INTEGRATING ENERGY EFFICIENT APPROACHES IN URBAN DEVELOPMENT OF GHAZIABAD CITY

A DISSERTATION

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

MASTER OF URBAN AND RURAL PLANNING

By

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CERTIFICATE

Certified that the report entitled **"INTEGRATING ENERGY EFFICIENT APPROACHES IN URBAN DEVELOPMENT OF GHAZIABAD CITY"**, which has been submitted by **Ms AKSHITA DAS**, for partial fulfilment of the requirement for the award of the degree of **Master of urban and Rural Planning**, submitted in the Department of Architecture and Planning, Indian Institute of Technology- Roorkee, is her own work done by her under my supervision and guidance. The matter embodied in this dissertation has not been submitted by her for the award of any other degree of this or any other institute.

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CANDIDATES DECLARATION

I hereby certify that this report entitled " **INTEGRATING ENERGY EFFICIENT APPROACHES IN URBAN DEVELOPMENT OF GHAZIABAD CITY",**which has been submitted in partial fulfilment of the requirement for the award of the degree of **Master of urban and Rural Planning,** submitted in the Department of Architecture and Planning, Indian Institute of Technology- Roorkee, is an authentic record of my own work carried out during the period from July 2011 to June 2012, under the supervision and guidance of **DR. V. DEVADAS** , Department of Architecture and Planning, Indian Institute of Technology, Roorkee, India.

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

Date: 15|06|12

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

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Abstract

Energy demand in cities is constantly rising to address the pressure of increasing population and economic growth. So there is a necessity of energy saving and to produce energy from renewable resources for urban areas. Considering cities, electricity is majorly consumed in buildings for space heating and cooling, lighting and operation of appliances. This dissertation work deals with estimating the future demand of electricity and checking possible solutions for sustainable and efficient use of energy in Ghaziabad.

In the first part of study, the present scenario of the cities in India and the world and renewable and non-renewable energy resources in India has been studied. Various energy policies, institutional and strategic framework in India has also discussed. The second part deals with national and international case studies of good practice in energy efficiency have been referred. The later part of the study of Ghaziabad city is done with the projection of future energy demand of the city and survey conducted in the residential sector of the 1500 household. In the end of the dissertation summery of conclusion is given from the research and possible recommendation for integrating energy efficient approaches in urban development of Ghaziabad city are discussed.

Keywords: energy efficiency, renewable energy, Ghaziabad city

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Abbreviations	Extended Form
NCR	National Capital Region
GDA	Ghaziabad Development Authority
GNN	Ghaziabad Nagar Nigam
THA	Trans Hindon Area
PVVNL	Pashimanchal Vidyut Vitran Nigam Limited
UPSED	Uttar Pradesh State Electricity Board
APDRP	Accelerated Power Development and Reform Programme
SWH	solar water heater
LFG	Land Fill Gas
LED	Light Emitting Diode
CO_2	Carbon-di-oxide
PV	Photovoltaic
BIPV	Building Integrated Photovoltaic
CFL	Compact Fluorescent Lamp
DC	Direct Current
AC	Alternating Current
GHG	Green House Gases
W	Watt
Wp	Watt Peak
kW	Kilo Watt
kWh	Kilo Watt Hour
TWh	Terra Watt Hour
GWh	Giga Watt Hour
MW	Mega Watt
GW	Giga Watt
V	Volt
MWp	Megawatt Peak
MT	Metric Ton
BTU	British Thermal Unit
QBTU	Quadrillion British Thermal Unit
MU	Million Unit
MWe	Mega Watt Electric
SERCs	State Electricity Regulatory Commissions

CERC	Centre for Environmental Research and Consultancy
SEBs	State Electricity Boards
DAE	Department of Atomic Energy
OECD	Organization for Economic Co-operation Development
BEE	Bureau of Energy Efficiency
LEED	Leadership in Energy and Environment Design
ECBC	Energy Conservation Building Code
ESCO	Energy Service Companies
IGBC	Indian Green Building Council
IIEC	International institute of for Energy Conservation
GRIHA	Green Rating for Integrated Habitat Assessment
NBC	National Building Code
TERI	The Energy Resources Institute
IREP	Integrated Rural Energy Program
WBREDA	West Bengal Renewable Energy Development Agency
USAID	Unites States Agency for International Development
USGBC	United States Green Building Code
NCPG	North China Power Grid
BEEC	Building Energy Efficiency Code
MoHURD	Ministry of Housing and Urban and Rural Development
LCC	Life Cycle Cost
CDM	Clean Development Mechanism
RES	Renewable Energy System

Executive summery

India is advancing with rapid urbanization as a consequence cities are continuously transforming and expanding to adapt the pressure of changing economy and increasing population. India possess 15% of world's population, approximately 307 million Indians live in 3700 towns and cities across the country. Further projections shows that about 140 million rural dwellers will move to urban areas by the year 2020, while 700 million people will get urbanize by the year 2050.

Urbanization and economic development are leading to a rapid rise in energy demand especially in urban areas. Energy is one of the most important inputs for economic growth and human development. Urban areas are heavily dependent on fossil fuel for powering houses, infrastructure, transport systems, industry and commerce. The International Energy Agency's World Energy Outlook 2000 projects that the total demand for electricity in India is expected to cross 950,000 MW by 2030 and about 75% of the electricity consumed in India is generated by thermal power plant.

To meet this immense power demand in the country, we are highly dependent on the non-renewable sources of electricity also these resources are limited and are not environmentally friendly. Many cities struggle to meet the growing energy demand. Reducing energy use through efficient measures and improved urban planning can lessen a city's dependence on imported fuel and reduce energy costs. So, there is a tremendous need of energy saving in the country to fulfill the energy demand and reduce the environmental pollution.

Need of the study

Increases population and the rapid urbanization will result in haphazard development of the city. So far the new development of the city only concerns about meeting the basic needs of the people like road network, water supply and sanitation. Till now energy never become the serious issue regarding the development of the city. Energy demand will increase with expansion of the city; on the other hand we know that we have limited resources for electricity generation which are also not environmental friendly. So it's time to seriously think about the alternative source of the energy generation which is feasible in city environment, technical & financially viable and beneficial to end users. The need of study is based on:

- The gap between energy supply and energy demand is widening.
- Available energy resources are limited and not used properly.
- Energy use is changing in accordance with the income, education and occupation etc.

Renewable and Non-Renewable Energy

Energy which obtained from unlimited energy sources are Renewable energies. Examples of renewable resources include wind power, solar power, geothermal energy, tidal power and hydroelectric power. The most important feature of renewable energy is that it can be harnessed without the release of harmful pollutants. Non-renewable energy is the conventional fossil fuels and their supply is limited such as coal, oil and gas, which are likely to deplete with time.

Energy issues in the present cities

- Per capita consumption levels in cities are rising.
- Consumption patterns are changing.
- Inefficient use and wastage of resources.
- Limited commercial energy reserves.
- Rising pollution levels.
- Changing climatic characteristics.

Ghaziabad City: Area of Study

Ghaziabad is located in the northeastern part of National Capital Region, about 20 km east of Delhi. Ghaziabad City is an important City in Uttar Pradesh State and it is headquarter of Ghaziabad District. The City is spread and developed on both the sides of River Hindan, an important tributary of River Yamuna. Ghaziabad is one of the important and fast developing city in the State of Uttar Pradesh and as well as in the National Capital Region.

Electricity demand and Supply Gap in Ghaziabad:

The demand supply gap of the electricity will rise in future. Power plants have installed capacity of 1362MW, and generation capacity in recent year is 3,906 million kWh. As per the projection, the existing demand supply gap is only to get widen if we continue to use energy on the current trend. It is not possible to cut energy use at end level without understanding the very nature of energy generation or energy cycle.

Hence, to lessen the demand supply gap, we not only have to reduce the exiting demand, but to use the available energy efficiently and to reduce dependence against non-renewable resources by opting renewable energy.

Impact of socio-psycho Economic condition on energy consumption

A survey has been conducted to analyze above virtue and it has been tried to establish a relation between various parameter to see whether there is a connection in between. The sample size of the survey was 60 families located in a posh colony of Ghaziabad. The survey has addressed questions about the households such as no. of electrical appliances in a house, house area, size of household, occupation of the family, level of education etc.

It also includes the questions to know the awareness of the people towards climate change, energy, environment and building.

While the varying figures in power units is obtained for the same expenditure group, the energy consumption graph overall is proportional to the monthly expenditure of the household.

The results show a direct relation between floor area and energy consumption. However variation is found in energy consumption for same floor area but on whole, energy consumption is found proportionately increasing with increased floor area. It can be understood that the more the no. of rooms, there will be more no. of power points and hence more points to drain electricity.

The survey reflects that the knowledge about the connection between building and energy is low among the masses and they accept this ignorance. In another set of questions people said they are willing to reduce energy consumption and want to save money but maintain that reduction in consumption (assumed conventionally) will cause inconvenience. The third and fourth set of questions address people attitude for environment and climate change in which they responded positively and awareness and concern have been seen in majority. The knowledge about the renewable energy is found very low. In next sets of questions they seem a little more alert and accuse transportation as the chief cause of air pollution and agreed that the most of CO_2 emission comes from power generation.

However, the questions which address their behavior pattern in terms of sharing the energy load of the city, gave answers in contrast to their said awareness. That can be understood because of many factors such as lack of proper, comfortable and reliable public transport, economically less viability of renewable energy etc.

