

2.4.4 Solar Thermal Electricity

Solar thermal-electric equipment converts solar heat to electricity, usually at a central power plant. There are three types of *solar thermal technology: through, central receiver and dish sterling.* Through technology uses reflective troughs to concentrate sunlight; central receiver technology uses tracking mirrors (heliostats) to focus heat from the sun. In both cases, the solar energy is used to produce steam, which then drives a turbine generator. In contrast, dish Stirling systems use sun-tracking parabolic dishes to focus heat onto an engine mounted on the dish, which directly converts collected solar heat into electricity.

Most solar thermal electricity generated to date has been from nine parabolic trough plants in southern California. However, central receiver and dish Stirling technologies are potentially more cost effective than troughs. Dish Stirling technology can be used for a broad range of electricity requirements, especially for needs between 5 kW and 100 MW. Needs less than 5 kW might better be served by a photovoltaic system, *whereas needs in excess of 100 MW tiny be more* economically met by a central receiver station, The environmental benefits of solar thermal electricity are potentially enormous. Like Photovoltaics, solar thermal captures non-polluting energy source; however, solar thermal probably has narrower applications than photovoltaic technology. Improvement in Stirling engines could make diffusion of solar thermal technology possible for small-scale operations, whereas improvements in heat-transfer fluids would have generic applicability for energy storage in buildings and industry.

2.4.5 Biomass

Biomass produced by natural photosynthesis is a good example of solar-driven complex chemical processes. However, photosynthesis is not a very energy-efficient process in nature. Only about half of the incident light falls within the energy domain (0-38 to 0.68 micrometer) that can be used by plants. About 40percent of the absorbed radiation energy are lost through reactions (photorespiration), which do not produce carbohydrates. Suppression of such photorespiration reaction is currently a topic of intensive research.

Different species of plants have different efficiencies, and improvement in natural efficiency of photosynthesis appears to be most promising for energy absorption. Biomass as a renewable energy source presents the largest potential for immediate use for producing automobile fuels and vegetable oils. The amounts annually synthesized are roughly equivalent to ten times the world energy demand in calorific terms. The drawback is the same as for most renewable energy sources: it is dispersed and unevenly distributed and is rarely found in great quantities where the energy consumption is the largest.

Today, biofuels are a key topic as a possible answer for many severe pollution problems caused by motor vehicles. The most common biofuel is ethanol produced from Biomass; the others are vegetable oils and biogas. Ethanol is already produced and used as a fuel in large quantities. Vegetable oils can be produced from the seeds of oil plants such as raps. This oil can be used as a substitute fuel in diesel engines, either directly or after modification. Lubricating oils made from vegetable oils for two-stroke engines seem more attractive in terms of the quantities and costs involved. Biogas is produced as a result of anaerobic fermentation of organic materials such as agricultural residues or urban refuse. Before use as a motor fuel, the methane in the gas must be separated from unwanted constituents such as carbon dioxide, hydrogen sulfide and sulfur-containing

1. Atomic energy, and mineral resources necessary for its production.
2. Regulation and development of oil fields, mineral oil resources, and petroleum and petroleum products.
3. Regulation of mines and minerals development as declared by the Parliament.
4. Regulation of labor and safety in mines and oil fields.
5. Regulation and development of inter- state rivers.

The concurrent list mentions only one energy-related subject, i.e., electricity. This skewed distribution of legislative powers explains the dominant role of the Union Government in the energy sector. In general, the States have no role in regulation, promotion, or conservation of atomic, petroleum, or coal based energy sources, which continue to be the preserves of the Union Government. Their main involvement has been in the electricity sector and, more recently, in the promotion of new renewable forms of energy.

2.5.1 ENERGY RELATED ORGANIZATION OF THE UNION GOVERNMENT:

There are multitudes of ministries and organizations vested with disparate functions concerning energy development. The forums and compounds. The purified gas can be used directly in Otto engines without modifications or in diesel-type engines with modification.

To make better use of the potential of Biomass-based energy production, a thorough systems study of the various opportunities should be done or different regions. Bioconversion is a low temperature process involving no hazardous chemicals, as opposed to the conventional chemical industry, which often employs high temperatures and dangerous chemicals. Further, there is negligible augmentation of the greenhouse effect compared to the burning of fossil fuel, as Biomass synthesis is part of the natural carbon cycle. The production of clean automobile fuels is another important area of development for Biomass uses.

2.4.6 Geothermal

Although naturally occurring hot water and steam formations now provide modest quantities of electricity, hot dry rock, and geopressurized technology have considerable potential. World resources of hot dry rock alone are estimated at 100 million quads (quadrillion BTUs), which are twenty times all fossil-fuel resources.

Because of this resource is widely distributed and potentially non-polluting, its potential risk reduction benefits are very high.

2.4.7 Wind Energy

A typical windmill contains four basic elements: (1) a rotor for capturing the kinetic energy of the moving air, (2) gearbox and transmission, (3) tower structure and (4) generator and control electronics. The most vulnerable part of the windmill is the rotor device, which is sensitive to imbalances caused by rain, snow and or ice. Windmills vary greatly in size, from a few kilowatts to more than 4 MW. The average size today is 50 to 100 kW but is expected to rise to 100 to 250 kW with the accumulated experience of the present stations. Technological refinements are necessary for producing more efficient windmill generators. An average wind speed of at least 12 miles an hour is needed for these machines to be economical [18].

Windmills are often used to provide electricity for remote houses, farms or ranches or sometimes-small villages. Larger windmills have been built to supply electricity to the grid system. It is also possible to have offshore wind turbine generators providing electricity on land.

2.4.8 Hydroelectricity

The typical hydropower technology is a dam where the water is stored and regulated. To convert the mechanical energy into electrical energy, the falling waterpower's a turbine linked to a generator. Hydroelectric plants can have serious environmental drawbacks. The dams needed by the bigger projects flood large tracts of land, upsetting the ecological balance and threatening wildlife. In the tropics, these flooded areas become insect breeding grounds and can spread waterborne diseases, threatening millions of lives.

Among the advanced and renewable energy technologies, photovoltaic, wind and solar thermal technologies are demonstrating the potential to contribute a greater share to electricity supply. They could benefit from accurate cost-accounting methods of resource comparison. However, they are intermittent power sources, generally producing electricity only when the wind blows or the sunshine's. This limitation makes them less attractive to utility companies, which generally prefer power sources to be dispatchable. Intermittent resources would be more attractive to utilities if cost-effective methods for storing electricity existed. Storage methods, such as, batteries and compressed air are currently being explored; in the longer term, the use of super conducting magnetic energy storage or hydrogen as an energy storage medium has potentials development of wind, photovoltaic and solar thermal technologies confronts several significant barriers: (1) wind and solar resources vary by geographic region and daily weather conditions, (2) they are generally not cost-competitive with fossil fuels Linder traditional utility accounting and (3) utility companies can be discouraged from developing renewable resources because they perceive their development projects as risky investments.

2.5 THE LEGISLATIVE FRAMEWORK

India is a union of 29 states. Consequently, the legislative authority under article 246 of the constitution of India is split between the Union and States with concurrent jurisdiction of both over some subjects. The seventh schedule of the Constitution provides three lists. Recently, vide the 73^{rd} and the 74^{th} amendments in 1991, devolution of authority, in the selected subjects, including those related to energy, has been recommended from the states to the village level panchayats and urban Municipalities. However no state has so far given effect to such devolution to bodies of local self-government. Of subjects reserved for the Union, the following relate to energy [14]:

the structure for coordinate action amongst all these separate centers are not well defined. Three forums for coordinated planning and thinking for energy development can, however, are identified.

1. Parliament and its comities.
2. The Cabinet.
3. The Planning Commission.

Hence, effective energy management is what is required in this area, so as to reduce the ever-widening gap.

2.6 ENERGY MANAGEMENT AT CITY LEVEL

Literature related to integrated energy resource management at the city level could not be found, but some studies have been reported at city level by sectoral level of energy consumption, demand, supply, management, etc. They are energy in industrial, transport, and household sector. Available literature on the above is collected, reviewed, and presented as follows:

1. Energy sector in Industrial sector

Industrial sector has registered impressive growth rate of 12.60 percent during the last decade. In India, there are large numbers of small and medium enterprises where there is a substantial scope for energy efficiency improvements. Most of these industries are in a cluster. Catering to these clusters can bring about substantial saving and energy audit and accounting can be gainfully employed. Four broad areas for conservation in industries are [18]:

1. Waste heat recovery and cogeneration.
2. Retrofits and improvements in operations.
3. Major changes in manufacturing and production methods.
4. Recycling and recovery of waste material.

The central concept is that the overall efficiency of energy use for the total plant be maximized rather than the efficiency of any single component or subsystem such as electricity generation.

It is observed that 54 percent of the total saving potential can be realized with net or marginal investment simply by adopting better housekeeping, operational and maintenance practices based on the existing literature. In addition to this, the studies have also instituted promotional schemes for promoting efficient utilization of petroleum products.

2. Energy in Transport sector

In view of substantial scope in the transport sector, the emphasis is given parallel on several fronts such as, more fuel-efficient engines, improving quality of roads, improved driving skills establishing model depots and model garages. The combination of price, legislation and government investments or other incentives can be used effectively.

3. Energy in Domestic sector

In the domestic sector, the studies emphasis is on oil and liquefied petroleum gas conservation by better cooking habits, types of equipment installed, and behavioral changes in the occupant. The behavioral changes may take a long time but with certain policies one might be able to achieve goals. Even the architectural design plays important role in minimizing energy use. However, beyond a certain point, costs of conservation outweigh benefits, thus, energy conservation, must be weighed against quantifiable and sometimes non- quantifiable costs.

Thus, going through various studies, the following major challenges emerge [18]:

1. Efficient use leading to conservation and environmental protection.
2. Strict demand management.
3. Reduced dependence on oil by inters fuel substitution.
4. Development of alternate and renewable source of energy.

CHAPTER 3

CASE STUDY

3.1 A Case Study of an Urban System in India

Karnataka is one of the more urbanized States in India with 30 percent of its population living in urban centers. However, the pattern of urbanization is not uniform with variations in intensity, rate of urbanization and spread in various sub-regions. Bangalore, the capital of Karnataka State, accounted for 46 percent of the total urban population. Another significant feature of urbanization is the correlation between the size of the urban area and their growths rate the bigger the area the larger its growth rate. For example, Bangalore achieved a growth rate of 7.6 percent p.a., whereas other urban centers showed a growth rate of 4.9 percent. Karnataka has been a pioneer in power generation having started as early as 1902. Electricity was first supplied to the city in 1905. The installed capacity was 3.166 mw during 1989-90 and the power generation was 14,155 gWh. As in any urban agglomeration, a large portion of Karnataka's energy consumption is through electricity and petroleum products like kerosene, liquefied petroleum gas, petrol, diesel and fuel oil. However, significant quantities of firewood, charcoal and coal are being consumed. Banglore's peak demand was just 25 mw in 1951 which rose to 550 mw in 1985 and is estimated to go up to 1,200 mw by the turn of the century, Bangalore city accounted for around one fifth of the total electrical installations, energy sold and energy entitlement of high tension (HT) industrial connections, and a quarter of the total connected load and contract demand of HT connections; it has a lion's share of 50 percent in the All Electric Home (AEH) with a connected load of 15-ampere installations. This is not in line with the egalitarian distribution of an essential item. What is more obvious is the fact that this inequality has arisen for an item whose distribution is managed by a public utility and not dictated by market forces. The power system in Karnataka is presented in ***Table no. 3.1.***

The big concession given to electricity consumption has not checked the firewood consumption. A study of firewood consumption and supply has revealed that the daily consumption of firewood by households was 970 tonnes, accounting for 3.5 percent of the State's firewood consumption. In the case of petroleum products, Bangalore accounts for more than 60 per cent of the light diesel oil supplies to Karnataka as a whole, about 45 percent of motor spirit, liquefied petroleum gas and kerosene, 37 percent of furnace oil and 22 percent of high-speed diesel. Transportation in Bangalore is dominated by road transport where automobiles and trucks consume about 90 percent of the total transportation energy out of which 80 per cent accounts for passenger transport. Personal transport, particularly two-wheelers, accounts for 60 percent of the total vehicle kilometers and their share in the energy use accounts for 30 percent of the total. Bangalore City accounts for 40 percent of motor vehicles in the State and 96 percent in the district. The rapid growth in passenger vehicles, particularly two-wheelers (i.e. 5.41 percent p.a.) is partly due to the inadequacy of public transport, partly due to the substantial increase in the city's population. This has not only increased the total fuel Consumption, but also the number of passenger kilometers. The result in increasing density of vehicles and environmental pollution. Energy consumption system in Bangalore City and Karnataka State is presented in ***Table no. 3.2***.

Table no: 3.1

POWER DVELOPMENT IN KARNATAKA

S no.	Item	Unit	1989-90
1	Installed capacity	MW	2645
2	Hydel	MW	2245
3	Thermal	MW	420
4	Power generation	gWh	11110
5	T & D distribution network	Ckt. Km	366058
6	T & D losses	Percent	21
7	Power requirement	gWh	18275
8	Power availability	gWh	13967
9	Power surplus (+)/ deficit (-)	gWh	-4308
10	Power surplus (+)/ deficit (-)	Percent	-24
11	Power consumption (utilities)	gWh	11978
12	Domestic	Percent	15.3
13	Agriculture	Percent	32.2
14	Industry	Percent	49.0
15	Commercial	Percent	2.0
16	Others	Percent	1.5
17	Per capita consumption		252
18	Profit / loss of state electricity board	Rs./ million	-840

Table no: 3.2

ENERGY CARRIER CONSUMPTION IN BANGALORE & KANATAKA

(1989-90)

S no.	Energy carrier	Bangalore	Karnataka	Share (percent)
1	Firewood (million tonnes)	0.49	14.00	3.54
2	Kerosene (million liters)	0.18	0.41	44.81
3	LPG (million tonnes)	0.03	0.07	46.51
4	Motor spirit (million tonnes)	0.19	0.41	46.06
5	HSD (million tonnes)	0.30	1.35	22.06
6	Furnace oil (million tonnes)	0.08	0.21	37.37
7	Electricity (gWh)	2290.00	9910.00	20.37

3.1.1 The Demographic profile of Bangalore

Bangalore is the capital of Karnataka State of south India. It is situated in the heart of the Deccan peninsula of India at 12° 58' N

Latitude and 77° 33' E Longitude at an elevation of 3021 ft (900 meters). Recorded history dates its construction to 1537 by Kempe Gowda. During the early years, the city was a major textile and trading center. The British, after their arrival in 1799, set up a new settlement outside the city called the civil and military station of Bangalore (Cantonment). To provide for its industrial growth, a railway station and a hydroelectric power plant, one of the earliest in the country, were built. The Bangalore City Corporation was formed in 1949 with the upgradation of the erstwhile municipality. Since then the city has grown by leaps and bounds-from 69 sq. km in 1949 to 500 sq. km by 1990.

Except for the relatively large share of nearly 20 percent of urban Bangalore of non-agricultural workers, its share in population, households and workers is less than 10 percent. The only indicator, which exhibits a relatively high figure, is the density of population. As per the 1991 census, it is 8,000 per sq. km. Yet another glaring difference is the significantly higher workforce that Bangalore City is supporting in the non-agricultural sector; 95 percent of this workforce is occupied in this sector as against 63 percent in Bangalore district. However, on the whole, the population, households and workforce supported by urban Bangalore are comparatively lower when viewed in the context of its share in energy, which will be shown later. The selected demographic indicators of Bangalore is presented in ***Table no. 3.3.***

During 1984-85, Bangalore accounted for 18.5 percent of the State domestic product and 29 percent of the income generated from the non-agriculture sector. The share of income from registered manufacturing industries is 65 percent. Bangalore accounted for 33 percent of investment and 56 percent of employment in large-, medium- and small-scale industries. Similarly the population of the city, which was 0.8 million in 1951, grew to 3.6 million by 1991. While the population growth rate of Bangalore was just 1.8 percent per year during 1901-1910, it was 5.8 percent per annum during 1971-80, the highest growth rate in the country.