As per result of the presented survey and the known causes of the energy consumption discussed in the theory chapters, we can see that the knowledge penetration about energy among the mass is very low and conventional way of using energy is still contemporary.

Strategies for reduction in non-renewable energy consumption

Reduce the energy demand for HVAC (heating-ventilation-air conditioning) and day lighting through energy efficient and climate responsive architecture.

Basic Guidelines for Energy Efficient Buildings

- Orientation of building towards east west ensures less radiation falling on walls and hence less heating and thus less need for cooling.

- Lesser opening on West side and broader opening on North side would allow maximum daylight and less radiation inside of the building.
- Shading devices on windows and other outside openings would prevent direct radiation generated heat to come inside.
- Usage of less energy absorbing material in construction.
- Usage of insulating material and techniques.
- Assisting natural ventilation through building design.

The various studies conducted by research organizations and expert group reveal that primary electrical consumption can be reduced as much as 60% and overall can be brought up to zero if we have designed energy efficient buildings.[1]

Reduce The Energy Consumption By Using Energy Efficient Household Devices

A significant amount of energy can be saved if conventional energy extensive household appliances get replaced by modern energy efficient devices. The preference should be given to higher (BEE) rated appliances. The calculation shows us the saving in an average HIG household can be as much as 1000 unit annually.

Integration of renewable energy in urban context

The solar energy among the rest of renewable energy has a very good scope of integration into urban context. We discuss here two proposals of integration of solar energy.

Proposal for Solar Street lighting

One alternative is to replace 250W sodium vapor lamp with 50W LED lamps. It will reduce the energy requirement of 12000 kW per day and a cost saving of Rs. 48000.00 per day.

[1] www.teri.in.org

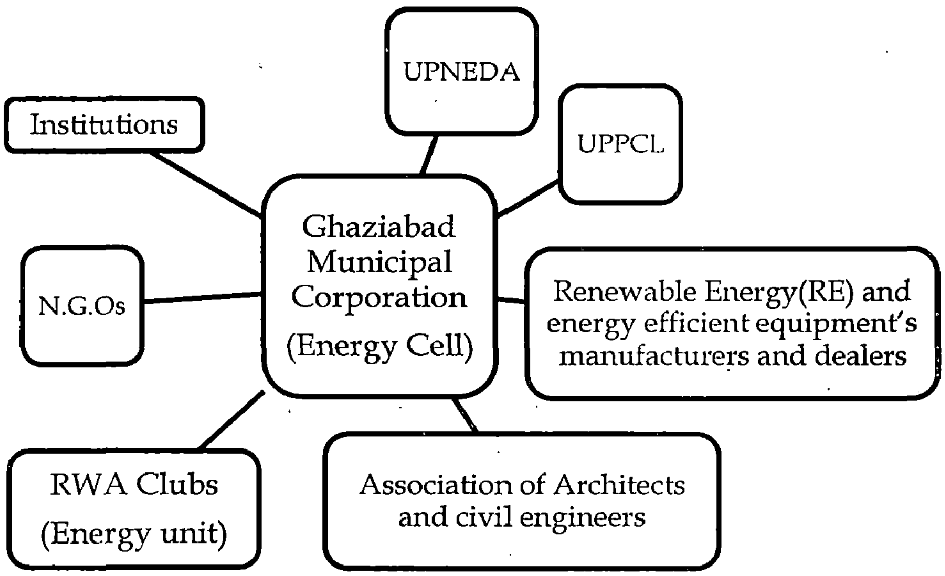
Second alternative is to replace sodium vapor lamps with LED based Solar Lamps. Total energy saved per day will be 15000kW. The total cost of installation of solar street lights will be Rs.100000000.

A public private partnership can be maintained. The good proposition about any scheme is the huge amount of saving that goes for electricity bills. This saving can be basis for such joint venture.

As per the Primary survey 60% of the households use electrical water geyser. The aim of the proposal is to target 30% of the 60% households using electric water heater to switch to SWH. This could be turned into saving of as much as 60000 kWh per day.

Proposed Institutional framework

To achieve the above stated targets of energy efficiency through Alternative means it is essential to establish an Energy Cell. This cell should be established in Ghaziabad Municipal Corporation under the joint patronage of Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) and Uttar Pradesh Power Corporation limited (UPPCL). It is also necessary to involve people and families at household level to work for energy efficiency. A formation of energy unit at RWA level would ensure the awareness among people for energy efficiency and knowledge dissemination for the same.



The ENERGY cell should consist of members from Uttar Pradesh Power Corporation, Association of Architects and civil engineers. NGO's can play an active role in demonstrating innovative ways of adopting solar energy.

The major responsibilities of the ENERGY cell will be:

Generate awareness among the people about environmental benefits through energy efficiency.

The cell should be responsible for the energy efficiency programs at household level. It would set target for annual emission reduction and energy saving against base case scenario. It can even further be developed as Independent Corporation.

The cell should focus its line of work at residential household as there is a lack of implementing agency at this segment.

The cell should interact with commercial establishments and institutions to adopt energy efficiency and renewable energy for their energy requirements. It should also identify CDM(clean development mechanism) opportunities.

The cell should interact with Banks for granting subsidies and loans for energy efficiency programs and renewable technologies promoting SPV and Solar thermal technology.

The energy cell should get engage in activities like workshops for Architects and Civil engineers and contractors on energy efficient buildings.

CHAPTER 1

INTRODUCTION

1.1. Identification of problem

India is advancing with rapid urbanization as a consequence cities are continuously transforming and expanding to adapt the pressure of changing economy and increasing population. India possess 15% of world's population, approximately 307 million Indians live in 3700 towns and cities across the country. Further projections shows that about 140 million rural dwellers will move to urban areas by the year 2020, while 700 million people will get urbanize by the year 2050.

Urbanization and economic development are leading to a rapid rise in energy demand especially in urban areas. Energy is one of the most important inputs for economic growth and human development. Urban areas are heavily dependent on fossil fuel for powering houses, infrastructure, transport systems, industry and commerce. The International Energy Agency's World Energy Outlook 2000 projects that the total demand for electricity in India is expected to cross 950,000 MW by 2030 and about 75% of the electricity consumed in India is generated by thermal power plant.

To meet this immense power demand in the country, we are highly dependent on the non-renewable sources of electricity also these resources are limited and are not environmentally friendly. Many cities struggle to meet the growing energy demand. Reducing energy use through efficient measures and improved urban planning can lessen a city's dependence on imported fuel and reduce energy costs. So, there is a tremendous need of energy saving in the country to fulfill the energy demand and reduce the environmental pollution.

Even today the development control regulations in India, only address the health and safety of people. In many cities like Boston, London, Singapore, the concern towards the environment and energy efficiency has already been an integral part of development at all levels. So, there is a need of including energy and environment in our planning regulations.

Acknowledging the rate at which urbanization is taking place and the corresponding rate of depletion of natural resources, pollution, and other negative impacts of urban development, it is evident that apart from technical knowhow, sustainable development should be mainstreamed into the planning process through mandatory building bye laws and regulations. The support of national and local governments is sought, especially reflecting sustainable development modals in the way that there wide range of buildings and facilities are designed, developed, owned and maintained.

1.2. Need for study

Increases population and the rapid urbanization will result in haphazard development of the city. So far the new development of the city only concerns about meeting the basic needs of the people like road network, water supply and sanitation. Till now energy never become the serious issue regarding the development of the city. Energy demand will increase with expansion of the city; on the other hand we know that we have limited resources for electricity generation which are also not environmental friendly. So it's time to seriously think about the alternative source of the energy generation which is feasible in city environment, technical & financially viable and beneficial to end users. The need of study is based on:

- Gap between demand and supply of energy is widening.
- Available energy resources are limited and not used properly.
- Energy use is changing in accordance with the income, education and occupation etc.

1.3. Aims

The study aims at estimating the future demand of electricity in Ghaziabad city and to check possible solution which is also environmentally sustainable for efficient use of energy in city

1.4. Objectives

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

- To assess the electricity consumption pattern and the parameters controlling it.
- To estimate future electricity demand (sector wise) of a city.
- To evolve a set of policy guidelines for rational use of energy resources.

1.5. Scope and limitation

- Projection of demand of electricity
- Calculate demand supply gap.
- Identification of feasible alternative source for fulfills the energy demand.
- Study of conventional and non- conventional sources for energy supply.
- Study of existing policies for energy efficiency.