Table no: 3.3

Selected demographic indicators of Bangalore

S no.	Item/ Unit	Bangalore	Karnataka	Share
1	Area (sq. km.)	425.0	191891.0	0.2
2	Population (million)	2.9	37.0	7.8
3	Households (million)	0.57	6.4	8.9
4	Main Workers (million)	0.95	6.23	7.0
5	Non - Agricultural workers (million)	0.93	4.77	19.4
6	Total Income (Rs. Million)	44650.0	267784.0	16.7
7	Per capita income (Rs./ month)	919.0	590.0	-

3.1.2 Infrastructure:

Bangalore City has a road network of 1,500 sq. km consisting of cement concrete and asphalt roads. The Corporation did not have any water supply and sewerage cell until 1964, when a special agency, Bangalore Water Supply and Sewerage Board (BWSSB), was set up. Bangalore the requirement of water is met from three sources-the Cauvery, Thippagondanahalli and Resaraghatta reservoirs. The City Corporation covers an area of 500 sq. km and has a population density of 8,000-persons/sq km. The population growth of the city is presented in ***Table no. 3.4***. The major land use is residential (35 percent), followed by roads (20 percent). The remaining land is used for commercial, industrial and other purposes. The present and future patterns of land use indicate that between 1991 and 2000, the share of residential and commercial sectors will increase and that of transport, industry and parks will decrease. The landuse pattern of Bangalore city is presented in ***Table no. 3.5***. The figures indicate that the land area provided for various services like road is inadequate and may be insufficient to meet the growing needs, of the city. Also increasing vehicle population and encroachment of footpaths by street vendors causes congestion of roads, and lead to deteriorating the quality of traffic service. These traffic hurdles result in low travel speeds, frequent stops with acceleration and deceleration of vehicles, leading to increased fuel consumption and exhaust pollution.

Bangalore is also a major center for institutions of higher learning and research, viz. the Indian Institute of Science (IISc), Indian Institute of Management (IIM), Indian Institute of Astrophysics (IIA), Raman Research Institute (RRI), National Institute of Mental Health and Neurosciences (NIMHANS), Indian Institute of Horticultural Research (IIHR), Indian Space Research Organization (ISRO), National

Aerospace Laboratory (NAL), Bangalore University and a host of engineering and medical colleges.

Giant public sector undertakings like Bharat Electronics (BE), Hindustan Machine Tools LTD (HMT), Indian Telephone Industries LTD (ITI), and Hindustan Aeronautics LTD (HAL), Bharat Earth Movers LTD (BEML), etc., are also located in Bangalore. Recently, with the economic liberalization of India, Bangalore has become the home for many well-known multinational corporations like Industrial Business Machines (IBM), Hewlett Packard (HP) and so on.

Table no. 3.4

Population of Bangalore

Year	Population	Growth rate (Percent)
1901	159046	
1911	189485	19
1921	237496	25
1931.	306470	29
1941	406760	33
1951	778977	92
1961	1199931	54
1971	1653779	38
1981	2913537	76
1991	3628165	27

The present study considers the direct consumption of energy in Bangalore City. However, the city also uses energy indirectly by utilizing a large number of goods and services produced elsewhere. This indirect energy content may be quite high and it is worth assessing the same. However, for the present study, the discussion is restricted to direct energy only.

Table no 3.5

Land use pattern in Bangalore (1989-90). -

Type of use	1991	2001
Residential	34.36	37.54
Transportation	20.83	20.53
Parks, playgrounds, etc	10.09	9.90
Industrial	10.14	9.92
Agriculture	4.17	3.09
Commercial	3.49	4.18
Others (Schools, public build.)	16.92	14.84
Total	100.00	100.00

With this background, the energy consumption pattern was examined for the city of Bangalore. The process of examination is referred to as the fuel cycle approach

3.1.3 Fuel Cycle Approach

This approach describes the flow of energy from source to end-use. At the supply end, the primary energy is in the form found in nature - trees for wood, a waterfall, an oil well, etc. This primary energy is converted into convenient energy carriers designated as secondary, energy, for example, firewood logs, charcoal, kerosene, liquefied petroleum gas, electricity, etc. Secondary energy, after transportation/transmission and distribution is delivered as final energy to consumers in the domestic, industrial, agricultural, and commercial, transport and other sectors. The final energy delivered to consumers is converted through various end-use devices (stoves, lamps, furnaces, engines, etc.) into the useful energy that provides energy services (cooking, illumination, process heating, shaft power, etc.) and satisfies the basic needs. There are losses associated with the conversion of one form of energy into another. These losses are particularly significant in the conversion of final energy into useful energy. All the energy carriers, viz. firewood, charcoal, kerosene, liquefied petroleum gas (LPG), petrol, diesel, fuel oil and coal are considered in the present analysis. The supply, transportation, distribution, consumption and end-use analysis of these energy carriers have been studied.

3.1.4 Efficiencies of Energy Flow

In many energy analyses, the efficiencies usually employed pertain only to the end-use of the devices. This method does not consider the amount of additional energy involved (such as diesel) for transportation/transmission of energy resources to the end-use point.

Therefore, to analyze the flow of energy from source to end-use service, it is necessary to study the following efficiencies:

1. **End-use device efficiency (EDE):** This is the efficiency of the device used for satisfying the demand of a particular end-use. This is used for calculating the useful energy.
2. **Simple energy efficiency (SEE):** This is the overall efficiency of using an energy resource for meeting the demands of a particular end-use. It considers the loss of the energy resource at each stage, i.e. from the supply point to the end-use point. More specifically, this efficiency takes into account the loss of the energy resource during the processing from primary energy, transportation to the end-use point and losses in the end-use device. A significant characteristic of simple energy efficiency is

that it considers the loss of only the energy resource for computing it.

3. **Complex Energy Efficiency (CEE):** This is an improvement over simple energy efficiency. It is the overall efficiency considering the loss of the energy resource from the supply point to the end-use point. Complex energy efficiency also takes into account the amount of other energy resources spent while transporting the energy resource from one place to another. Specifically diesel spent on transportation will be taken into account in calculating the complex energy efficiency. Obviously, complex energy efficiency provides a clearer picture compared to simple energy efficiency as it considers other significant energy losses incurred before deriving the end-use service using a particular energy resource.

3.2 CASE STUDY - II: WASTE AS A MAJOR ENERGY RESOURCE:

Garbage is today " Vital Natural Resource." The United States Environmental Protection Agency has estimated that there is over one billion dollars worth of recoverable metals available in that nation's waste every year. The trash also contains over one billion dollars worth of energy, which is being discarded annually. It has being estimated that the energy value of refuse generated every year in the U.S is equivalent to 290 million barrels of low sulphur oil or 800,000 barrels a day. Municipal refuses, if converted into energy at normal efficiency, could generate 14,000 Mw of power [12].

The world's largest plant, which converts 1,500 tonnes of refuse into steam, is built by Wheelabrator - Frye, Inc., the U.S. at Saugus, Massachusetts, supplies steam to the Lynn works of the General Electric Company. The plant costs around $30 million, handles the waste of 18 adjacent communities to provide General Electric with the equivalent of about 1,750 barrels of low sulphur oil. It also recovers ferrous and other metals for use as scrap, and ash to be used for roadfill.

A director of Wheelabrator has stated that Frankfurt West Germany, now produces 7 percent of its electrical energy and Amsterdam, Holland, 6 percent from the Von Roll system.

When American announced the formulation of Americology, a unit for recycling solid waste, H. Blair Smith, Vice President for environmental affairs, said: " Simple open pit dumping and burning of garbage methods developed by the Julies Caesar can no longer be tolerated on either environmental or economic grounds."

Other major projects are planned for Boston, Cleveland, New Orleans, etc. Connecticut expects to be recycling about 60 percent of its household and industrial waste, 12 times today's percentage. This would provide 11 percent of its electrical needs along with enough reclaimed steel for 200,000 cars. Massachusetts has announced plans for a $342 million network of refuse recycling plants that would turn about 56 percent of the State's waste into combustible fuel. This would constitute about 15 percent of the total energy used by the State's utilities to produce electricity [12].

3.2.1 ELCTRIC POWER FROM WASTE:

The Union Electric company of St. Louis, Missouri, U.S.A., recently announced plans for the development of a solid waste utilization system capable of handling all of the solid waste generated in the metropolitan St. Louis region. The president of Union Electric company stated that the system to be built, owned, and operated by the company, without governmental subsidy, " will provide a long term, economically self supporting solution to the metropolitan area's solid waste disposal problems." The economic justification for the estimated $70 million in the capital costs and $11 million in the annual operating costs will come from the heating value of the burnable material, dumping fees and the sale of the non burnable recyclable materials. Apart from the utilization of the tremendous heating value of solid waste, which will save millions of tonnes of fuel, the projects offers a noteworthy solution to municipal waste disposal problems.

3.2.2 PROCESSING FACILITIES:

The city of St. Louis has provided facilities to process raw refuse at a rate of 45 tonnes per hour. In a single shift of 8 hours, an average of 300 tonnes of refuse is processed, which provides sufficient supplementary fuel for the replacement of 10 percent of the coal requirement of the Meramec plant for 24 hours.

The hammermill is a horizontal shaft mill powered by a direct connected 1,250 hp, 900 rpm motor. The mill grate has openings of 2-1/4 inches by 3-1/4 inches but most milled particles are less than 1-1/2 inches in size. The milled refuse is conveyed to the air classifier metering and a surge bin which provides a controlled feed into the entrance of the air classifier. Those components which are light and combustible are carried with the air flow and discharged through the top of the classifier, while the heavy particles fall out through the bottom onto a conveyor belt. These then pass under a magnetic belt separator for removal of magnetic materials. The magnetic materials are then transported to the Granite City Steel Company for charging blast furnaces.

The heavy fraction remaining after the removal of the magnetic is currently being taken to the landfill. However, plans are made under way to provide for separation of the glass, organics and non-ferrous metals into different components. The light fraction is carried by air to a cyclone separator and discharged on a conveyor belt to the storage bin. The material withdrawn from the bin is compacted into conventional 75 cubic yard, self unloading, transfer trailer trucks and transported approximately 20 miles to the Meramec Plant.

3.2.3 ENVIRONMENTAL EFFECTS:

The Union Electric Company and the Environmental Protection Agency are conducting comprehensive tests on the effect of burning refuse on the environment. No adverse effects on the environment have so far been noticed.

CHAPTER 4

STUDY AREA

4.1 INTRODUCTION:

Ghaziabad is one of the important cities in the National capital region. It acts as a gateway to Delhi for all parts of Uttar Pradesh, Bihar, West Bengal, Assam and other eastern states. The greatest resource of Ghaziabad lies in its situation at the junction of three important routes coming from Calcutta, Dehradun and Moradabad. The high degree of nodality of the city in respect to its surrounding areas is further reinforced by its proximity to Delhi (at a distance of just 15 km.)[19].

The total area of the city is 67.50 sq. km, and a population of 5.75 lacs (1991). The site, on which the city stands, consists of almost level plane, sloping gently from north to south and from east to west. River Hindon, a tributary of Yamuna, rising from shivalik hills flows almost through the middle of the city. Main part of the city is known as east Hindon area, lies to the east of river Hindon.

The city of Ghaziabad was included in the Delhi Metropolitan area in the 1962 Master Plan of Delhi to contribute and accommodate the population influx, to the National capital. The state Government of Uttar Pradesh also encouraged in developing the city by encouraging industrialization, which has also led to population migration to the city.

The city of Ghaziabad evolved by the development of three villages Jatwara, Kaila and Bhonj. Ghaziabad as it stands today is not the true picture reflection of its part. Due to its vicinity of Delhi, which has been the center of all major historical events. Ghaziabad has not been able to come to the fore on the national scene.

Impressed by its strategic location, Ghazi-ud-din, the Vazir of emperor Mohammed Shah of Delhi, constructed a fortress here to have a sound base around Delhi, which he thought, would act as a check post for eastern part of the country. This was the physical origin of Ghaziabad. The fortress was constructed in an area of 19.5 ha. (2000 ft. length and 1000 ft. width). The entire length was dividing by cross roads into four equal roads. At the ends of these roads four huge gateways were made[19].

For almost 125 years, i.e., since its inception, the town did not have much social, cultural and political activities. The first railway line was constructed in 1864. This gave a new name to this town, i.e., Ghaziabad. An effort was made in the city planning by providing commercial areas in the area between the railway station G.T. Road and old town.

During the post independence era, the influx of refugees from Pakistan, a new dimension and character was observed in the town. Refugees inhabited all areas around G.T. ROAD haphazardly. These refugees started setting up industries and thus the whole set up was unplanned and haphazard. All these development was so fast that the authorities could not make an alternative [19].

Ghaziabad is basically an industrial city and thus for its development energy is a major concern. The problem of energy is not only in the terms of fulfilling the demand of various sections, but the changing environmental condition cannot be ignored.