1.6. Methodology

The methodology adopted for the research has been shown in a flow chart in the figure

Data Collected

Secondary sources:

- Various publications of central, state, local governments
- Various publications of foreign governments
- Books, journals and news papers
- Reports prepared by research scholars, universities etc., in different fields
- Reports published by various organizations
- Public records, statistics

- Other published information
- Technical journals

Primary sources:

The methodology of primary source of data collection is discussed in the figure 2

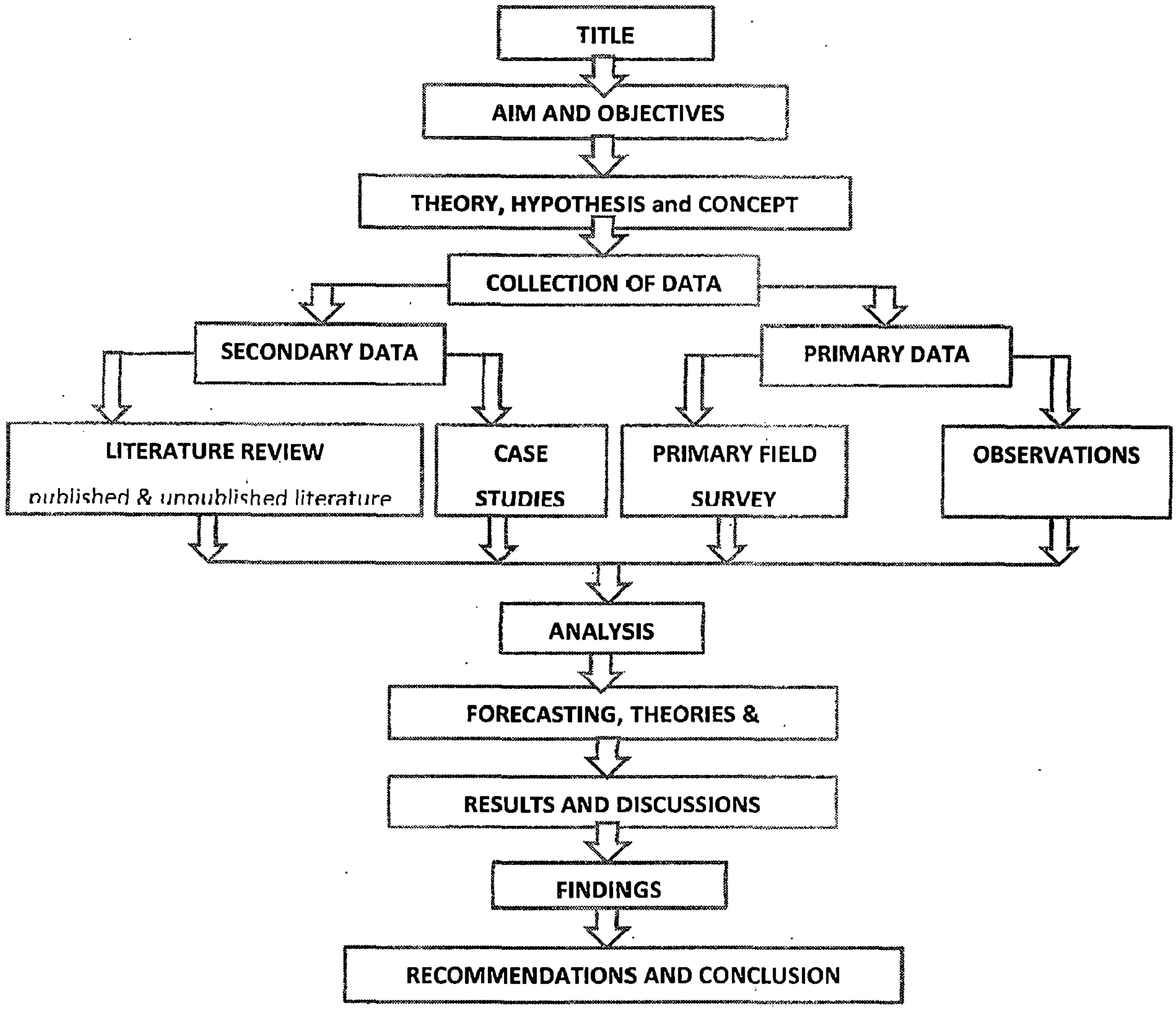


Figure 1: Research Methodology

Based on this the primary data collection will be done. The indicators will be incorporated in the schedule so as to get the real-time and on site data for the study.

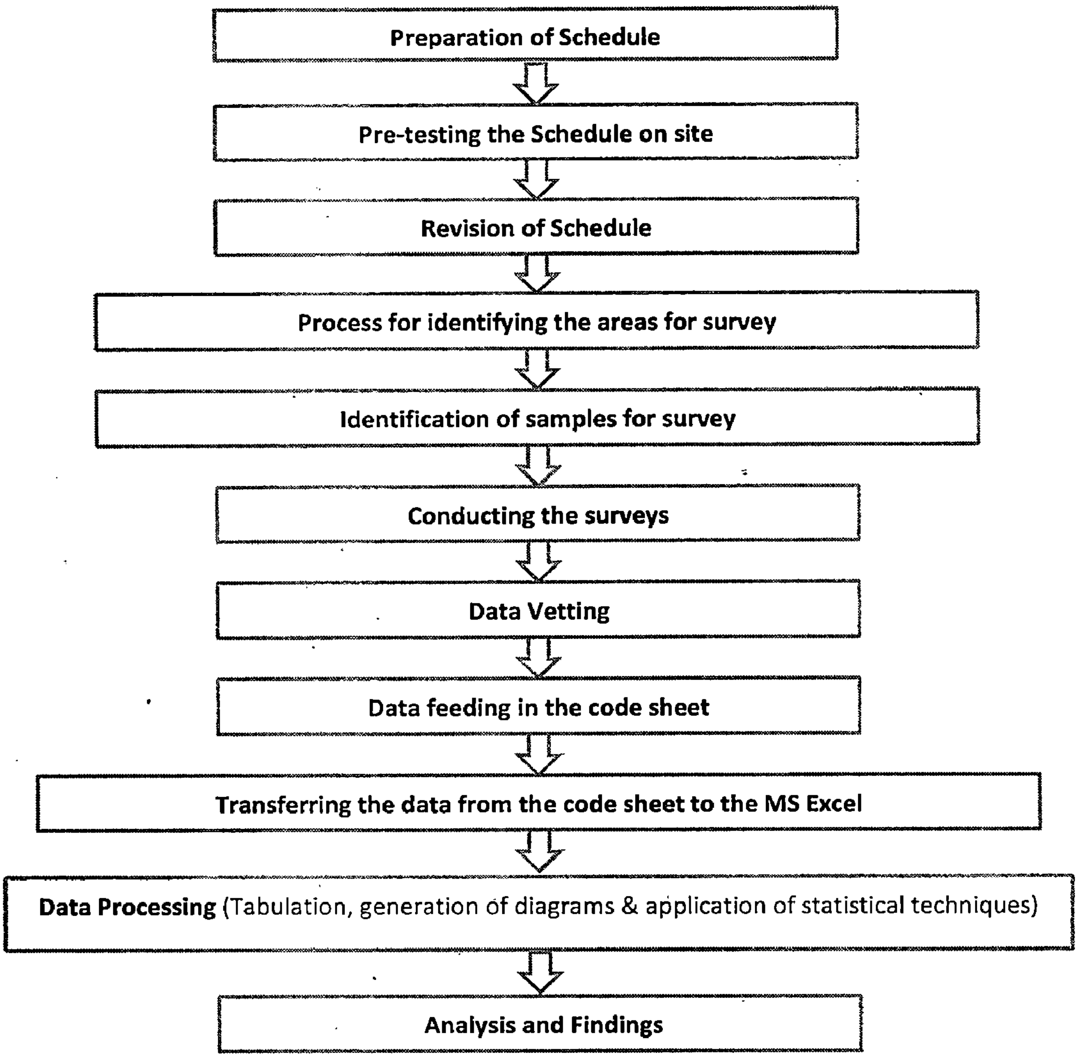


Figure 2: Methodology for primary survey and analysis.

Tools and Techniques

Survey tools:

Relevant survey tools, such as, schedules, questionnaire have been employed.

Survey techniques:

Suitable sampling techniques have been employed for identifying relevant values of the identified indicators as well as other appropriate base data for further justification of the indicator values.

Analytical tools:

Relevant analytical tools, such as, code sheets, computer hardware; software (Microsoft Excel, MATLAB) have been used for data processing and analysis.

Analytical Techniques:

Relevant analytical techniques, such as, tabulation, co-relation etc. is attempted based on the requirement.

Analysis

Comprehensive analysis has been done in the interactive manner to find out the feasibility using tools and employing techniques to identify the present problems, inadequacies, forecasting, probable solutions, requirements etc. for the future development.

Forecasting

- Projections have been done in order to arrive at the real situation in future, i.e. optimal and feasible solution for 2021 AD.
- Forecasting the demand and supply of resources and finding the gaps for future have been done for sustainable development in the study area.

Results and discussions

Results of all types of analysis, such as, literature review, household survey etc., would be discussed in detail to draw inferences. Plausible findings would be drawn for evolving a set of policy guidelines and for developing a feasible sustainable development plan.

Recommendations and conclusion

- Plausible recommendations have been made to achieve sustainable development of the system (study area).
- The study concludes with the plausible recommendations.

1.7. Organization of the Dissertation

- **Chapter 1:** Consists of introduction to the broad research area, identification of the problems, aims & objectives of the study, scope & limitations of the study and methodology adopted for the research.
- **Chapter 2:** Mainly consists of the relevant literature study done for the better understanding of the research area. The chapter contains the present energy scenario of the cities of India and world and various renewable and non-renewable resources in India.

- **Chapter 3:** Deals with the various Energy policies, Institutional and Strategic Framework of India.
- **Chapter 4:** Deals with the international and national case studies of energy efficiency in urban areas. Various case studies are of Canadian cities , Tianjin city in China , Solar housing complex Rabi Rashmi Abasan in Kolkata ,Street lighting in Akola in India
- **Chapter 5:** Describes the profile of Ghaziabad city like Area of the city, Population and density, land use and electricity supply in the city.
- **Chapter 6:** Deals with analysis of primary data and secondary data. Primary data analysis consist of questionnaire for household analysis dealing with questions on the socio economic parameters such as construction and type of dwelling unit , economical condition of the household , no of electricity appliances in the house , their power rating etc.
- **Chapter 7:** Summarizes the conclusion from the research. It begins with the review of some specific conclusions that emerge from the various analyses undertaken. The chapter ends with a discussion on some of the possible recommendations for energy management in Ghaziabad city.