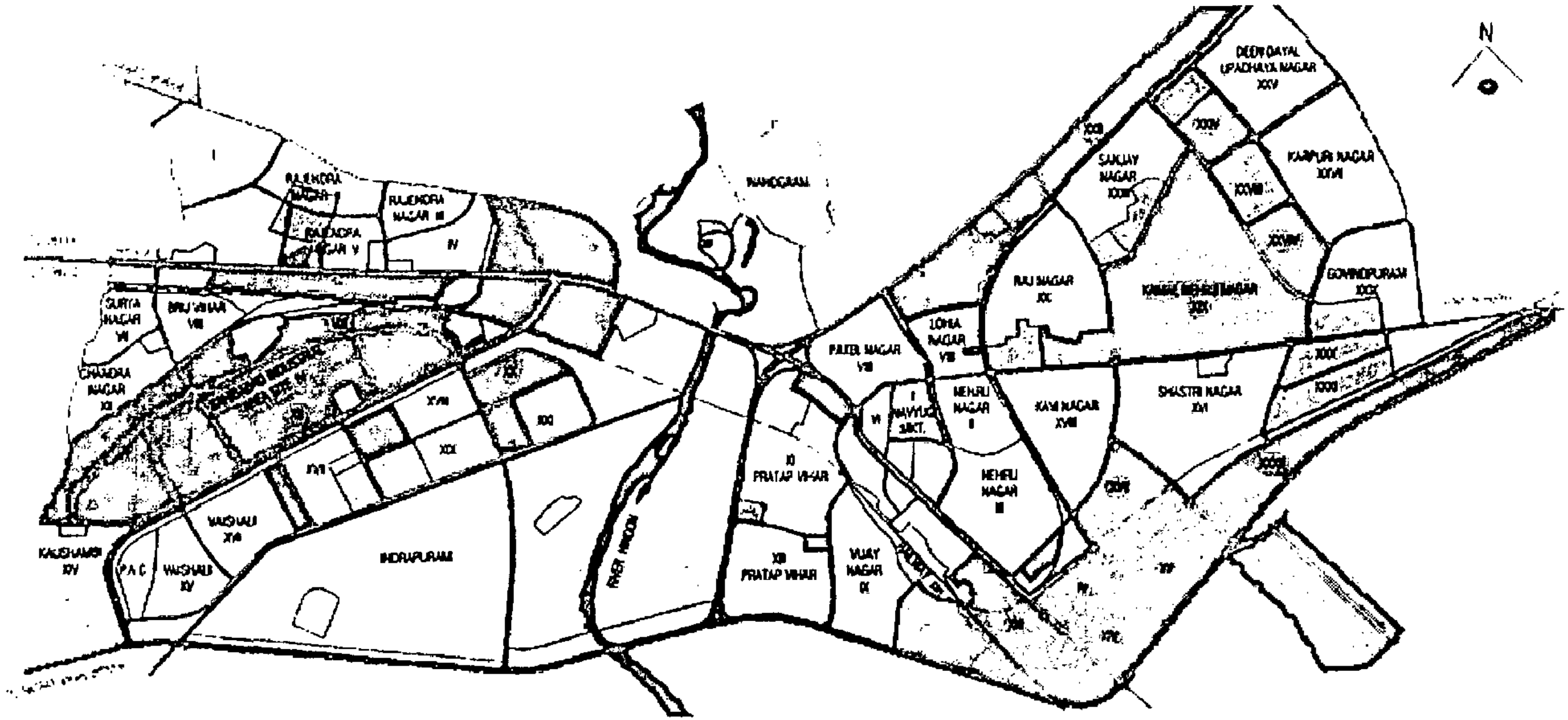
4.2 LOCATION

4.2.1 REGIONAL SETTING

Ghaziabad lies in the latitude 28° 30' to 28° 45' and longitu 77° 15' to 77° 30' on east and adjacent to the boundaries of the st of Delhi. Ghaziabad is one of the important cities in the National capi region. The greatest resource of Ghaziabad lies in its situation at t junction of three important routes coming from Calcutta, Dehradu and Moradabad. The high degree of nodality of the city in respect to surrounding areas is further reinforced by its proximity to Delhi (a distance of just 15 km.) [19].The total area of the city is 67.50 sq. k And a population of 5.75 lacs (1991). The study area is shown in ***no. 4.1.***

4.2.2 PHYSICAL FEATURES

The site, on which the city stands, consists of almost level plai sloping gently from north to south and from east to west. Ri Hindon, a tributary of Yamuna, rising from shivalik hills flows alm through the middle of the city. Main part of the city is known as e Hindon area, lies to the east of river Hindon. The elevation of the c



LANDUSE PLAN OF GHAZIABAD CITY

Fig no: 4.1

LEGEND:

- Residential
- Industrial
- Pub- utilities
- Pub & Semi Public uses
- Commercial
- Transport & Communication
- Open Spaces
- Green Belt
- Water body
- Agricultural l

above the mean sea level ranges from 705 feet's in the east to 667 feet in the south.

4.2.3 CLIMATE

Climate of the city is quite invigorating for about eight months from September to April as there is seldom a severe cold spell. During May and June, excessively high temperature of the day often reaches 40 degree Celsius. Average rainfall of the city is 81.4 cm.

4.3 TREND OF GROWTH

4.3.1 FACTORS AFFECTING THE GROWTH OF THE CITY

The following factors are responsible for the present growth of the city:

1. The River Hindon
2. Proximity to Delhi.
3. Productivity of land.
4. Communication Routes.

(1) The River Hindon: The river Hindon is the most important factor of growth. Till the beginning of the 20th century, it acted as a physical barrier between Delhi and the eastern part of the country. There used to be floods in the river every year before 1955, and the floodable area was right up to the present Patel Nagar. So the urbanization limits of this town were restricted only up to that point till a bund came up on the eastern side of this river. This river has always enjoyed the sanctity of a holy place for the people of this town. They have been using its tanks for cremation of dead and are also used as a bathing place during religious festivals.

(2) Proximity to Delhi: This factor has affected the entire city planning aspects. It is estimated that about 45,000 to 50,000 People commute from Ghaziabad to Delhi everyday for their work. Similarly, most of the industries that are located here have their business offices in Delhi.

(3) Productivity of land: Productivity of land in this region has always been beneficial to the town in terms of its economy. Because of large production of grains and vegetables, for which Delhi has been the major market, wholesale business of these commodities has given birth to most of its present commercial areas. Grain and vegetable markets are prominently located around the old city.

(4) Communication Routes: The city till 1857, remained within the Walled areas. But with the construction of Grand Trunk road and railway line, the town started growing along with the communication routes. In the early part of the 20th century, it was felt that the railway line was causing hindrance in the growth of the town, so it was shifted to its present alignment in 1929. The present Urban Configuration of Ghaziabad clearly outlines the importance of rail and major road network.

4.4 DEMOGRAPHIC PATTERN

4.4.1 POPULATION

The study of population statistics reveals that from the year 1911 to 1941 there was rapid increase of population shown in ***Table 4.1***. The reasons for population growth in 1941 were due to the migration of people from rural areas who were attracted by the high standards of living. Population growth rate has been on the increase since independence.

Table no. 4.1

DECADAL GROWTH OF GHAZIABAD CITY FROM 1911 TO 1991:

S. no	YEAR	POPULATION (in lacs)	RATE OF GROWTH
1.	1911	11304	-
2.	1921	12343	9.2
3.	1931	18831	52.5
4.	1941	23834	26.5
5.	1951	43745	83.5
6.	1961	70438	61.2
7.	1971	128036	81.77
8.	1981	287170	124.28
9.	1991	575000	80.91

Source: District Statistical Handbook -1998

4.4.2 SEX RATIO

Sex ratio has undergone minor changes during the last three decades. The sex ratio in 1961 was 805 females per 1000 males. This ratio further reduced to 795 in 1971 and 791 in 1981. Sex ratio is lowered because of the tendency of industrial labor living apart.

4.4.3 LITERACY

The literacy rates of Ghaziabad in terms of previous three census decades (47.30 percent, 49.18 percent and 51.72 percent) have been higher than the U.P State in the corresponding period.

4.5 ECONOMIC BASE

As per 1981 population statistics, the percentage of workers was 30 percent of the total population. The employment in primary sector was 2.20 percent, 42.50 percent in secondary sector, and 55.30 percent in tertiary sector.

4.6 SOCIAL BASE

It is important to study the social base of the city because it is directly related to the energy consumption. More percentage of people is having high living standards more demand of energy and hence to fulfill that needs more energy resources. In Ghaziabad, most of the people have a very high standard of living as most of them are involved in business activities.

4.7 INFRASTRUCTURE FACILITIES

4.7.1 WATER SUPPLY

The main source of water is tube wells. Presently there are 41 tube wells and 13 overhead tanks. They have a total capacity of 21,00,000 gallon. Thus water supply is adequate.

4.7.2 ELECTRICITY

The city substation receives electric supply of 220 kW grid situated 20 km from the city in Muradnagar, which has a thermal power plant. The main use of electricity is in industrial sector, followed by domestic and commercial sectors. The city has a total of 23 sub stations in which 18 sub stations are of 33 kW capacity, and five are of 132 kW capacity. Even now the city electricity demand is not fulfilled, hence in the future the gap may widen more if necessary steps are not taken accordingly.

4.7.3 SEWERAGE AND DRAINAGE

Trunk sewers cover about 70 percent of cis Hindon area and about 30 percent of Trans Hindon area. However, nothing so far has been done on construction of intermediate main sewer pumping stations, primary and secondary treatment works, and also for disposal activities. About 35 percent of activities on external storm water drains confined in cis Hindon area, and the rest is i.e., 60 percent is confined in Trans Hindon area.

4.7.4 TRAFFIC AND TRANSPORTATION

Transport facilities are an important aspect to be considered in the area since it is known as the proximity to the National Capital. The city has developed along with major transportation routes. Travelling by bus is most common in and out the city.

Table no. 4.2

Land use Pattern of Ghaziabad City

S no.	Land use	Percentage
1	Residential	37.36
2	Commercial	1.12
3	Industrial	43.73
4	Public & semi public	2.82
5	Open spaces	0.53
6	Traffic & Transportation	14.04

Source: Master Plan of Ghaziabad City 1981-2001

CHAPTER 5

ASSESSING THE AVAILABLE ENERGY RESOURCES

5.1 PRESENT ENERGY RESOURCES

This is one of the most important parts in the investigation, since it assesses the present energy resources that are in use. This helps to understand the nature and type of energy use of the city, and the energy resources that are in demand and used more frequently. ***Table 5.1*** shows the power development in Uttar Pradesh.

The various types of energy resources in the city are:

1) Electricity.
2) Petrol
3) Diesel
4) LPG

Table 5.1

POWER DVELOPMENT IN UTTAR PRADESH

S no.	Item	Unit	1998-99
1	Installed capacity	MW	4955
2	Hydel	MW	1494
3	Thermal	MW	3461
4	Power generation	Gwh	21432
5	Plant load factor	Percent	48.6
6	T & D distribution network	Ck[illegible]	290745
7	T & D losses	Per[illegible]	26
8	Power requirement	GWh	20354.4
9	Power availability	GWh	16284.4
10	Power surplus (+)/ deficit (-)	GWh	-4070
11	Power surplus (+)/ deficit (-)	Percent	-21
12	Domestic	Percent	17.3
13	Agriculture	Percent	28.4
14	Industry	Percent	42.0
15	Commercial	Percent	5.8
16	Others	Percent	4.3
17	Per capita consumption		252
18	Profit / loss of state electricity board	Rs./ million	-546.8

Source: TEDDY Teri Handbook 1998-1999

5.2 AVAILABILITY OF RESOURCES:

5.2.1 ELECTRICITY:

The authority responsible of supplying electricity to the city is Uttar Pradesh State electricity board (UPSEB). They are receiving, supply from the Muradnagar thermal power plant, situated at a distance of 20kms from the city.

The requirement of electricity is quite high, as the city is an industrial city so more quantity, of electricity is required for the functioning of the industrial sector.

Apart from the industrial sector, commercial and domestic sectors are also the main consumers of electricity. The year wise electricity consumption in the city is shown in ***Table no. 5.2.***

Table no. 5.2

Electricity consumption pattern in Ghaziabad City(in Mw)

S. No.	Sectors	1996-97	1997-98	1998-99	1999-00
1	Domestic	154.02	165.45	197.05	241.56
2	Commercial & Miscellaneous	53.78	52.31	65.80	79.66
3	Pub. Lighting	18.89	20.36	17.84	29.55
4	Pub. Water Works	33.38	40.85	31.69	25.81
5	Industries Light	236	271	206	166
	Heavy	142.14	145	138	142
6	Railway Traction	156	186	188	188
7	Total	794.07	875.97	851.38	860.58

Source: Annual Report UPSEB 1999-2000

Thus from the above table it can be observed that the requirement for electricity is increasing with each passing year, and keeping the same pace the future requirement for electricity is bound to increase.

5.2.2 PETROL:

The city is supplied with petrol from various oil companies like Hindustan Petroleum limited, Indian Oil, etc. Requirement for petrol in the city is fully satisfied. At present there are 17 petrol pumps spread all over in the city.

At present the city is supplied 32165 gallons of petrol from the various oil companies to the petrol pumps. The present quantity of petrol is sufficient for the city's requirement.

5.2.3 DIESEL:

The consumption of diesel is low as compared to petrol in the household sector as people are having more number of vehicles run by petrol than by diesel, but if we see the total scenario of consumption pattern of diesel it is much higher than petrol. The main reason behind this is, that heavy vehicles like buses, trucks, etc., use diesel as fuel and as their requirement is high so the consumption is also high. The other reason behind the higher consumption of diesel is that the industries in the city are also using it for some of their works.

At present the city is supplied a quantity of 190546 gallons. This quantity is able to serve the need of the city.

5.2.4 LPG:

The city is supplied with liquefied petroleum gas from various companies like Indane, etc. Requirement for liquefied petroleum gas in the city is fully satisfied. At present there are 11 gas agencies spread all over in the city.

At present the city is supplied 29580 MT of liquefied petroleum gas from the various companies to the gas agencies. The present quantity of liquefied petroleum gas is sufficient for the city's requirement.

5.2.5 WASTE PRODUCTION

Waste is defined as ' the goods, which is not suitable to use for productive purpose'. But, unfortunately, the resource, which is left out after major used, is considered as waste in India, and thrown them out in the public spaces.

Thought these resources have very larger number of utility purposes, generally, it has been considered as waste after a specific use and thrown in the public spaces. Waste can be classified into two, such as, rural waste and urban waste. Rural waste is produced in the rural areas and is recycled almost all in the different forms in the rural areas itself except non-degradable items. Hence, accumulation of waste in rural areas is negligible. On the other hand, waste produced in the urban system is dumped in the urban system itself, which creates several problems.

It has been observed from the several studies that in many urban areas, only about 50 percent to 70 percent is collected and the rest is unattended, which creates havoc in the system. Most of our cities fall woefully short of equipment and facilities to meet the growing needs for solid waste management. There are options for private sector involvement through contracts or outright privatization.

It has been found that the government agencies, which involve in collection and disposal of the garbage, give more attention where higher income group people live and neglect the areas where low income group people inhibited. It has been also found that even besides the premises of the low-income group people. In some cases, it has been found that the prime importance areas of the city are only attended for garbage collection and rests of the areas are absolutely neglected. The government organizations, which are engaged in the collection and disposal of garbage, are suffering from lack of funds, human resources and material resource due to lesser resource allocation for this particular activity by the government.

The most of the urban centers do not have proper place to store the garbage. As a result, the government agencies are unable to dispose even the little garbage collected from the system in a proper place.

Accumulation of waste creates hazardous problems in the urban system, and also it is purely responsible for pollution. Pollution refers as " an addition to some exogenous substances in the environment, which are harmful for organism including human being".

Pollution in the urban system is generally occurred due to directly dumping of solid wastes and pumping of liquid industrial effluents in the urban system.

Recycling of urban waste is the challenging task. Different types of wastes usually generated in the system. So that it is imperative to have a close look at the waste before recycling. At the outset, the entire waste shall be collected, transported, stored in convenient places and segregated by different types for recycling. The garbage can be divided into three forms: combustible like paper, cloth, wood, biological residues, etc., incombustible waste such as, metal, glass, ceramics, soil, sand, etc., and other items, such as, leather, rubber, and plastics. Once segregated by different types, its quality and quantity of recycling would once more segregate the same garbage. Appropriate technology would be employed for recycling the wastes as per its usage in different purposes.

It has been observed that the following technology are adapt in some pockets pertaining to garbage management system. They are Vermiculture, Biomass Gasification, Biomass Gasifier, Sterling engine and Steam Operated Pistonless Pump. These technologies are given to the public related to the functioning of these technologies, this can be operated by even public mass for their requirements.

Since, we are considering waste as a resource in our study, thus this part will help us with various information of waste in the city, like the type of waste produced, the total amount of waste produced and based on that we can very well estimate that will it be able to use it as a resource or not, (as there are certain specific criteria for its use) ***Table 5.3*** shows the production of Solid waste in the city and ***Table 5.4*** shows composition of Solid waste.

Urban waste can be divided into two major parts, they are as follows:

1) Municipal Solid Waste.
2) Hazardous Solid Waste.

The wastes that contribute to municipal solid waste are as follows:

1) Domestic waste.
2) Agricultural waste.
3) Commercial waste.
4) Institutional waste.

5) Construction and Demolition debris.

Where as the wastes that contributes to hazardous solid waste are as follows:

1) Industrial waste.

2) Hospital waste.