CHAPTER 2

LITERATURE REVIEW

2.1. Energy

Energy is one of the vital parts of the universe. From Industrial machineries to tractors in fields are all powered by energy. Energy from sun gives us the light during day. Energy is connected to us in every way from one form to another. It is the ability or capacity of a system to do work. Here a system is a complex whole, made up of set of interconnected parts or things. Energy change takes place whenever anything happens; energy changes form, when mechanical energy of generators is converted into electrical energy; or energy changes location, as when heat flowing too fast out of your body makes you cold. All forms of energy fall under two categories:

- **Potential energy: Potential energy is stored energy and the energy of position (gravitational).**
- **Kinetic energy: Kinetic energy is motion -the motion electrons, atoms, molecules of waves, and substances.**
- **Chemical energy, nuclear energy, mechanical energy and gravitational energy are the forms of potential energy and radiant energy, sound, motion and electrical energy are the forms of the kinetic energy.**

2.2. Sources of energy

Energy can be classified into types as follows:

- **Primary and Secondary energy**
- **Commercial and Non-commercial energy**
- **Renewable and Non-Renewable energy.**

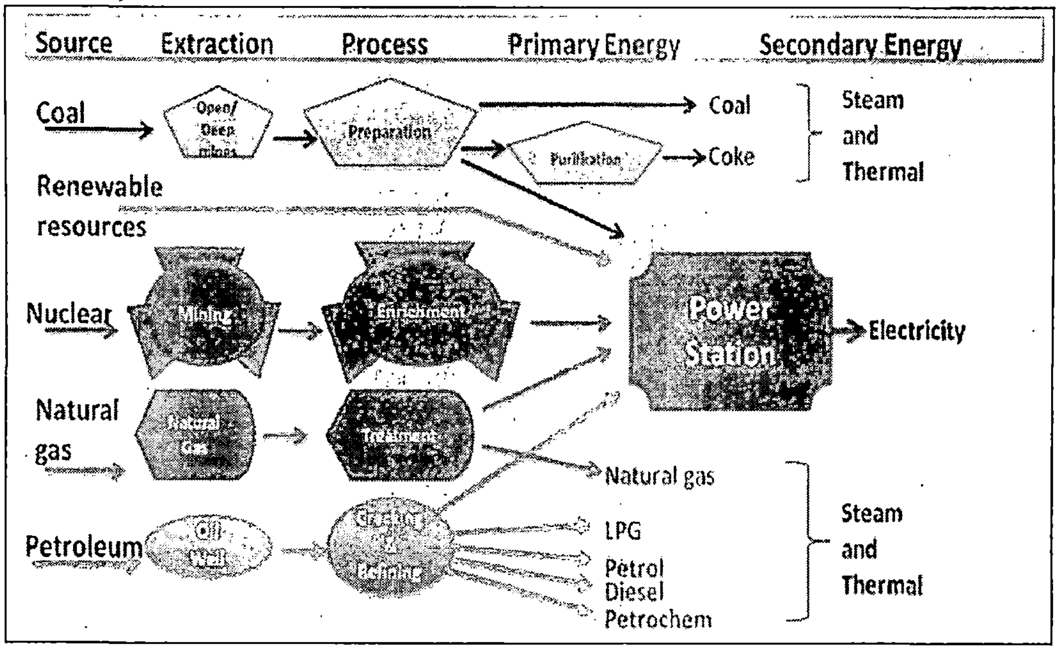


Figure 3: Renewable and Non-renewable energy sources

1. Primary and Secondary Energy:

Energy sources which are found or stored in nature are Primary energy sources. Common primary energy sources are natural gas, coal, oil, and biomass (such as wood). Other primary energy sources available include nuclear energy from radioactive substances, thermal energy stored in earth's interior, and potential energy due to earth's gravity. The major primary and secondary energy sources are shown in Figure.4

Primary energy sources are mostly converted in industrial utilities into secondary energy sources; for example coal, oil or gas converted into steam and electricity. Primary energy can also be used directly. Some energy sources have non-energy uses, for example coal or natural gas can be used as a feedstock in fertilizer plants.

2. Commercial Energy and Non Commercial Energy

a) Commercial Energy: The energy sources that are available in the market for a definite price are known as commercial energy. By far the most important forms of commercial energy are electricity, coal and refined petroleum products. Commercial energy forms the basis of industrial, agricultural, transport and commercial development in the modern world. In the industrialized countries, commercialized fuels are predominant source not only for economic production, but also for many household tasks of general population. Examples: Electricity, lignite, coal, oil, natural gas etc.

b) Non-Commercial Energy: The energy sources that are not available in the commercial market for a price are classified as non-commercial energy. Non-commercial energy sources include fuels such as firewood, cattle dung and agricultural wastes, which are traditionally gathered, and not bought at a price used especially in rural households. These are also called traditional fuels. Non-commercial energy is often ignored in energy accounting. Example: Firewood, agro waste in rural areas; solar energy for water heating, electricity generation, for drying grain, fish and fruits; animal power for transport, threshing, lifting water for irrigation, crushing sugarcane; wind energy for lifting water and electricity generation.

3. Renewable and Non-Renewable Energy:

Renewable energy is energy obtained from sources that are essentially inexhaustible. Examples of renewable resources include wind power, solar power, geothermal energy, tidal power and hydroelectric power .The most important feature of renewable energy is that it can be harnessed without the release of harmful

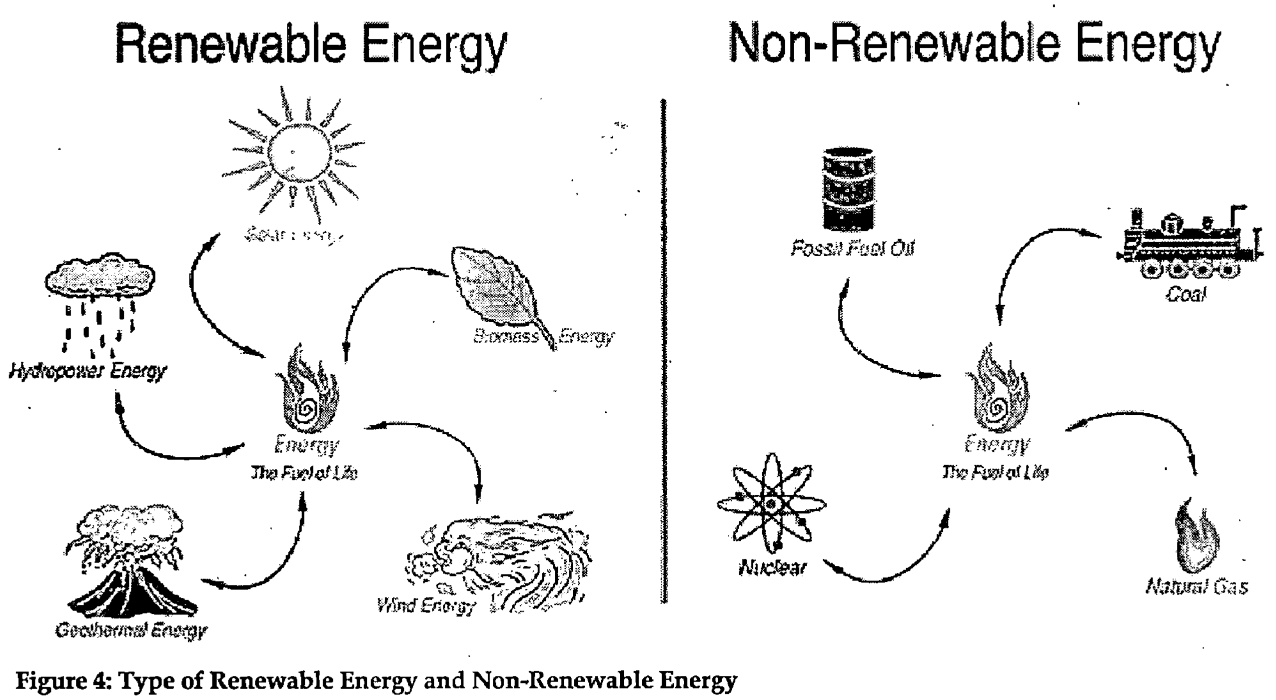


Figure 4: Type of Renewable Energy and Non-Renewable Energy

pollutants. Non-renewable energy is the conventional fossil fuels such as coal, oil and gas, which are likely to deplete with time.

2.3. Energy use in cities

City is very similar to Organic system as they also have their own metabolism. City's metabolism process involves physical inputs water, energy and material which are used and transformed, by the means of technological and biological systems, into goods and wastes as city's output. During metabolism combustion process takes place for the generation of energy this contributes to global warming and depletion of natural resources; but energy also plays a vital role in sustaining the metabolism of cities.