Since the two wastes are entirely of different nature hence, their storage, collection, transportation and disposal system are also different. The storage, collection and transportation of municipal solid waste and hazardous solid waste are shown in ***fig no. 5.1.***

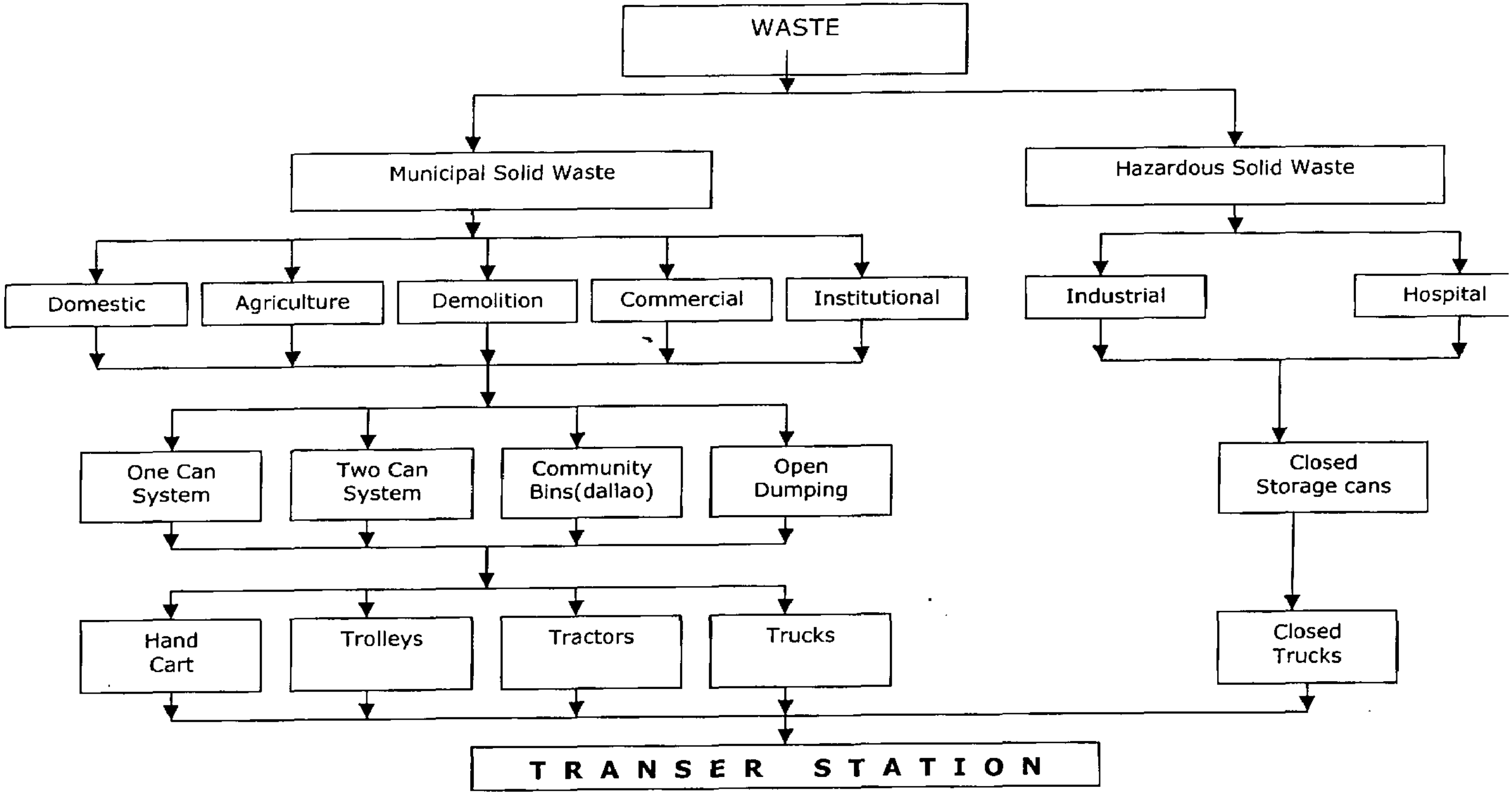


Fig no: 5.1 Collection Of Waste in an Urban System

There are four types of system that can be used as per the requirement for the storage of municipal solid waste. They are:

1) One can system

2) Two can system

3) Community bins (dallao)

4) Open dumping.

In one can system, only the non- decomposable waste is put in the can, which include plastic bags, paper, tin, containers, cardboard boxes, etc. This type of system can be adopted in the institutional areas and in some of the commercial areas too. Since the waste is non- decomposable so the number of trips required to collect the waste will also be less, as the waste wont decompose and can stay in the bins for a longer duration, i.e., about one week.

In the two-can system, two cans are provided one for non-decomposable waste and other for decomposable waste. Thus there is a segregation of waste at the storage level and hence time will be saved in segregation of waste at the transfer stations. The can that will be storing the decomposable waste should have a closing cover on top of it so that there are no flies or mosquitoes sitting on the waste and hence causing health problems in the area. This system can be adopted in the, domestic and commercial sector.

Community bins are very common feature of the residential areas, and there are many bins located in the residential areas at appropriate distances. So that a bin can cater to 15 to 20 households. These bins are larger in size as they have to cater to larger quantity of waste.

Open dumping is not suggested, as such, but it can be used if a piece of land is unutilized and is of no use temporarily, this can be used in case of keeping the debris of demolition and construction works. As the quantity of waste is larger in size in this case, and it can be kept on that land and latter can be disposed off to a landfill site

There are certain norms that have been specified and they have to be followed strictly for storing hazardous solid wastes, so that hazardous solid wastes do not cause threat to human beings. So the hazardous solid wastes are stored in closed containers such that by any means they are not exposed to the environment, which may be dangerous.

To collect and transport the municipal solid waste following devices can be used:

1) Hand carts.
2) Trolley.
3) Tractors.
4) Trucks.

Handcarts are commonly used, for local collection of the municipal solid waste, which take it directly to the trucks standing at a place. The handcarts are convenient, as they are small in size and can be easily taken even in narrow lanes to collect waste. Handcarts can only be used for short distances. Whereas, trolleys, tractors and trucks can be used to take the waste for larger distances. Only closed trucks should be used for collecting and transporting hazardous solid waste.

Once the available waste has been collected and bought to the transfer stations, then segregation of waste is done as shown in ***fig no.5.2***.

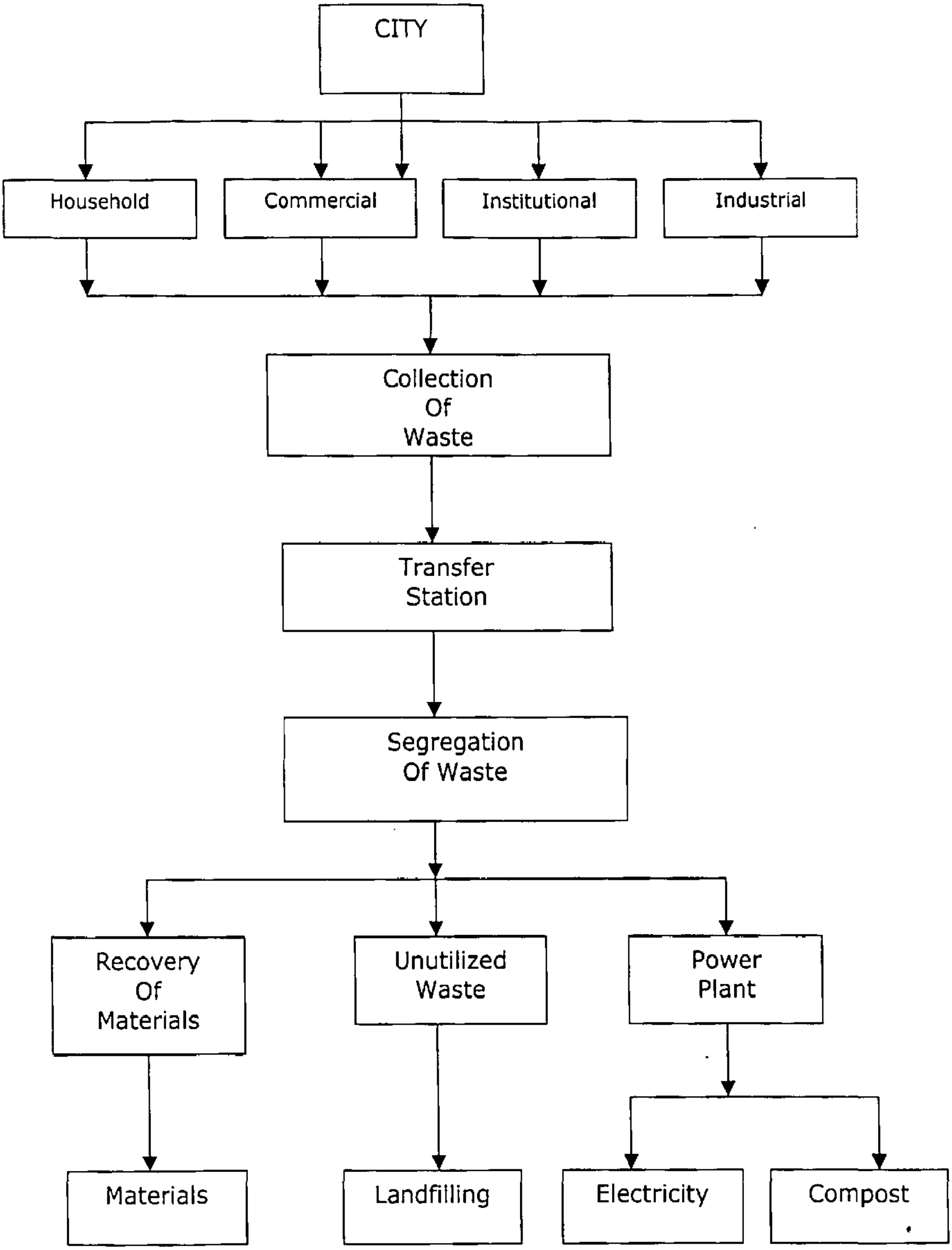


Fig no: 5.2 Waste Disposal System

Table no 5.3

SOLID WASTE DATA

S no.	Nature of Waste	Quantity (MT)
1	Domestic	302
2	Commercial & industrial	45
3	Institutional	52
4	Street	10
5	Trade	62
6	Total	480

Source: municipal corporation(1999)

Quantity of solid waste generated/capita/day (gm.): 400 gms.

Total qty. of solid waste generated per day : 480 MT

Table 5.4

Composition of solid waste (physical)

S no.	Physical Composition	percentage
1	Rubber plastic	3percent
2	Paper	3percent
3	Metal	1percent
4	Stone	10percent
5	Glass	1percent
6	Cloth	30percent
7	Other	52percent

Source: municipal corporation (1999)

CHAPTER 6

ASSESSING THE ENERGY CONSUMPTION PATTERN

6.1 TREND OF USE

It gives the details of the trend of energy consumption pattern in the city. The energy consumption pattern is very important as it is directly related to income, living standard and various other factors, which will be of great help in later part of the study. It will also help us in knowing that what is the trend of use of the various types of the resources available.

6.2 NUMBER OF HOUSEHOLD

Identification and selection of household at the grass root level for conducting the survey in the study area is one of the most important tasks.

In the present investigation, 75 households have been surveyed from different parts of the city. The distribution of the household b income classwise is shown in ***Table no: 6.1***.

The table indicates that maximum number of households are confined in the income range of 1.8 lacs to 3.6 lacs per annum i.e. 45.33percent, followed by 26.67percent in the income range of 0 to 1.8 lacs per annum. Then 20percent household are in the income range of 3.6 lacs to 5.4 lacs per annum. It is interesting to observe that there is only one household in the income range of 7.2 lacs and above per annum is found, of which consisting only 1.33percent of the total households studied.

6.3 POPULATION DISTRIBUTION

Population is one of the most important criteria in a study, as everything is directly related to it.

Thus the distribution of population according to various income groups of the sample households are studied very carefully, and the results are presented in ***Table no:6.2.***

graduates, followed by 24 percent are under the category of technical education. Whereas, it is seen that there are only 6.46percent of people having an education Upto 10th standard.

Further studying the educational status of the various income groups it is observed that a major part of them, 41.5 percent belong to the income range of 1.8 lacs to 3.6 lacs per annum, followed by the lower income range people i.e. 0 to 1.8 lacs per annum accounting for 24.9 percent, while the higher income group forms a very meager part, i.e. 2.3 percent of the total literate people since only 6 persons are representing the group of the total population. However, graduates and postgraduates mainly confined to higher income group. This table draws a very important inference, i.e., more number of graduates and technical people are found even in the lowest strata of the income group, while is a good sign for overall development of the system.

6.5 STATUS OF EMPLOYMENT

Status of employment is one of the most important factors, which decide the functioning of the system. If more number of people are employed, then the system will fetch more income, which will lead to more and more spread effect. It is the deciding factor in the issues

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Population is one of the most important criteria in a study, as everything is directly related to it.

Thus the distribution of population according to various income groups of the sample households are studied very carefully, and the results are presented in ***Table no:6.2.***

The table illustrates that maximum numbers of people are confined in the income range of 1.8 to 3.6 lacs i.e. 41.34 percent of total population, since the segment also covers 45 percent of the total sample household. Followed by 25.08 percent in the income range of 0 to 1.8 lacs per annum. Whereas, very large number of population is found in the lowest income range of 7.2 lacs and above, i.e., 2.13 percent. It is very interesting to note that only one household lies in the highest income category of the sample households. It has been observed that the size of the household is increasing along with increasing in income ranges. The size of household is the lowest, i.e., 3.44 in the income range of 1.8 t 3.6 lacs, followed by 3.55 in the income range of 0 to 1.8 lacs. It is 6 in the income range of 7.2 lacs and above.

In India, generally the population size of the household is decreasing along with increase in income due to several factors. The higher income group people have more awareness about the population problem compare to the lower income group. Whereas, in the study area, it is in reverse form. The reason for the same is the higher income group categories in the study area have more income, more educational status, and hence they can afford it. It has been also observed that the highest income group person never bother about the number of children, because they are more well off.

6.4 EDUCATIONAL STATUS

Education is considers as the most important parameter which has the power to control various activities of the system, even the other parameters are directly related to it, like income, quality of life, etc. education is the parameter which is directly related to the awareness regarding various matters.

Thus in the present investigation the educational status of the people is studied very carefully, and the results are shown in ***Table no: 6.4***. The level of education is divided into five groups they are:

- Upto 5^{th}.
- 5^{th} to 10^{th}.
- 10^{th} to 12^{th}.
- Graduation.
- Technical Education.

It is observed that of the total people surveyed i.e. 283, 97 percent of the population is literate, and of which 61 percent are graduates, followed by 24 percent are under the category of technical education. Whereas, it is seen that there are only 6.46percent of people having an education Upto 10^{th} standard.

Further studying the educational status of the various income groups it is observed that a major part of them, 41.5 percent belong to the income range of 1.8 lacs to 3.6 lacs per annum, followed by the lower income range people i.e. 0 to 1.8 lacs per annum accounting for 24.9 percent, while the higher income group forms a very meager part, i.e. 2.3 percent of the total literate people since only 6 persons are representing the group of the total population. However, graduates and postgraduates mainly confined to higher income group. This table draws a very important inference, i.e., more number of graduates and technical people are found even in the lowest strata of the income group, while is a good sign for overall development of the system.

6.5 STATUS OF EMPLOYMENT

Status of employment is one of the most important factors, which decide the functioning of the system. If more number of people are employed, then the system will fetch more income, which will lead to more and more spread effect. It is the deciding factor in the issues like accruing more income, quality of life, saving, etc. It is observed that generally most of the population is engaged in the service sector, whereas few are engaged in trade and commercial activities in the city. As mentioned earlier in the study area profile, the city is an industrial city, and more percentage of population is engaged in business related activities. *Thus, the income of the people is much higher and hence,* their standard of living is also high.