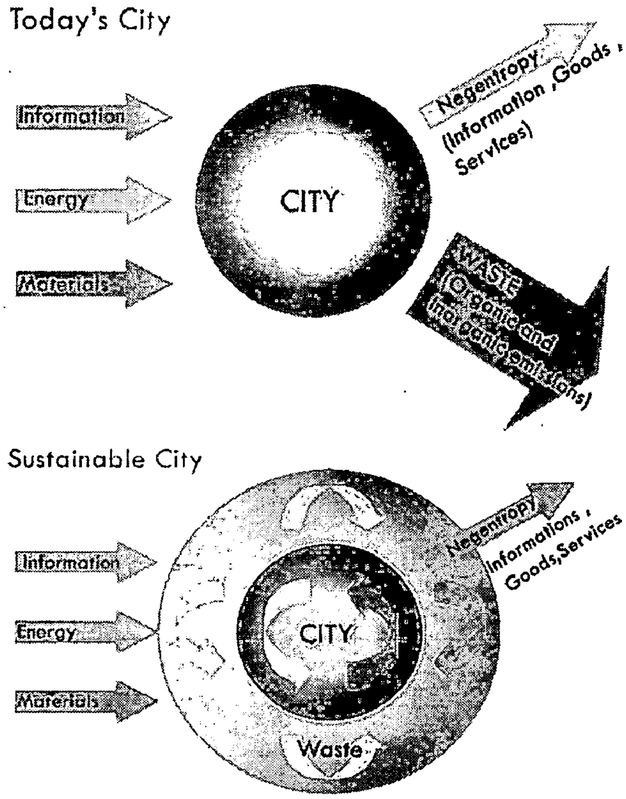


Figure 5: Energy use in the cities.

Economic development and growth of the cities depends majorly on the amount of energy consumption. This is due to the fact that the amount of energy used to produce one unit of gross domestic product is very high, due mainly to the high energy consumption of the construction and industrial sectors and energy is also used for heating and lighting residential, commercial and transport sectors. This show:

- The level of energy consumption is an indicator of development.
- Energy play's a major role in the growth of urban settlements
- High energy intensity in developing countries.
- Fuels are the predominant energy sources in cities.

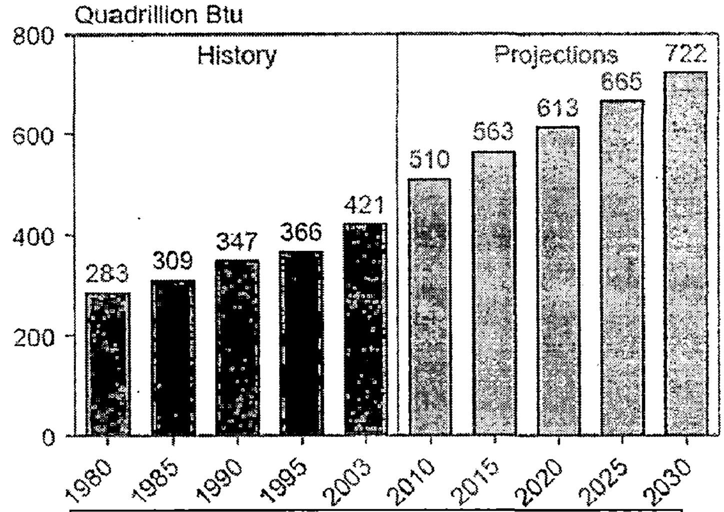
Energy issues in the present cities

- Per capita consumption levels in cities are rising.
- Consumption patterns are changing.
- Inefficient use and wastage of resources.
- Limited commercial energy reserves.
- Rising pollution levels.
- Changing climatic characteristics.

2.4. World's energy consumption

2.4.1. Total Consumption Scenario

According to the American Energy Information Administration (EIA) and to the International Energy Agency (IEA), the world-wide energy consumption will on average continue to increase by 2% per year. The graph below shows the actual values starting from 1980 until today in blue and the predictions of the energy consumption until the year 2030 in orange. A yearly increase by 2% leads to a doubling of the energy consumption every 35 years.



World's energy consumption 1980 to 2030
Source: Energy Information Administration (EIA)

Figure.6: World's energy consumption.

World energy consumption in this year's is projected to increase by 60 percent over a 23-year forecast period, from 1080 to 2030. Energy use worldwide will increases from 283 quadrillion Btu in 1980 to 722 quadrillion Btu in 2030. This means the world-wide energy consumption is predicted to be twice as high in the year 2040 compared to today (2007).The highest annual growth of energy consumption is predicted for Asia (3.7%), NON-OECD countries (3%) and Central and South

America (2.8%). The lowest annual growth of energy consumption is predicted for Europe with 1%[2].

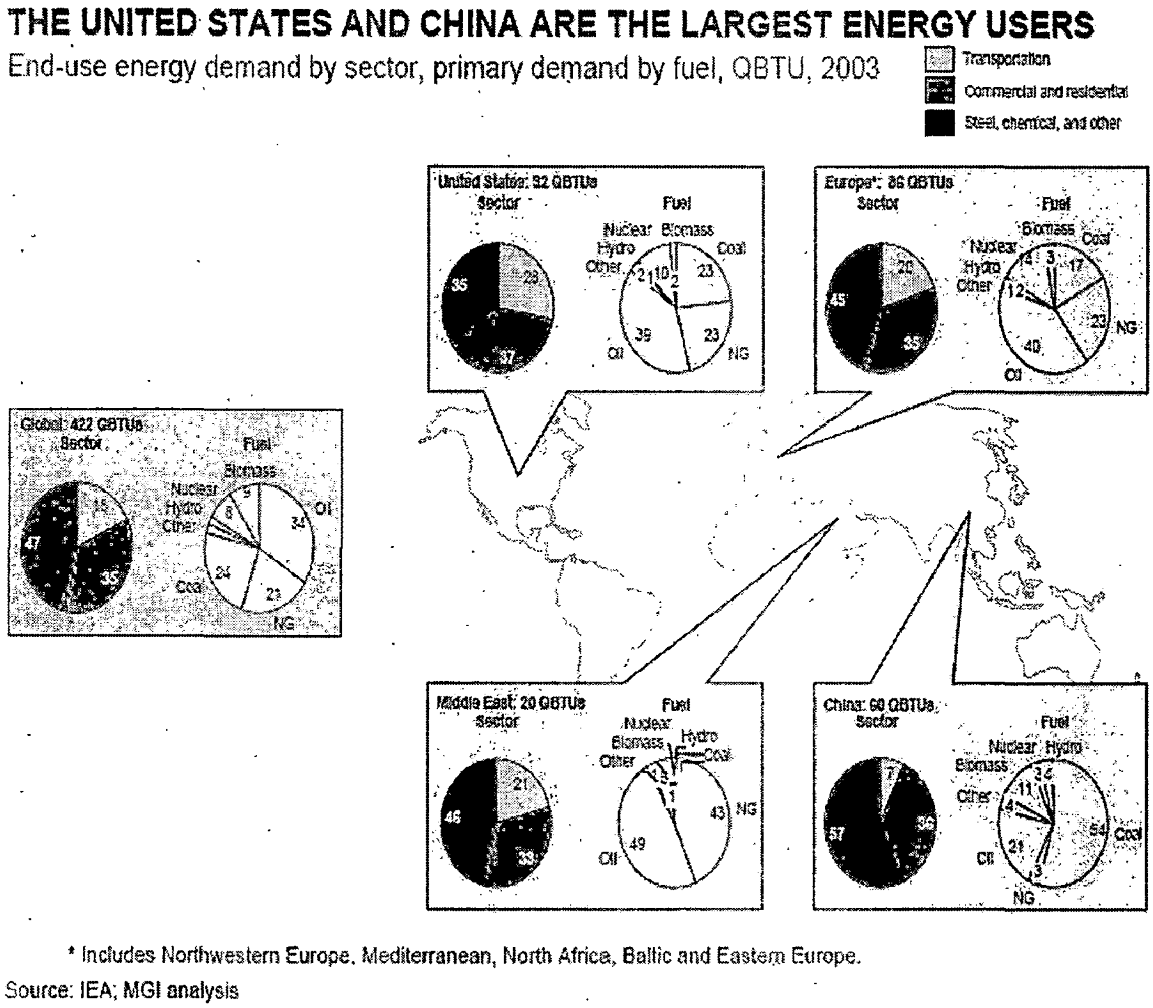


Figure 7: Energy consumption scenario in the world.

2.4.2. World Per capita Energy Consumption scenario:

Following table gives the data of per capita energy consumption per day in various countries all over the world. The data show that Canada has the highest per capita energy consumption one the other hand India has the lowest per capita energy consumption in the world. Energy consumption is also directly related to the

[2] Projections, (EIA) international Energy Annual(2003)System for the analysis of global energy markets (2006)

economic development of the country, so the countries having more energy consumption are more economically developed[3].

Table 1. World Per capita energy consumption

World Per capita energy consumption(2003)			
Country	**kWh/d**	**Country**	**kWh/d**
Canada	350	Ireland	131
United States	272	Spain	130
Australia	218	Europe	117
Sweden	207	Italy	110
Netherlands	206	Middle East	99
Russian	170	Poland	75
South Korea	152	Mexico	51
France	145	South America	42
Japan	142	China	41
Germany	141	Africa	13
United Kingdom	132	India	11

Source: Energy Information Administration (EIA)

About 80% of all the worldwide energy use is currently from fossil fuel. As we know that the prices of oil and natural gas are already high will increased in near future, this can slow down the growth of energy demand in the long run , but world

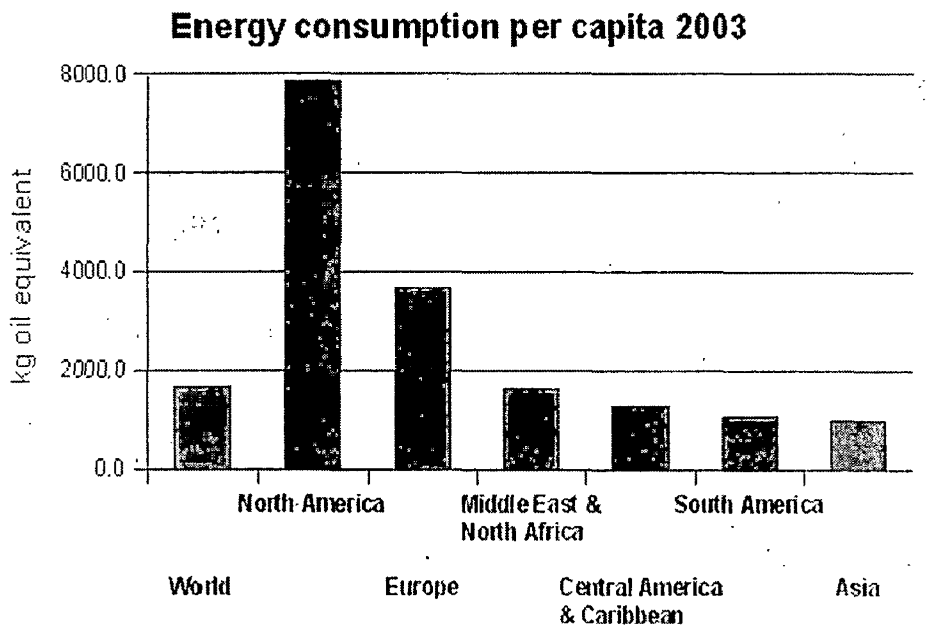


Figure 8: World's per capita energy consumption in (2003).

[3] www.eia.doe.gov/iea/.

energy consumption will continue increasing strongly because ongoing economic growth and increasing populations in the world's developing countries[4].

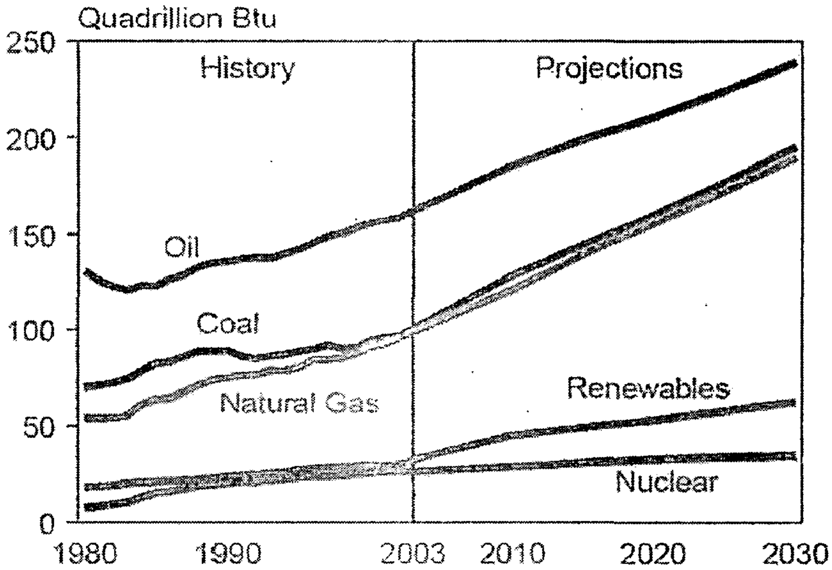


Figure 9: World's energy consumption of fuel.

2.4.3. World Energy Consumption by fuel Type (1980-2030):

The graph shows the world existing energy consumption from 1980 to 2003to the projected energy consumption from 2003 to 2030 in QBtu.

World-wide energy consumption for the future use will be from all three fossil fuels: oil, coal and natural gas. The renewable energy use is predicted to grow as well, but much less than fossil energy. Nuclear energy use will grow relatively moderate[5].

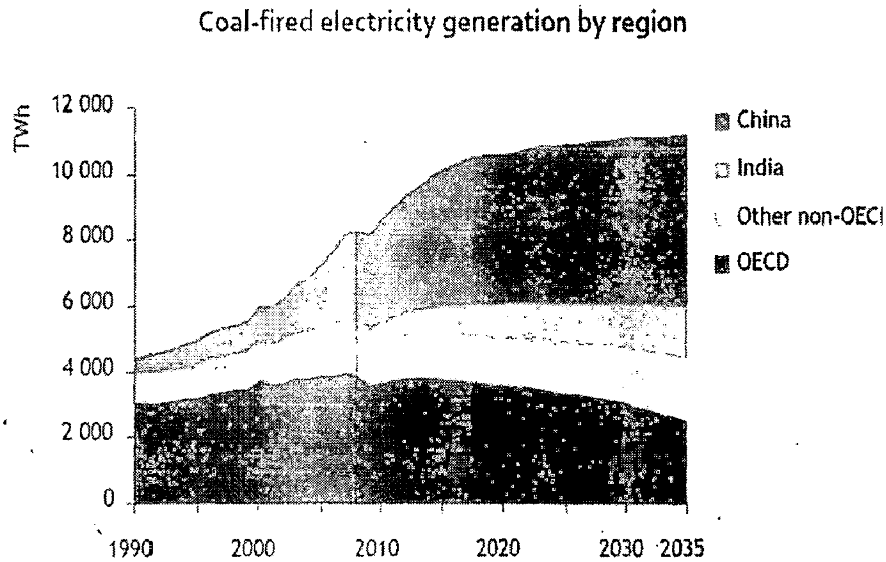


Figure 10: Coal fired electricity generation in the world.

In resent future China and India will be one of the fastest growing economies and they will become the major contributor to world energy consumption. It can be seen

[4] Projections, (EIA) international Energy Annual(2003)System for the analysis of global energy markets (2006)

[5] Projections, (EIA) international Energy Annual(2003)System for the analysis of global energy markets (2006)

in the past decades, that the energy consumption share of developing countries like India and China in the total world's energy consumption has increased considerably[6].

The fundamental factors of the world oil supply and demand are changing. Global demand of oil is rising as the less-developed world-led by China and India-rapidly industrializes, and the developed world continues to grow.

Until recently, most of the decisions about the energy use were based solely on cost and availability of the energy resources. Now, with the rise in carbon emissions from fossil fuels, environmental concerns are becoming important matter of concern. When oil and coal being used at the peak now, and run out of stock in near future, wind energy and solar energy becomes the most sustainable and easily available energy sources.

2.5. India's energy consumption

2.5.1. Total Energy Consumption in India

Economy of India has been growing with a very fast rate and must continue doing so to ensure inclusive growth and the GDP growth rate has reached at 7.5 per cent a year. This growth will be accompanied by increased urbanization, with well over half a billion people living in Indian's cities two decades from now. Economic growth compels the energy demand in to all sectors. India's demand for power is anticipated to increase from 700 TWh in 2005 to 3870 TWh by 2030[7].

Table 2: Percentage of various sectors in energy contribution

Chart Area

Sectors	MW	Percentage
State sector	85668.65	42.91%
Central sector	59682.63	29.89%
Private Sector	54275.75	27.18%
Total	199627.03	100.00%

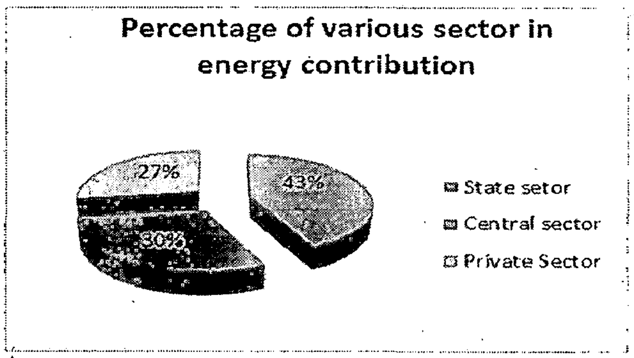


Figure 11 Percentage of various sector in energy contribution.

[6] (EIA) international Energy Annual 2005 (June-October 2007) Projection: EIA, World Energy projections plus (2008)

[7] Environmental and energy sustainability: an approach for India ,McKinsey and Company(2011)

If India has to meet its increasing future energy demand, then its share of world energy consumption would nearly double. When oil and coal being used at the peak now, and run out of stock in near future, wind energy and solar energy becomes the most sustainable and easily available energy sources.

60 percent of total energy need in India is produce from commercial fuels and the rest 40% from non-. Total energy produced in the form of electricity, is 60% from coal, 25% from hydel power, 4% from diesel and gas, 2% from nuclear power and less than 1% from non-conventional sources like solar, wind, ocean, biomass, etc.