The status of employment has been studied very carefully among the sample households, and presented in ***Table no: 6.5.***

The table indicates that two fifth (40.9 percent) of the population of the sample households are employed. Of which, the number of person employed at the household level is increasing along with increase in income range. It has been observed that more than five sixth (83.33 percent) of the population confined with the highest income group are engaged in employment activities, followed by about half (46.77 percent) of the employed persons are found in the income range of 3.6 lacs to 5.4 lacs per annum. It is very disturbing to note that the lowest number of persons (33.8 percent) employed in the income range of 0 to 1.8 lacs per annum.

Thus it can be inferred that the status of employment is increasing with the increase in the income range. The higher income group people are able to get better and higher education, whereas in lower income group, the people are not able to get good education and hence the status of employment is also very low.

6.6 VEHICULAR DISTRIBUTION

India has started to have open market economy since 1991, which resulted large number of multinational companies flow in the sub continent. There are few multinational companies setup their small car production and small car production have increased to very considerable level. The higher income group started to have more than one car, and the usage of cars have been increased to the larger extent. As a result, the demand of fossil fuels has increased manifold, which is an unfavorable sign for this country as India is importing fossil fuels from other countries and huge amount of money is spend in this regard.

Ghaziabad, as said earlier, is an industrial city, hence most of the people are engaged in business related activities. So they can easily afford more vehicle. The other reason contributing to it is the lack of good public transportation system, thus people prefer for personal vehicle.

The distribution of vehicles in the different income groups of the sample household is given in ***Table no: 6.6***

It has been observed that the households own a total of 123 vehicles. Of which 50.4percent are cars and 49.6percent are two wheelers. It has been observed ownership of four wheelers (cars) is increased along with increase in income. The availability of four wheelers (cars) per household is increased to 0.25,0.82,1.26,1.6, and 2 respectively to the classification of income ranging from the lowest unit to the highest unit. On the other, the availability of two wheelers per household's analysis results that availability of two wheelers is decreased along with increase in income. This trend very clearly shows that people who have higher income prefer four wheelers rather two wheelers.

6.7 TYPE OF HOUSING

House is one of the basic necessities just after food and clothing. House is a shelter where one gets protection against sunlight, rain , extreme weather conditions like cold, summer, other such odds, besides providing privacy and comfortable living conditions. Thus owning a house is the final dream of everyone.

But in the present conditions the situation has become very complex. As the land is becoming scarce with each passing day. This has also resulted in the sky rocketing prices of land. Therefore, a person owns a house depending upon his means.

In the present investigation, the houses belonging to each of the household of a specific income class are classified into four groups for analysis namely:

- Detached
- Semi detached
- Row housing
- Apartments.

Among the sample households, the different types of houses available in the system is studied very carefully, and presented in ***Table no: 6.7.***

The Table shows that of the total household surveyed, detached and semi detached houses together represent more then two third (71 percent) of the total and the rest are confined in row and apartment housing system.

Of the total detached housing type, more than three fourth number of houses are confined with income range of 1.8 lacs to 5.4 lacs category, and the rest is evenly distributed.

In the semi detached housing type, more than half (57.4percent) households confined in the income range of 3.6 lacs to 5.4 lacs per annum, followed by 35.71percent in the income range of 0 to 1.8 lacs per annum, and rest of them i.e. 6.88percent are confined in the income range of 3.6 lacs to 5.4 lacs per annum. It is interesting to note that there is no semi-detached house observed in the higher income group of 5.4 lacs to 7.2 lacs and above per annum. It is very clearly shown that the higher income group people live separately, since they can afford it.

As one go to the next type of housing i.e. row housing, it is observed that all the houses are confined in the lower income group category i.e. the income range of 0 to 1.8 lacs, thus it is inferred that as the lower income group people cannot afford the luxurious detached and semi detached housing, and can afford only this category.

It gives surprise to notice that mostly low and medium income people live in the apartments that too in government quarters, who are working at the lower levels. Of which half of them are confined in the lowest income strata and the rest are confined in the immediate higher level of income.

Thus, it indicates that most of the middle income group people are living in the semi detached housing type followed by detached type housing.

6.8 AVAILABILITY OF WATER SUPPLY

The drinking water supply is one of the most important aspects, which linked with man's day to day life. If water supply is affected almost all the subsystems of the urban system would be affected, and the urban system as a whole would be paralyzed because water supply is the parameter, which is considered equal to blood in the human immune system. In Indian metro cities and cities, polluted water is also supplied often due to various reasons. The polluted water supply directly affects the human system. One can very easily understand from that how much water is so important for the survival of human being.

The deficiency of water supply at the household level causes scarce and polluted water supply, causes several diseases, such as, diarrhea, dysentery, entire figures, infectious skin, eye diseases and certain louse borne infections, etc. this can be reduced by the improvements in personal domestic hygiene. The availability of sufficient quantity of water for different purposes, such as, bathing, cleaning, and laundry are thus of great importance.

Water is one of the basic necessity needed for human survival just as we need air. We not only need water for drinking purpose but also for washing, bathing, etc.

Therefore, in the present investigation the availability of water supply is carefully studied in the surveyed households and shown in ***Table no: 6.8.***

The water supply is always metered i.e. whatever amount of water is used in the houses it is recorded in the meter, but some people also have illegal (non- metered) connections. It is shown in the tables that all the houses have water supply, and also all of them have metered connection, except one house, which belongs to economicallyweaker section category.

6.9 AVAILABILITY OF ELECTRIC SUPPLY

Electricity is one of the most important infrastructure facilities required for any development. Its absence may cause lot of problems in day to day life, as one has become dependent on it. Though it is being so important, the desired level of requirement is not been fully met. It is not only required for household activities, but also a considerable quantity is required for industrial and commercial activities. Since the requirement is not fulfilled, it affects the growth of the economy. Earlier there were not many appliances being run by electricity at the household level, but now the number is unlimited, thus causing increased dependence. It has come to the stage that failure in supply of electricity disrupts the entire life of the city.

Therefore, in the present investigation, the availability of electricity supply at the household level is very carefully studied in the sample households and presented in ***Table no: 6.9***. The table illustrates all households in the sample households are having electric supply, that the electrical connection is always metered i.e. whatever electricity is used of which only one household has illegal connection. Out of curiosity, the investigator further inquired the economic status of the particular household and found that it belongs to economicallyweaker section category. Since the initial cost of electric connection at household level is very high, the particular household arranges the connection illegally.

6.10 NUMBER OF APPLINCES

Application of appliances is one of the important factor, which vary in accordance with their income. The person earning higher amount of income used to have more quantity of sophisticated appliances at their household level, such as, air conditioners, fridge's, computers, higher quality of audio systems, televisions, ovens, washing machines, etc. Whereas, it is a dream to have these appliances those who have little amount of income. Moreover, these appliances consume more quantity of energy for there functioning. Since lot of industries, in the study area, and more number of people are engaged in industrial activities, the investigator very carefully studied the availability of different types of appliances at the household level in the selected samples. The results are presented in ***Table no. 6.10, 6.11,6.12***. This table illustrates that there are twelve types of appliances are very commonly used in the system. They are:

- Fridge's
- Immersion rods
- Air conditioners
- Mixers
- Computers
- Audio systems
- Television's
- Geysers
- Ovens
- LPG stoves
- Washing machines.
- Pressure cookers.

It has been observed that the number of appliances availability is increasing along with increase in income in their respective strata of income category. Though the availability of all appliances discussed earlier is having increasing trend along with income, the availability of sophisticated appliances, such as fridge, A/c, computers, audio system, T.V, geysers, etc, are found higher number among the higher income group category, whereas immersion rods (common man's water heater) is found only at the lower income group category. Out of curiosity, the investigator inquired about the utilization of the sophisticated appliances and found that though the higher income group people have more number of sophisticated appliances, there application are more or less under utilized.

6.11 CONSUMPTION PATTERN OF ELECTRICITY

Electricity is one of the most widely used commercial energy in urban system. It is available in refined form and hence it is very easy to use, as compared to other energy resources. Thus, one can be able to use it for various purposes in his/her house for lighting, heating, cooking, etc. as the technology is improving day by day more electrical energy based appliances are also used.

Therefore, consumption of electricity at the household level is very carefully studied among the sample households and presented in ***Table no: 6.13.***

The table illustrates that the per capita electricity consumption is increasing along with the increase in income. Moreover, it is also observed that it is very low in the lowest income strata and it is the highest among the highest income strata. It very clearly explains that income is the basic control parameter, which decide the consumption of electricity at the household level.

Thus from the above observations, it is inferred that the higher income range people, since they have more resources , are able to afford various luxuries in terms of modern electrical appliances, hence they are the main consumers of electricity. Whereas, people belonging to the lower income groups are not able to afford these luxuries and hence, resulting in less per capita electricity consumption by them.

6.12 CONSUMPTION PATTERN OF PETROL

As urbanization is increasing day by day, which is resulting into expansion of cities. Thus, one has to travel for longer time, and larger distances to reach his/her destination. This has caused the increasing number of vehicles, which resulted in increasing the consumption of petrol. Petrol is one of the most widely used fossil fuel in the world. The main consumer of petrol is the transportation sector. This increased in vehicle number has caused problem to environmental degradation.

The consumption pattern of petrol in the sample household is shown in ***Table no: 6.14.***

The table explains that the per capita consumption of petrol is increasing along with increase in income. It has been observed that the per capita consumption of petrol is increased more than 200 percent in the highest income group category compared to the lowest income group.

Thus, there is an increasing trend in the consumption along with the increasing income ranges. The main reason of consumption of petrol in the income range of 3.6 lacs to 5.4 lacs per annum is because these households have higher numbers of two wheelers, and four wheelers ownership, while lower income range households have more number of two wheelers only, so consumption is found very low quantity at the lower level of income category.

6.13 CONSUMPTION PATTERN OF DIESEL

Diesel is also one of the important fossil fuels, which is used in transportation sector, but it is mostly used by heavy vehicles like trucks and busses, and a very little quantity of it is used in small vehicles like cars, as most of the cars are being run by petrol. Though diesel consumption is very less in domestic activities, it has been studied very carefully, and presented in ***Table no: 6.16.***

It is interesting to observe that there is absolutely no consumption of diesel in the income ranges of 0 to 1.8 lacs, 1.8 lacs to 3.6 lacs and 7.2 lacs and above per annum. Whereas there is a consumption of 5liters/capita/month of diesel in the income range of 5.4 lacs to 7.2 lacs per annum and 0.403 liters/capita/month of diesel consumption in the income range of 3.6 lacs to 5.4 lacs per annum. Thus this shows that in the household sector, the consumption of diesel is very less as compared to petrol. But in terms of sales consumption of diesel is more than petrol.

6.14 CONSUMPTION PATTERN OF LPG

Liquefied Petroleum Gas is another important source of energy, which is used, in the day to day life. LPG is mainly used for cooking purpose. The use of LPG has helped us to switch over from older methods of cooking, like earlier coal, cow dung, etc were used for the purpose of cooking. Thus LPG is a safer and environmental friendly energy. Now day's people have also started using LPG cylinders in their cars as an alternative to fuel.

The consumption pattern of LPG in the sample households is shown in the ***Table no: 6.15.*** The table illustrates that the per capita consumption of LPG is decreasing along with increase in income, i.e., the per capita quantity of LPG consumption is higher in lower income segment and lower in higher income segment.

Thus it is seen that as the income is increasing the consumption pattern is decreasing. During the course of the survey, the investigator discussed the causes for the trend and found several reasons for the same. The major reasons are as the higher income people have other means of cooking electrical stoves, ovens, microwaves, etc. Therefore, LPG is not as important as compared to lower income people, who cannot afford these appliances, and hence are purely dependent on LPG.

6.15 SOLID WASTE GENERATION

Having the importance of garbage management in the urban system, the investigator has included garbage management also as one of the parameters in this present investigation. Literature pertaining to the garbage management are collected and reviewed and careful inferences are drawn.

A study of the solid waste generated gm/capita/day in the various income groups of the surveyed household is shown in ***Table no: 6.18.***

The table indicates that the maximum generation of solid waste is observed in the highest income groups, which has the income range of 7.2 lacs and above per annum, which is 666.66 gm/capita/day, followed by 588.70 gm/capita/day in the income range 3.6lacs to 5.4lacs per annum. Whereas in the low-income range of 0 to 1.8 lacs it is lowest i.e. 478.87. Thus, from the above observation it has been found that the solid waste generation is increasing along with increase in the income level. Thus it is inferred that the major contribution of waste generation is of the higher income group segment.

Table 6.1 **No. of household**

S no.	Range of Income per year	Total no. of Household	%age
1	0-1.8 lacs	20	26.67
2	1.8 lacs-3.6 lacs	34	45.33
3	3.6 lacs-5.4 lacs	15	20
4	5.4lacs-7.2 lacs	5	6.67
5	7.2lacs & above	1	1.33
	Total	75	100

Table 6.2 **Population**

S no.	Range of Income per year	Population	%age	Household Size
1	0-1.8 lacs	71	25.08	3.55
2	1.8 lacs-3.6 lacs	117	41.34	3.44
3	3.6 lacs-5.4 lacs	62	21.91	4.13
4	5.4lacs-7.2 lacs	27	9.54	5.4
5	7.2lacs & above	6	2.13	6
	Total	283	100	

Table6.3 **Composition of population**

S no.	Range of Income Per year	No. of Males	%age	No. of Females	%age	No. of Children's	%age
1	0-1.8 lacs	36	26.68	28	24.77	6	22.22
2	1.8 lacs-3.6 lacs	53	40.16	48	41.29	15	55.57
3	3.6 lacs-5.4 lacs	29	20.49	31	24.77	2	7.4
4	5.4lacs-7.2 lacs	14	11.04	11	7.34	4	14.81
5	7.2lacs & above	3	1.63	3	1.83	0	0
	Total	135	100	121	100	27	100

Table 6.4 **Educational Status**

S no.	Range of Income Per year	Upto 5th	%age	Upto 10th	%age	Upto 12th	%age	Upto Graduation	%age	Upto tech. Education	%age
1	0-1.8 lacs	4	19.05	10	55.55	10	37.04	39	22.81	6	15
2	1.8 lacs-3.6 lacs	13	61.91	7	38.89	6	22.22	68	39.78	21	52.5
3	3.6 lacs-5.4 lacs	2	9.52	0	0	8	29.63	41	23.97	9	22.5
4	5.4lacs-7.2 lacs	2	9.52	1	5.56	3	11.11	18	10.52	3	7.5
5	7.2lacs & above	0	0	0	0	0	0	5	2.92	1	2.5
	Total	21	100	18	100	27	100	171	100	40	100

Table 6.5 **Status of Employment**

S no.	Range of Income Per year	No. of people employed	%age
1	0-1.8 lacs	24	20.68
2	1.8 lacs-3.6 lacs	47	40.53
3	3.6 lacs-5.4 lacs	29	25
4	5.4lacs-7.2 lacs	11	9.48
5	7.2lacs & above	5	4.31
	Total	116	100

Table 6.6 **No. of Vehicles**

S no.	Range of Income Per year	Total no. of household	No. of cars	Per household	No. of two wheelers	Per household
1	0-1.8 lacs	20	5	0.25	19	0.95
2	1.8 lacs-3.6 lacs	34	28	0.82	25	0.73
3	3.6 lacs-5.4 lacs	15	19	1.26	13	0.86
4	5.4lacs-7.2 lacs	5	8	1.6	3	0.6
5	7.2lacs & above	1	2	2	1	1
	Total	75	62		61	

Table 6.7 **Type of Housing**

S no.	Range of Income Per year	Detached	%age	Semi Detached	%age	Row Housing	%age	Apartments	%age
1	0-1.8 lacs	1	4	10	35.71	12	100	5	50
2	1.8 lacs-3.6 lacs	9	36	16	57.41	0	0	4	40
3	3.6 lacs-5.4 lacs	10	40	2	6.88	0	0	1	10
4	5.4lacs-7.2 lacs	4	16	0	0	0	0	0	0
5	7.2lacs & above	1	4	0	0	0	0	0	0
	Total	25	100	28	100	12	100	10	100

Table 6.8 **Availability of Water**

S no.	Range of Income Per year	Availability of Water	%age	Metered	%age
1	0-1.8 lacs	20	26.67	19	25.67
2	1.8 lacs-3.6 lacs	34	45.33	34	45.96
3	3.6 lacs-5.4 lacs	15	20	15	20.27
4	5.4lacs-7.2 lacs	5	6.67	5	6.75
5	7.2lacs & above	1	1.33	1	1.35
	Total	75	100	74	100

Table 6.9 **Availability of Electricity**

S no.	Range of Income Per year	Availability of Power	%age	Metered	%age
1	0-1.8 lacs	20	26.67	19	25.67
2	1.8 lacs-3.6 lacs	34	45.33	34	45.96
3	3.6 lacs-5.4 lacs	15	20	15	20.27
4	5.4lacs-7.2 lacs	5	6.67	5	6.75
5	7.2lacs & above	1	1.33	1	1.35
	Total	75	100	74	100

Table 6.10 **No. of Appliances**

S no.	Range of Income Per year	No. of Fridge	Per household	No. of Immersion rods	Per household	No. of A.C's	Per household	No. of Geysers	Per household
1	0-1.8 lacs	19	0.95	12	0.6	3	0.15	9	0.95
2	1.8 lacs-3.6 lacs	34	1	9	0.26	24	0.7	33	0.97
3	3.6 lacs-5.4 lacs	18	1.2	5	0.33	33	2.2	29	1.93
4	5.4lacs-7.2 lacs	7	1.4	0	0	14	2.8	11	2.2
5	7.2lacs & above	2	2	0	0	3	3	4	4
	Total	80		26		77		86	

Table 6.11 **No. of Appliances**

S no.	Range of Income Per year	No. of Computers	Per household	No. of Audio systems	Per household	No. of TV's	Per household	No. of Mixers	Per household
1	0-1.8 lacs	1	0.05	8	0.4	27	1.35	13	0.65
2	1.8 lacs-3.6 lacs	11	0.32	27	0.79	36	1.05	32	0.94
3	3.6 lacs-5.4 lacs	8	0.53	17	1.13	26	1.73	15	1
4	5.4lacs-7.2 lacs	4	0.8	6	1.2	9	1.8	6	1.2
5	7.2lacs & above	2	2	2	2	3	3	2	2
	Total	26		60		101		68	

Table 6.12 **No. of Appliances**

S no.	Range of Income per year	No. of Ovens	Per household	No. of LPG Stoves	Per household	No. of Washing machines	Per household	No. of pressure cookers	Per household
1	0-1.8 lacs	1	0.05	20	1	8	0.4	23	1.15
2	1.8 lacs-3.6 lacs	20	0.58	35	1.03	23	0.67	39	1.14
3	3.6 lacs-5.4 lacs	15	1	17	1.13	14	0.93	29	1.93
4	5.4lacs-7.2 lacs	5	1	5	1	5	1	10	2
5	7.2lacs & above	1	1	2	2	1	1	4	4
	Total	42		79		51		105	

Table 6.13 **Consumption Pattern of electricity**

S no.	Range of Income Per year	Qty of elec. Used/month	%age	per capita consumption in units/month
1	0-1.8 lacs	3150	15.34	44.36
2	1.8 lacs-3.6 lacs	7610	37.08	65.04
3	3.6 lacs-5.4 lacs	6620	32.24	106.77
4	5.4lacs-7.2 lacs	2350	11.45	87.03
5	7.2lacs & above	800	3.89	133.33
	Total	20530	100	

Table 6.14 **Consumption Pattern of Petrol**

S no.	Range of Income Per year	Consumption of petrol /month in liters	%age	per capita consumption in liters/month
1	0-1.8 lacs	157	14.04	2.21
2	1.8 lacs-3.6 lacs	503	45	4.29
3	3.6 lacs-5.4 lacs	333	29.79	5.37
4	5.4lacs-7.2 lacs	97	8.67	3.59
5	7.2lacs & above	28	2.5	4.66
	Total	1118	100	

Table 6.15 **Consumption Pattern of LPG**

S no.	Range of Income Per year	Qty. of LPG cylinder Used/month	%age	per capita consumption in kgs/month
1	0-1.8 lacs	20	25	4.16
2	1.8 lacs-3.6 lacs	35	43.75	4.42
3	3.6 lacs-5.4 lacs	17	21.25	4.05
4	5.4lacs-7.2 lacs	6.5	8.125	3.56
5	7.2lacs & above	1.5	1.875	3.7
	Total	80	100	

Table 6.16 Consumption Pattern of Diesel

S no.	Range of Income per year	Consumption of diesel /month in liters	%age	per capita consumption
1	0-1.8 lacs	0	0	0
2	1.8 lacs-3.6 lacs	0	0	0
3	3.6 lacs-5.4 lacs	25	15.625	0.403
4	5.4lacs-7.2 lacs	135	84.375	5
5	7.2lacs & above	0	0	0
	Total	160	100	

Table 6.17 Amount of Waste Generated /capita /day

S no.	Range of Income Per year	waste generated / capita /day in gm	%age
1	0-1.8 lacs	478.87	23.69
2	1.8 lacs-3.6 lacs	478.63	39.03
3	3.6 lacs-5.4 lacs	588.7	25.43
4	5.4lacs-7.2 lacs	481.48	9.06
5	7.2lacs & above	666.66	2.79
	- Total	2694.34	100

Table 6.18 Average time of usage of electric appliances

S no.	Appliances	Average usage per day
1	Lights	12.38
2	Fans	10.65
3	Heaters	10.25
4	Coolers	0.82

6.16 INFERENCES:

The following inferences are drawn from the above analysis, and are presented below:

- The household size is larger in higher income group.
- Literacy rate is found to be high in the study area.
- More number of people opting for higher and technical education.
- Employment status in the study area is more in higher income group due to better quality of education.
- Lower income group people own more of two wheelers, whereas the higher income groups own more number of four wheelers.
- The study area has more of detached and semi detached type of housing than row and apartment housing system.
- The availability of water is adequate in the study area.
- The study area has adequate electric connection.
- The higher income groups have more number of appliances at the household level, which consume more quantity of electricity.
- Higher income group consumes more quantity of electricity.
- In the study area, the per capita quantity of liquefied petroleum gas consumption is high in lower income group.
- Petrol consumption is more in higher income group due to more ownership of four wheelers.
- Consumption of diesel is very low in the household sector.

- The higher income groups are contributing a major portion in solid waste generation.

CHAPTER 7

FORE CASTING THE ENERGY RESOURCES FOR THE YEAR 2021:

7.1 POPULATION:

Total population in the year 1981=2,871,70

Total population in the Year 1991= 5,750,00

$$Pn = Po(1+r)n$$

Using Geometric Increment Method,

Where, P_n =Forecasted population of n years.

$P0$ = Population at present

-n= numbers of years

r= rate of growth

To find r,

$$P1991 = P1981\ (1+r)10$$

$$1+r = (575000 \div 287170)^{1/10}$$

$$5{,}750{,}00 = 2{,}871{,}70(1+r)10$$

Therefore, r= 1.071 - 1

= 0.071

Therefore total population in the year 2021 shall be,

$P_{2021} = P_{1991}(1+r)_{30}$

$= 5{,}750{,}00\ (1+0.071)_{30}$

$= 45{,}014{,}45$

Therefore, increase in population = 45,014,45 - 5,750,00

= 39,264,45.

7.2 ELECTRICITY:

Through the survey conducted in the selected sample households, the average per capita consumption of electricity is 87.306 units per capita per month.

Thus the present requirement of electricity is,

Electricity required = 5,750,00 x 87.306 kWh/month

= 502,009,50 kWh/month

= 502,00.95 MWh/month

Therefore, yearly consumption,

= 502,00.95 x 12

= 602411.4 MWh/ year

Now, keeping the same per capita consumption the future requirement, will be.

Future requirement of electricity will be,

Electricity required = 45,014,45 x 87.306 kWh/month.

= 39,30,031,57 kWh/month.

= 393003.15 MWh/month

Therefore, yearly consumption,

= 3,930,03.15 x 12

= 4716037.8 MWh/year.

Thus the increase in demand will be,

= 4716037.8- 602411.4 MWh/year

= 413626.4 MWh/year.

At present, the annual quantity of electricity supplied to the city,

=518073.72 MWh

Therefore, the present shortfall for supply of electricity in the city is,

= 602411.4 -518073.72 MWh

= 84337.68 MWh.

Thus, at present the city requires an additional of **84337.68 MWh** per year to fulfill the requirement of the city.

7.3 PETROL:

Through the survey conducted in the selected sample households, the average per capita consumption of petrol is 4.024 liters per capita per month.

Thus the present requirement of petrol is,

= 5,750,00 x 4.024 liters/ month

= 2313800 liters/month

= 2313.8 gallons/ month

= 27765.6 gallons/year

Now keeping the same per capita consumption the future requirement, will be.

Future requirement of petrol will be,

Petrol required = 45,014,45 x 4.024 liters/ month

= 18113814.68 liters/ month

= 18113.81 gallons/month

= 217365.72 gallons/year

Thus the increase in demand will be,

= 217365.72 - 27765.6 gallons/year

= 189600.12 gallons/year

At present, the annual quantity of petrol supplied to the city,

= 32165 gallons/year

Therefore, the present excess for supply of petrol in the city is,

= 32165 - 27765.6 gallons/year

= 4299.4 gallons/year

Thus, at present the city has excess petrol supply of **4299.4 gallons** per year and it fulfills the requirement of the city. But it has come to less, as more quantity of fuel is consumed by floating population, i.e. vehicles coming from outside of the city fill there tanks from these sources.

7.4 DIESEL:

Through the survey conducted in the selected sample households, the average per capita consumption of diesel is 1.0806 liters per capita per month.

Thus the present requirement of diesel is,

= 5,750,00 x 1.0806 liters/ month

= 621345 liters/month

= 621.34 gallons/ month

= 7456.14 gallons/year

Now keeping the same per capita consumption the future requirement, will be.

Future requirement of diesel will be,

Diesel required = 45,014,45 x 1.0806 liters/ month

= 4864261.46 liters/ month

= 4864.26 gallons/month

= 58371.13 gallons/year

Thus the increase in demand will be,

= 58371.13 - 7456.14 gallons/year

= 50914.99 gallons/year

At present, the annual quantity of diesel supplied to the city,

= 190546 gallons/year

Therefore, the present excess for supply of diesel in the city is,

= 190546 - 7456.14 gallons/year

= 183089.89 gallons/year

Thus, at present the city has excess supply of **183089.89 gallons** per year and fulfills the requirement of the city. But it has come to less, as more quantity of fuel is consumed by floating population, i.e. vehicles coming from outside of the city fill there tanks from these sources.

7.5 LIQUIFIED PETROLEUM GAS (LPG):

Through the survey conducted in the selected sample households, the average per capita consumption of liquefied petroleum gas is 3.978 kgs per capita per month.

Thus the present requirement of LPG is,

= 5,750,00 x 3.978 kgs/ month

= 22,873,50 kgs/month

= 2287.35 MT/ month

= 2744.82 MT/year

Now keeping the same per capita consumption the future requirement, will be.

Future requirement of LPG will be,

LPG required = 45,014,45 x 3.978 kgs/ month

= 17942550.21 kgs/ month

= 17942.55 MT/month

= 215310.6 MT/year

Thus the increase in demand will be,

= 215310.6 - 2744.82 MT/year

= 48170.17 MT/year

At present, the annual quantity of LPG supplied to the city,

= 29580 MT/year

Therefore, the present excess for supply of LPG in the city is,

= 29580 - 2744.82 MT/year

= 26835.18 MT/year

Thus, at present the city has excess supply of **26835.18 MT** per year and fulfills the requirement of the city.

7.6 SOLID WASTE GENERATION:

Through the survey conducted in the selected sample households, the average per capita consumption of solid waste generation is 538.86 gms per capita per month.

Thus, the present generation of solid waste in the city is,

= 5,750,00 x 538.86 gms/ month

= 309844500 gms/month

= 309.84 MT/ month

= 3718.08 MT/year

Now keeping the same per capita generation the future requirement, will be.

Future generation of solid waste will be,

Solid waste generated = 45,014,45 x 538.86 gms/ month

= 2425648652.7 gms/ month

= 2425.64 MT/month

= 29107.68 MT/year

Thus the increase in generation will be,

= 29107.68 - 3718.08 MT/year

= 25389.6 MT/year

At present, the annual quantity of solid waste generated in the city,

= 5760 MT/year

CHAPTER 8

EVOLVING A SET OF POLICY GUIDELINES FOR OPTIMAL ENERGY MANAGEMENT:

The study aims at to prepare a set of policy guidelines for optimal energy management in the study area. So that a set of policy guidelines is evolved based on the outcome of the analytical work done, which are presented in earlier chapters. The Author hopes that if these policy guidelines are implemented properly, it will pave the way for achieving the desired goals.

8.1 POLICY GUIDELINES:

The following set of policy guidelines are evolved and recommended for optimal utilization of energy in Ghaziabad City:

1. Waste Resource Assessment:

The city generates huge quantity of waste every day i.e., 480 tonnes per day. These wastes should be collected, segregated, and utilized for generating electricity. Hence, these waste will be turned into resource, i.e., input to the power plant (waste resource based power plant). This power plant will produce electricity and the electricity will be distributed in the system, which will reduce the energy crisis on one hand, and solve the problem of waste accumulation in the city, which creates environmental problem, on the other.

2. Waste Resource based power plants:

In India few places, such as New Delhi, Chennai, Kolkatta, Pune, Calicutt etc., are having power plants based on waste resource. These models may be borrowed and employed in this study area for power generation. It has been observed that tenders have been called for setting up of waste based power plants in this study area.

3. Production of compost from waste:

Compost (farm yard manure) can be produced as an end product from the waste based power plants, by employing Vermiculture method which can be sold in the market as manure for various agricultural and horticultural activities. As in the case of

Bangalore City, the compost is packed in handy packages of 1,2 and 3kgs and sold in the market, thus it becomes very convenient for the city dwellers to take the compost and use it in there lawns or flower pots, etc. Therefore, this type of model will be very much useful, as it will help in creating employment opportunities, and generating income out of these resource.

4. Night Soil Based Power Plants for Domestic and Street Lighting:

Twin objectives can be achieved based on these plants, such as, producing methane gas and generating electricity, and reducing the intensity of accumulating the quantity of night soil in the system. This will help in reducing the load on other commercial energy, thus will be effective and also will require low maintenance cost. For example, in Banares, and in Mumbai night soil based plants are working perfectly, and the output are being supplied to the household either for cooking, space heating or for lighting. In the study area, feasibility analysis shall be carried out to have night soil based power plants for generating electricity. As in the case of Banares or Mumbai.