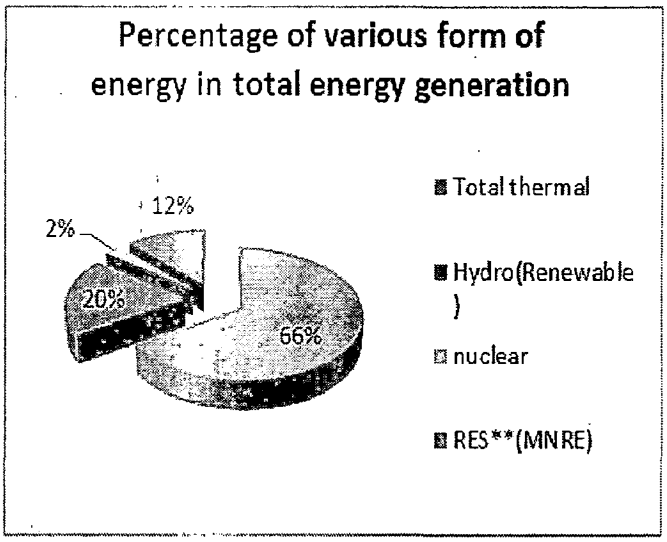
The country's current population of over one billion people is spread over an area of 329 million hectares (3.29 million square kilometers).

Table 3: Percentage of various forms of energy sources contributing in the total energy generation.

Fuel	MW	Percentage
Total thermal	131353.18	65.79
coal	112022.38	56.11
gas	18131.05	9.08
oil	1199.75	0.6
Hydro(Renewable)	38990.4	19.53
nuclear	4780	2.39
RES**(MNRE)	24503.45	12.27
Total	199627.03	100

Table 3 Percentage of various form of energy in total energy generation[3]

RES- renewable energy sources, it include small hydro power, biomass gasifier, biomass power, urban and industrial waste power, solar energy and wind energy



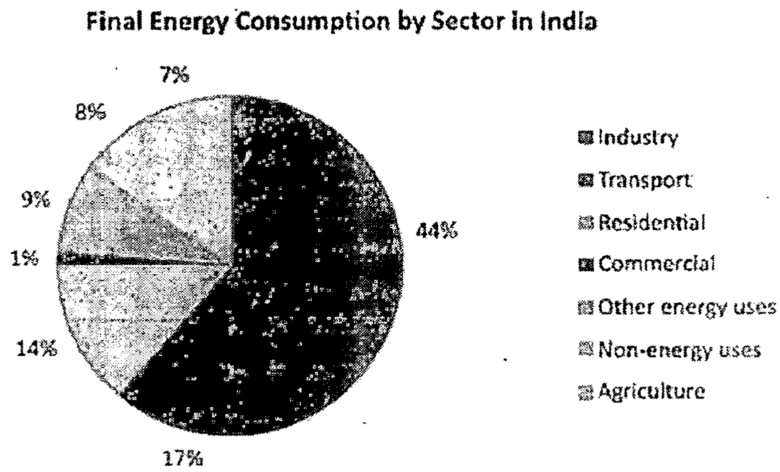
On the consumption front, the industrial sector in India is a major energy user accounting for about 52 percent of commercial energy consumption. Energy intensity, which is energy consumption per unit of GDP, is one of the highest in comparison to other developed and developing countries. For example, it is 3.7 times that of Japan, 1.55 times that of the United States, 1.47 times that of Asia and 1.5 times that of the world average. Thus, there is a huge scope for energy conservation in the country. Final energy consumption is the actual energy demand at the user end. This is the difference between primary energy consumption and the losses that takes place in transport, transmission & distribution and refinement. The energy consumption from various sources is given in Table 4.

Table 4: Demand for energy from various sources.

DEMAND FOR ENERGY FROM VARIOUS SOURCES.					
Source	**Units**	**1994-95**	**2001-02**	**2006-07**	**2011-12**
Electricity	**Billion Units**	**289.36**	**480.08**	**712.67**	**1067.88**
Coal	**Million Tonnes**	**76.67**	**109.01**	**134.99**	**173.47**
Lignite	**Million Tonnes**	**4.85**	**11.69**	**16.02**	**19.70**
Natural Gas	**Million Cubic Meters**	**9880**	**15730**	**18291**	**20853**
Oil Products	**Million Tonnes**	**63.55**	**99.89**	**139.95**	**196.47**
Source: Planning Commission *BAU: Business As Usual*					

2.5.2. Sector wise Energy Consumption in India:

The figure shows the various energy consuming sectors in India. Industrial sector and the transport sector is the major consumer of energy with their share of 44 per cent and 17 per cent in the total energy consumption of the country. After this residential is there with 14 per cent of energy consumption of the whole.



Source: TERI

Figure 12: Energy Consumption by sector in India.

2.5.3. Electricity consumption in India:

The requirement and availability of electricity in India is as shown in Figure. From the figure it is clear that requirement has been always greater than the availability the energy deficit is 7.3% and peak deficit is about 11.7% during 2004-05 (Ministry of Power, 2005-06).

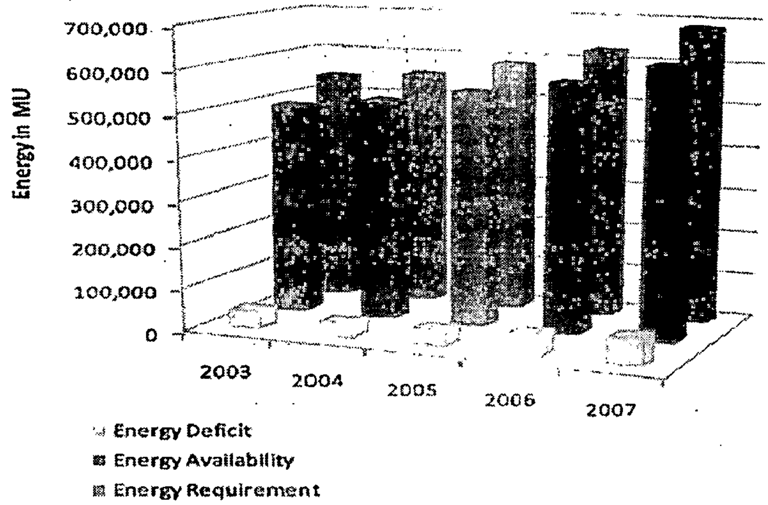


Figure 13: Power availability across India
Source: Central Electricitv Deoartment (CEA)

2.5.4. Electricity Demand Projection in India

The total electricity demand by summation of all electrical energy is shown by Fig. The total electricity demand increases with an average growth rate of about 7% and becomes 1520 billion kWh in 2044-45 which is four fold from base year 2004-05.

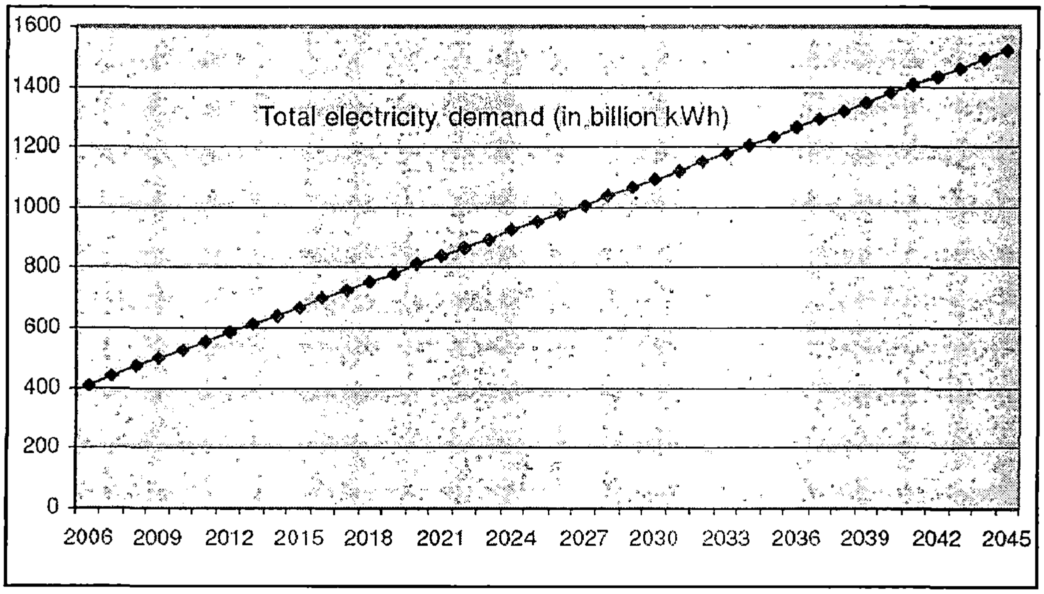


Figure 14: Total electricity demand projection for India

2.6. Sources of Power generation available in India:

Table 5: Available power generation sources in India

Sources	Available in India	Technological problem	Transport /extraction	Resources
Non- Renewable				
Coal	yes	No	yes	Limited
Oil	yes	No	Yes	Limited
Nuclear	yes	Yes	Yes	Limited
Natural Gas	yes	No	Yes	Limited
Oil shale and tar sands	No	No	No	No
Renewable				
Solar	Yes	Yes	No	No
Wind	yes	Yes	No	No
Hydro	Yes	No	No	Yes
Biomass	Yes	Yes	No	No
Hydrogen	No	No	No	No
Geothermal	Yes	Yes	Yes	Very limited

The table shows the available Power Generation Sources in India. In which most of them are thermal based sources and the availability of these sources are also very limited, plus the transportation cost is also very high and they are not eco-friendly. We have an availability of Nuclear power generation but the technology is less in the séance of waste management and linkages of hazardous rays. All Renewable sources such as solar, wind, hydro and biomass are available in India but the implementation is very less because of lake of technologies and instalment cost. Geothermal and hydrogen is not available in India.