5. Compact Fluorescent tube lights:

Application of compact fluorescent tube lights will reduce the quantity of energy requirement in the system. At present, the households are using ordinary bulbs for lighting, which consume huge quantity of energy, i.e., 87.31 units per capita per month. The compact fluorescent tube lights gives more output by consuming little input. For Example, 40-watt ordinary bulb is equivalent to the usage of 9-watt compact fluorescent tube lights. Similarly, 60-watt ordinary bulb is equal to 11- watt compact fluorescent tube lights, 70 watt ordinary bulb is equivalent to 15 watt compact fluorescent tube lights, and 100 watt ordinary bulb is equal to 20 watt compact fluorescent tube lights. It shows that usage of compact fluorescent tube lights will reduce the requirement of energy, i.e., **four-fifth** of the quantity, which is consumed by using ordinary bulbs. Since, the initial cost of installation of compact fluorescent tube lights is higher it may not be possible to have the same at the economically weaker section and low income group segments, it may require some financial assistance from any corner to satisfy the requirement. By providing subsidies so that it can meet the twin objectives of good quality of light to the economically poor segments of the society along with the main objective of conservation of electricity.

It clearly shows that the energy consumption in lighting will reduce substantially, i.e., **four-fifth** of the required quantity. In lighting.

It has further several advantages:

a) The compact fluorescent tube lights never flickers.

b) It works very satisfactorily between 170 and 250 volts, i.e., during low voltage period it will also provide required lighting

c) Ordinary bulbs may not work below 170 volts.

d) Life expectancy of compact fluorescent tube lights is six times more than the ordinary bulbs.

e) The output of compact fluorescent tube lights is more pleasant than the ordinary bulb.

6. Popularization of Compressed Natural Gas:

Conventionally the people are using petrol, diesel, etc. as fuel for transportation. These fuels produce more quantity of emissions, which creates pollution, and are hazardous health problems, in the system. Since, Indian cities are having more pollutant content in the air, the Government. has come forward to reduce the intensity of pollution and made compulsory of using compressed natural gas fuel based vehicles in the capital city.

Since Ghaziabad (the study areas) is also situated very close to the Capital City, and is also having the problems of air pollution, the Investigator suggests to have compressed natural gas based fuel vehicles in the system. It will result in to the following, such as, reduction in the consumption of oil, and reduction in air pollution level, which results better and clean environment.

7. Stopping of Polluting vehicles:

Application or usage of polluting vehicles should be stopped. These vehicles should not be allowed to move on the roads, as they are the ones, which cause more environmental problems and also are dangerous for the traffic.

8. Application of Improved stoves:

Application of energy efficient stoves, which conserve energy at the maximum level, is very much essential for energy consumption. In this particular field, lot of research has been done, and solutions are made which help in conserving energy, thus awareness should be created among the people for applying these appliances (energy efficient stoves) at the household level.

The energy efficient stoves save energy about 20 percent compared to the conventional stoves. In the economically weaker section and low income group there would be substantial quantity of reduction in energy consumption, since these segments only use more of conventional stoves. Subsidies may be given to the poor (economically weaker section & low income group) peoples to procure these energy efficient stoves ate the household level.

9. Clean Environment:

To have clean environment trees should be planted along the roads, since trees cause reduction in many types of pollution, and hence create better environment.

10. Pedestrian Paths:

Pedestrian paths should be provided on both sides of the roads to arrest the traffic jams and road accidents. As there is an absence of well-defined pedestrian paths thus people walk on the roads itself, so leaving less carriageway for the vehicles. The traffic jams cause application of breaks, changing gears, etc., in the vehicles often, which consume more quantity of energy and lead to energy crisis.

11. Alternate Source of Energy:

New means of power generation like solar energy should be used. Solar energy is a wonderful source of energy. Earth receives about 170 trillion kW of radiation of sun. Eight days of sunshine will be equal to the all-available energy in the world put together. Solar energy can be used for multitude of operations like street lighting, heating /cooling buildings, pumping water, cooking, disinfection. The most important feature of solar energy is that it is pollution free and perennial. Energy of sunlight can be harnessed in many ways. Sunlight can be converted into electricity directly by photovoltaic cells. This energy can be stored in a battery to use it as per the need. Solar energy can also be used to generate electricity at larger scale, by constructing solar towers which collect's solar energy and transfer it to the boilers through which steam is generated and steam can be used to function turbines, which in turn generate electricity.

Most part of India receives about 5 to 7 kW/sq.m/day of solar energy for about 300 days a year [17]. Solar power generation in India is about 8 MW/year against the world scenario of about 85 mw/year. India is the second largest manufacturer of photovoltaic panels based on crystal silicon cells.

Since the study area is prone to the usage of solar energy, it is very much essential to cater solar energy, properly and applying the same for more productive purposes. Solar energy, can be used in various activities, such as, cooking, lighting, space heating, etc.

As an Architect Planner, the Investigator suggests to have a proper design at the household level to have solar energy in the inner part of the household, which can give better natural light, heat the space automatically, and give better environment, which lead to reduce the quantity of energy consumption at the household level.

12. Energy Conservation Law:

Setting up of a conservation law in which firms using more than 1 mtoe of energy per year should be required to submit quarterly and annually energy conservation report to the bureau, and the firms consuming more than 2 mtoe of energy per year should be required to submit detailed report on application of energy saving program in that firms. They will be also advised to have highly efficient energy system. The bureau may also help certain firms who need any assistance if necessary regarding this matter.

13. Distribution Loss Reduction Program:

When the actual supply part comes into the picture, it is seen that it is very less quantity of energy reaching the tail end due to transmission loss. This distribution loss occurs while transmitting the energy. Since the distribution loss cannot be stopped completely, it should be checked very carefully to minimize the loss, thus it will help in demand of more quantity of electricity and reducing the gap further.

It has been observed that the transmission and distribution loss of electricity has touched about 50.00 percent of the production in New Delhi [21]. It is further observed that there are about 18 percent loss is occurred due to technical losses, and the rest is due to rampant power theft [21].

If the required energy quantity is generated within the system, there would be possible to reduce the transmission loss, and these quantities can also be supplied for productive purpose. Developing micro level energy plant, such as, hydel power, waste based power plant, etc., are another options in this regard.

Since the study area is located just outside of New Delhi City, the investigator feels that the same proportion of loss (both technical and theft) occur in the Delhi City also reflects in the study area. As a result, the available quantity of electricity will reduce from 518073.72 MWh to 259036.86 MWh. If one calculates the available quantity of electricity by deducting the technical loss than the available quantity will be 419420.46 MWh, for end uses. The loss occur due to theft also used for productive/ domestic purposes, but it is unaccounted.

8.2 ENERGY MANAGEMENT MODEL:

8.2.1 ADMINISTRATION:

The objective of the study is having efficient energy management system of Ghaziabad City. Thus, an energy management model has been prepared, in which formation of an administrative body is proposed, which will look after all aspects of energy management in the city. The body will have information about energy production, supply and demand of the various energy resources in the city. Thus, from the available information, the overall energy scenario of the city can be judged and wherever modifications are required they can be done accordingly. The body will also take care of the present and future needs of the city, like if a new industry or a colony is about to come up, then how much energy resources will be required, and how it can be provided.

The structure of the Managing Body is shown in ***Fig no. 8.1***. At the highest level of the body there will be a Chief Managing Director. He will monitor the functions of the body and will keep a track on various activities of the body. Thus, the body will be divided into three sections they are:

1) PRODUCTION.
2) RESEARCH AND DESIGN.
3) SUPPLY.

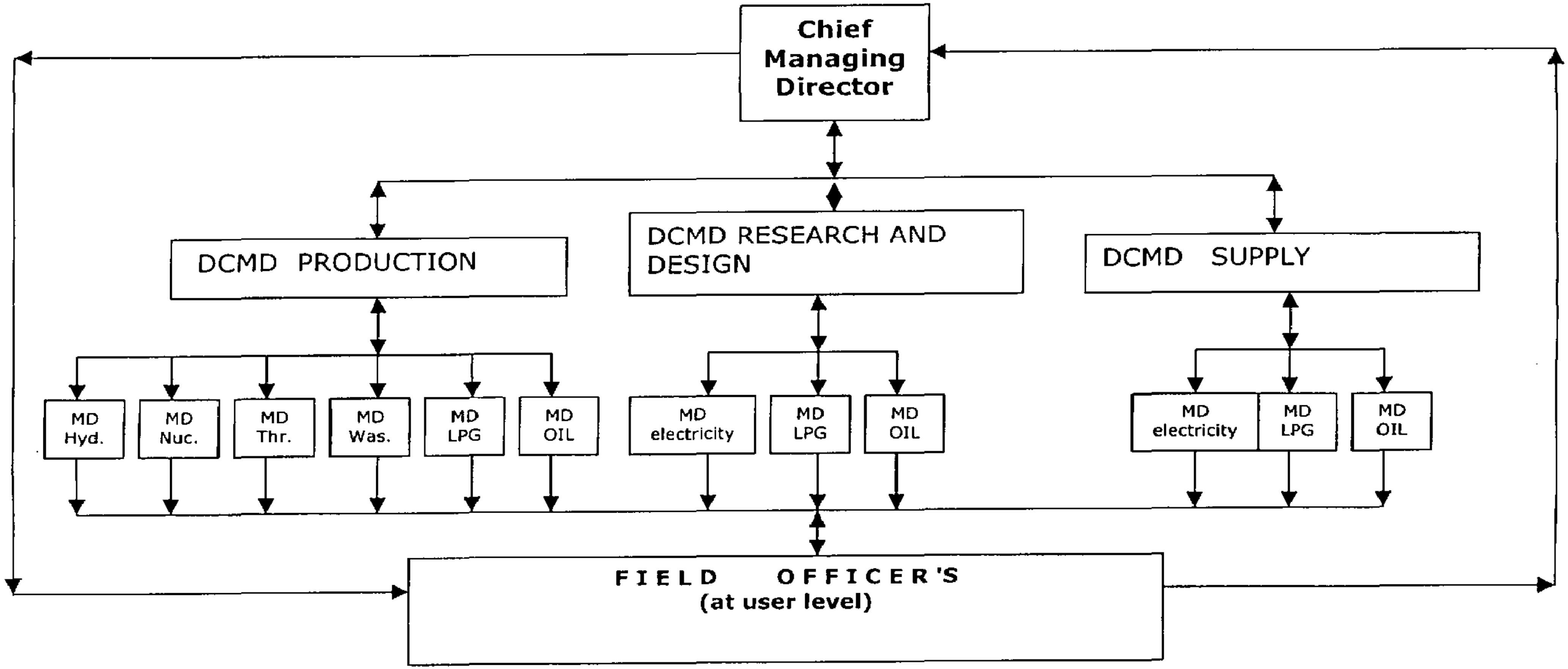

FIG:8.1 LAYOUT OF THE MANAGING BODY

Each said section will have Deputy Chief Managing Director and Managing Director's, that will be holding one aspect of the sections. Thus, they will be empowered to handle one particular source of energy. The Managing Director's will also be empowered with decision making process. Therefore, each Managing Director will have to take decision for their own section. The decision making process is given to them, so that decentralization of administrative power is done, as these people will be experts in there respective fields, and hence they will be able to take better decision in accordance with the situation present in the particular section. Hence, the role of the Chief Managing Director will be to allocate the funds to the various sections and direct them to perform as per the requirement in a given framework of time. This will ensure proper decision-making and work can also be monitored since they have to show the results in a given framework of time. Thus, if a particular section is not functioning properly then the Chief Managing Director can interfere the work of the concerned Managing Director. Each Managing Director has to submit a report stating progress of the section to the Chief Managing Director.

The various sections of the body will be interrelated to each other and can get answers of any query they want from the other section. Thus, they do not have to go through the Chief Managing

Director at every time. If there are some differences between the section then the Chief Managing Director will solve the matter.

The Field Officer's will follow the Managing Director's who will collect the information from field and give it to the concerned Managing Director for decision making. The Field Officer's are empowered to send information to all the hierarchies, i.e., Managing Director level, Deputy Chief Managing Director level and Chief Managing Director level.

8.2.2 PRODUCTION:

The administrative body is divided into three sections:

1) PRODUCTION.
2) RESEARCH AND DESIGN.
3) SUPPLY.

In this section there will be a Deputy Chief Managing Director and below him Managing Directors Responsible for each type of energy production. This section will have all the information about production of energy, i.e., regarding the sources of generation of energy, quantity of generation energy, and if any lacunae in production, then it can be rectified.

The Managing Directors coming under the following production segments. They are:

1) Managing Director, Hydel.
2) Managing Director, Nuclear.
3) Managing Director, Thermal.
4) Managing Director, Waste.
5) Managing Director, Refineries (LPG).
6) Managing Director, Refineries (OIL).

The information contained by them can be transferred to the supply department so that the supply department knows that how much quantity of energy is produced form time to time.

8.2.3 RESEARCH AND DESIGN:

This section will deal with carrying out research in developing indigenous technologies in the field of energy, modification of imported technology in accordance with suitability at the local level, and applying the same at the grass root level for optimal energy utilization.

The research work that carried out and there significance have to be informed to the Chief Managing Director so that it can be applied in the city.

8.2.4 SUPPLY:

This section of the body will take care of the supply of energy in the city by different sector wise.

Thus, the various kinds of information, such as, the quantity of energy required in various parts of the city, in different time duration, by different sectors. The source of energy and their distribution to different sectors also put under the supply system. This supply body also informs the requirement of energy to the producing body about time to time requirement.

8.2.5 EFFICIENT ENERGY MANAGEMENT SYSTEM:

An management information system (MIS) can be defined as, "a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making and control in an organization. In addition to supporting decision making, coordination, and control, information systems may also help managers and workers analyze problems, visualize complex subjects, and create new products" [22].

By information we mean data that have been shaped into a form that is meaningful and useful to human beings. Data, in contrast, are streams of raw facts representing event occurring in an organization or the physical environment before they have been organized and arranged into a form that people can understand and use.

Three activities in an information system produce the information organization need for making decisions, controlling operations, analyzing problems, and creating new products or services they are:

1) Input
2) Processing
3) Output

Input captures or collects raw data from within the organization or from its external environment. Processing converts this data into more meaning full form. Output transfers the processed information to the people or activities where it will be used. Information system also requires feedback, which is output returned to appropriate members of the organization to help them evaluate or correct the input stage.

From a management perspective, information systems are far more than input output process in a vacuum. It is an organizational and management solutions based on the information technology, to a challenge posed by the environment.

Management information system primarily functions of planning, controlling and decision making at the management level.

To have efficient energy management system, at various levels, a management information system model has been evolved and presented in ***fig no: 8.2***.

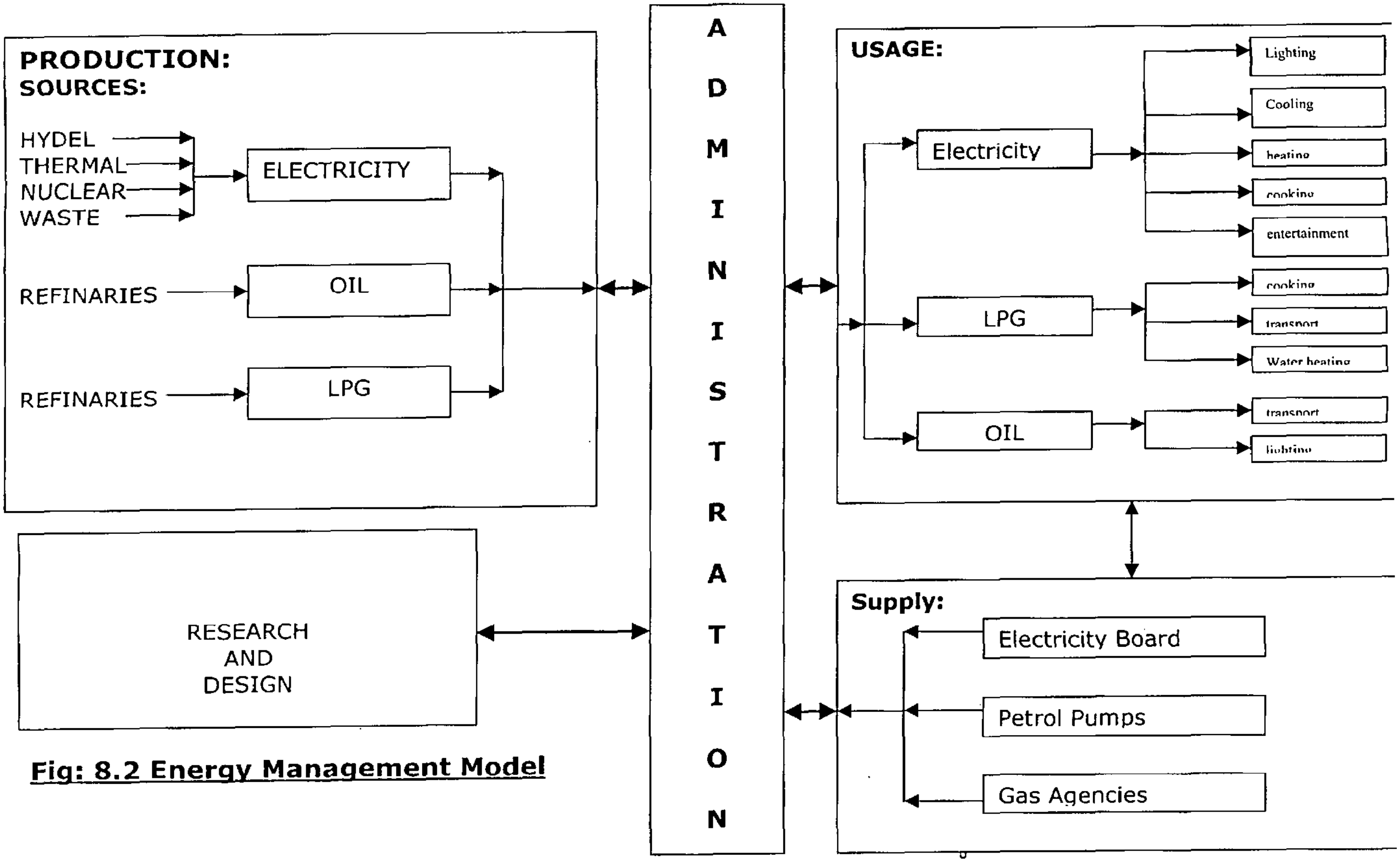

Fig: 8.2 Energy Management Model

Functions of MIS Model:

A management information system based flow model is evolved for having proper energy management system in the study area and is presented in ***fig no: 8.2.*** This clearly shows that there are four divisions in management, along with administration they are energy production, energy supply, and research and design and end usage of energy. In production, various sources of energy production are considered, and are having proper linkage with the administration. In research and design, energy-based technology, appliances, etc, are considered, and are also having proper linkage with the administration. In energy supply, the sources of supply distribution agencies (electricity board, petrol pumps, LPG agency etc) are considered and proper linkage with the administration is established. In end uses, proper link is established between various sources of energy agencies, which supply energy, appliances used, and energy used for different activities. In administration, the system of administration, which is evolved, is shown in ***fig no: 8.1***.

In the management information system model (see fig no: 8.5), information will flow from one small segment to the administration and vice- versa. The administration will have the knowledge about the demand and supply of energy by product wise, in different sector wise and different source wise. In case the quantity of energy requirement is very high in a particular season, it will be communicated to the respective departments by the field officers. The respective departments Managing director's will report the matter to the Deputy Chief Managing director and the Deputy Chief Managing director's will report to the Chief Managing director. In the model, the Managing director's are empowered to take necessary timely action to solve the problem. In the model, the request is reported to the supply system, and the supply system reports to the production system. The Deputy Chief Managing director of the production system will inquire the Managing director's of the production system about the availability of energy, and if the energy is not sufficient to supply, he may order to the Managing director's of the production system to increase the production to meet the requirement. In the production systems, all the Managing director's of various sources of production will meet under the Deputy Chief Managing director production, and decide the quantity of production. This will be reported to the Chief Managing director and the supplying agencies. In case, one of the energy production system fails or over produce energy, this also will be reported to the Deputy Chief Managing director, and the Chief Managing director. Similarly all the Managing director's will have meeting with the respective Deputy Chief Managing director, and the Deputy Chief Managing director 's will have meeting with the Chief Managing director for making policies, and implementation. The role of all the sectors, i.e., production, supply, and research and design are very much critical and thus proper linkage, coordination, and cooperation will pave the way for efficient energy management system

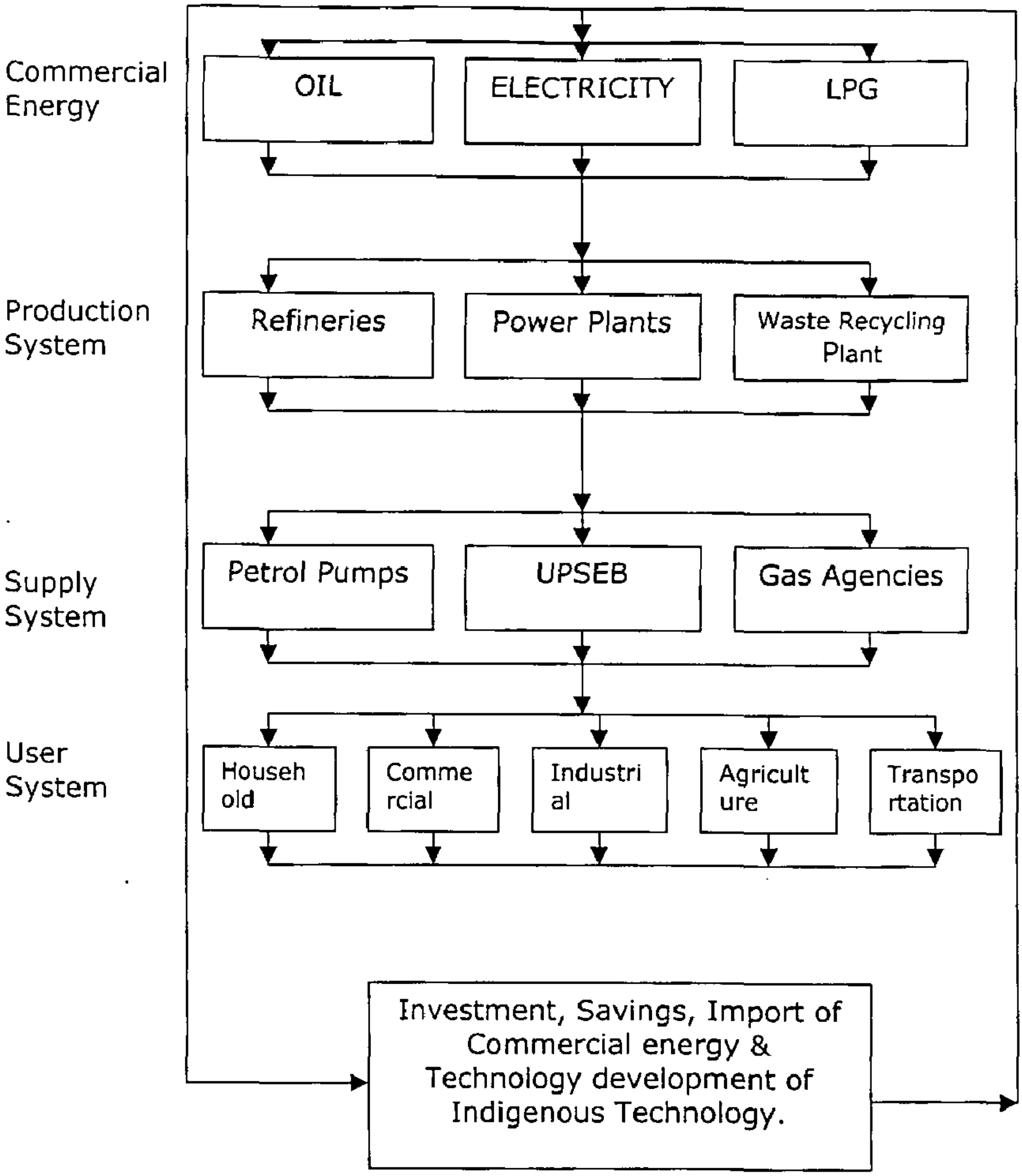

Fig: 8.3 Urban Energy System

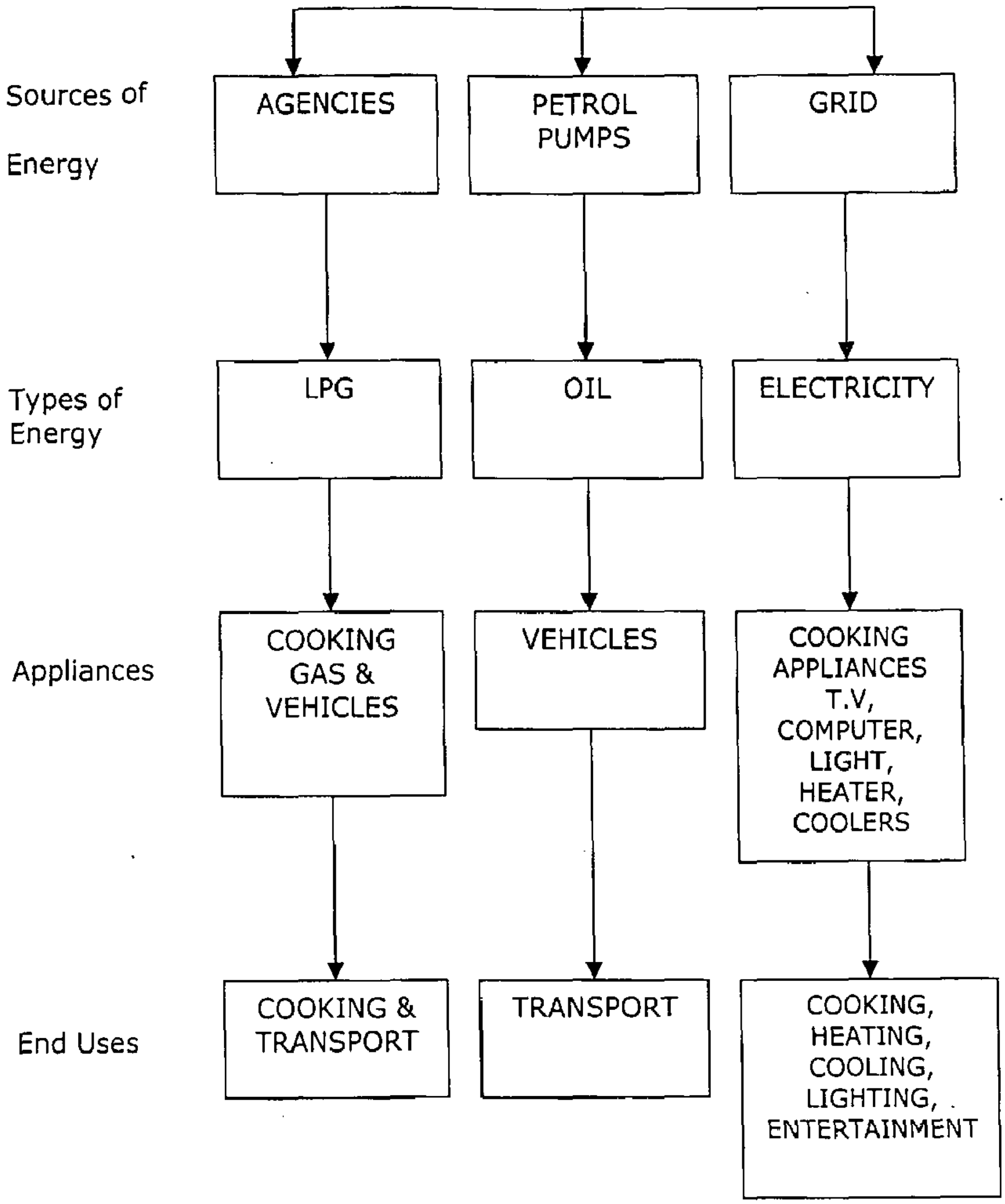

FIG: 8.4 Energy Consumption at the Household level

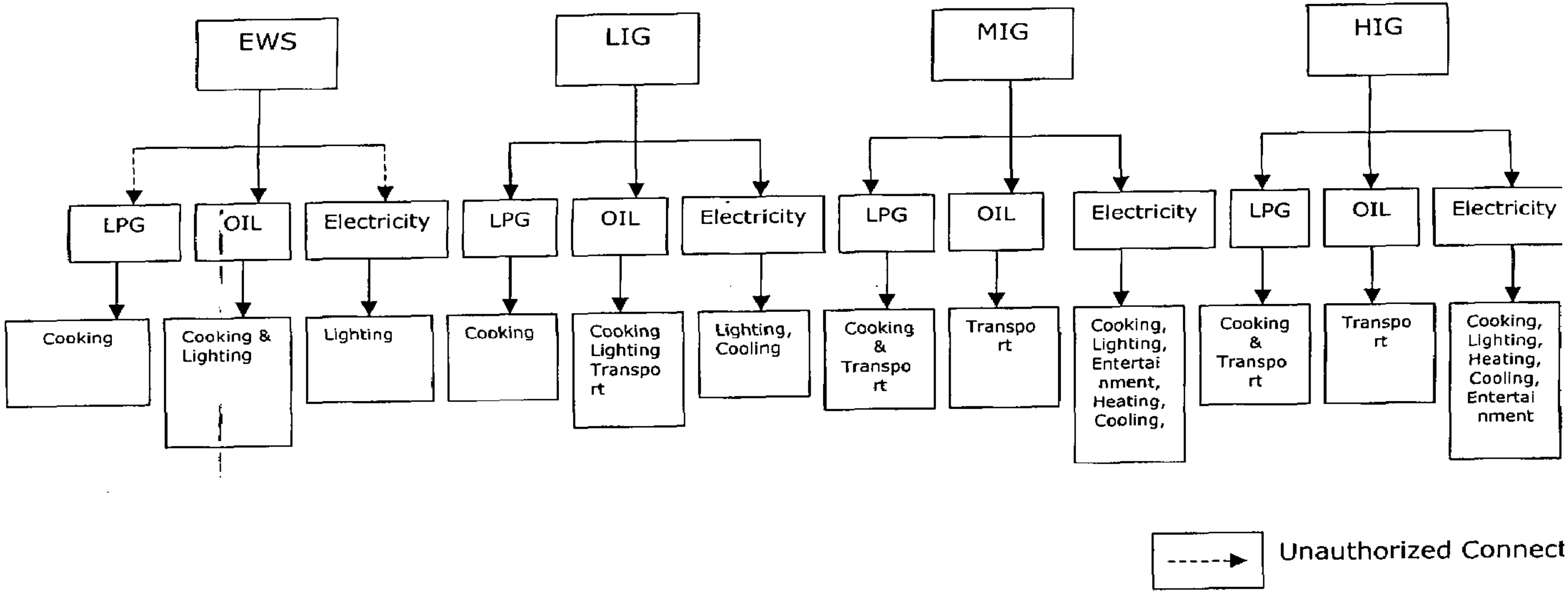

Fig 8.5 Usage of Energy in The Household Sector

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