2.7. Non Renewable sources:

1. Coal (Production, Use and Imports)

India, which has about 214000 million tons of coal deposits, produces about 330 million tons annually. Many coalfields of India are located in the northeastern region of the sub-continent. About two thirds of the total production of coal is made from Jharkhand, Madhya Pradesh, Chhattisgarh and Orissa. One third of the total production is obtained from Andhra Pradesh, Maharashtra, West Bengal and Uttar Pradesh[8]..

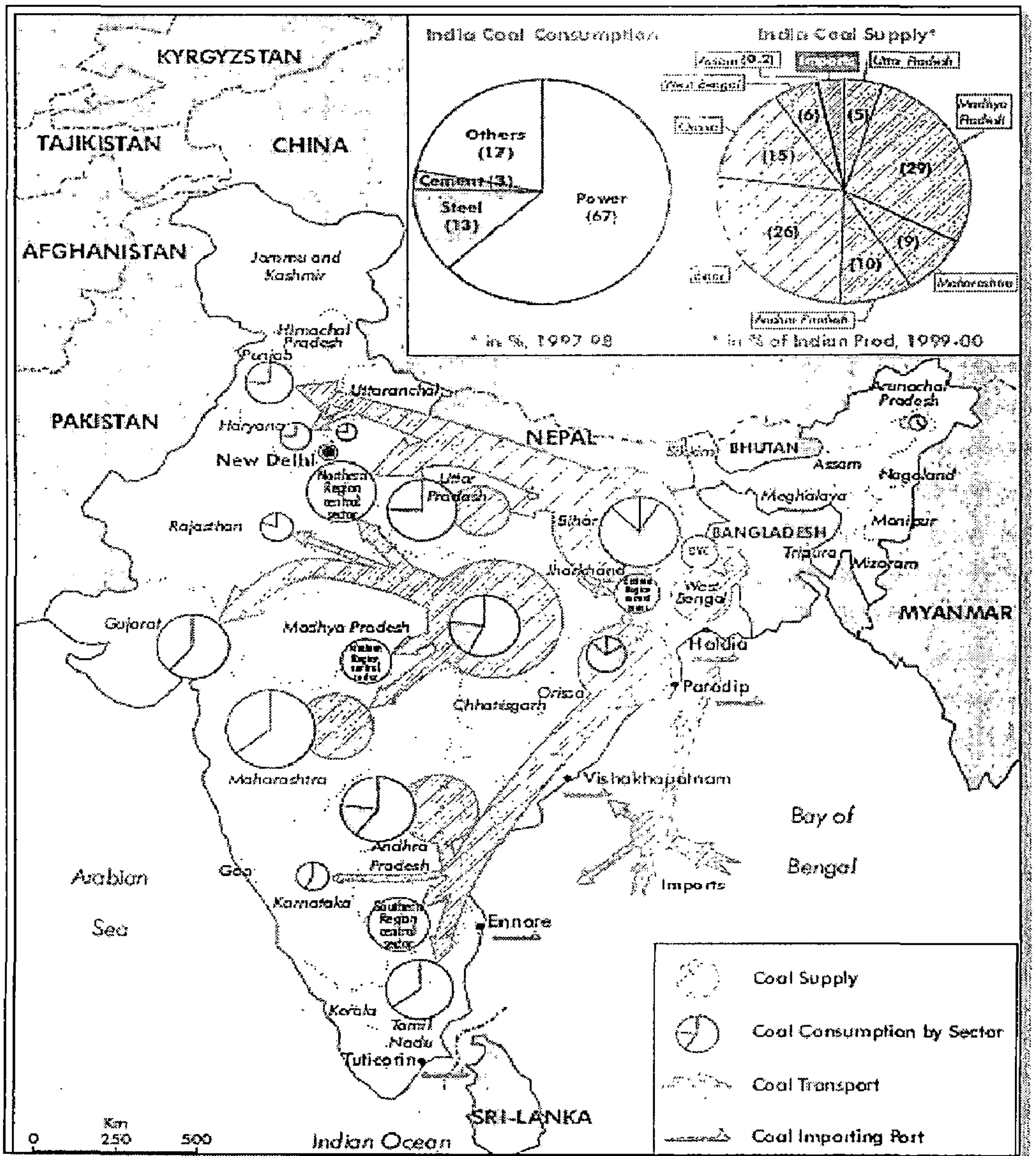


Figure 15: Description of coal demand by sectors, supply, transportation route in India

[8] IEA, Electricity in India

2. Oil:

In India about 33 million tons of petroleum is mined annually. 63% of this is from Mumbai High, 18% from Gujarat and 16% from Assam. The remaining 3% is rigged from Arunachal Pradesh, Andhra Pradesh and Tamil Nadu.

3. Natural gas:

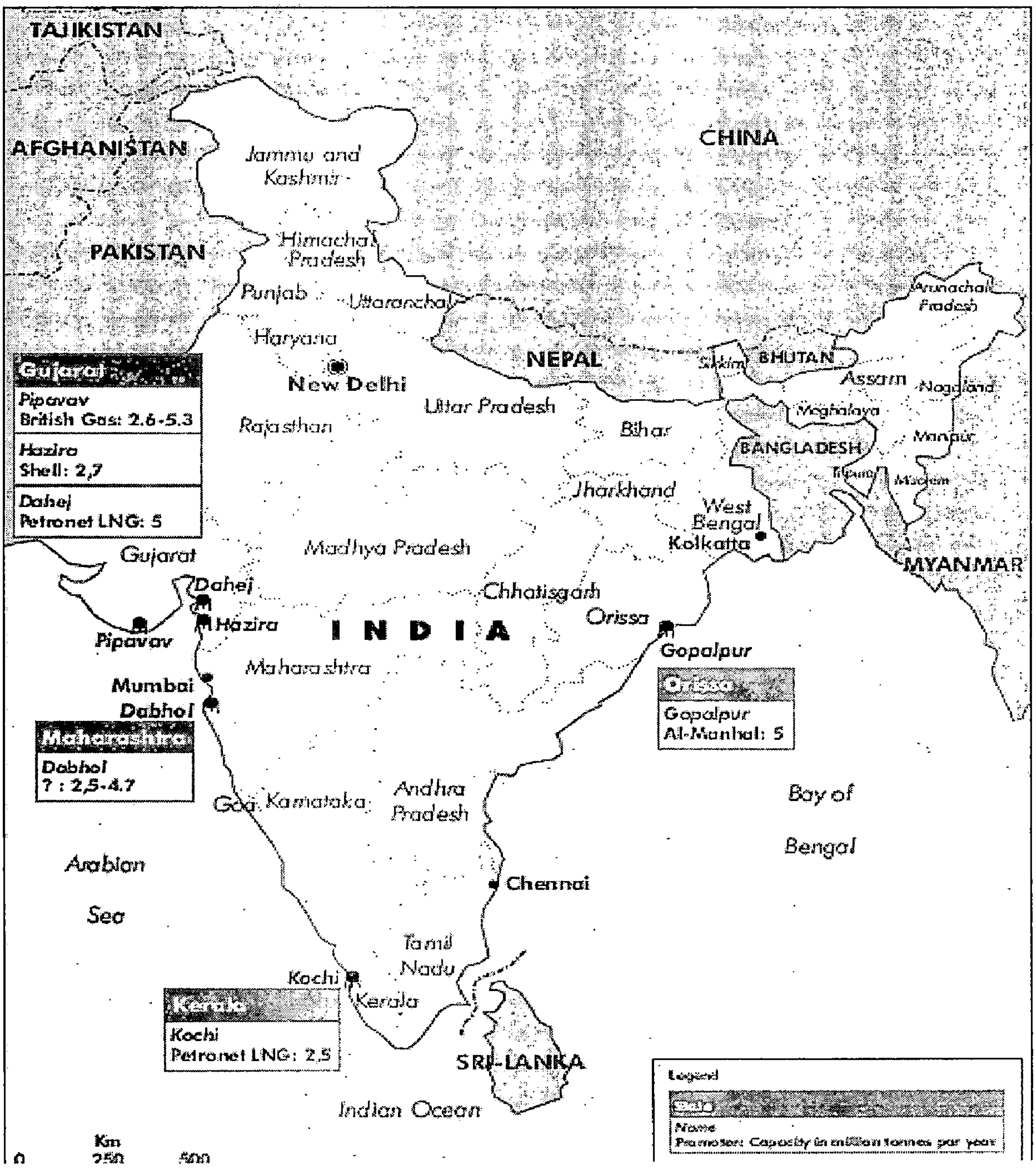


Figure 16 Natural gas terminals in India
Source: IEA, Electricity in India

Production of natural gas, which was almost negligible at the time of independence, is at present at the level of around 87 million standard cubic meters per day (MMSCMD). The main producers of natural gas are Oil & Natural Gas Corporation Ltd. (ONGC), Oil India

Limited (OIL) , JVs of Tapti, Panna-Mukta and Ravva. Most of the production of gas comes from the Western offshore area. The on-shore fields in Assam, Andhra Pradesh and Gujarat States are other major producers of gas. Smaller quantities of gas are also produced in Tripura, Tamil Nadu and Rajasthan States. The gas brought to Hazira is sour gas which has to be sweetened by removing the sulphur present in the gas. After sweetening, the gas is partly utilized at Hazira and the rest is fed into the Hazira-Bijaipur-Jagdhishpur(HBJ) pipeline which passes through Gujarat, MadhyaPradesh, Rajasthan, U.P., Delhi and Haryana. The gas produced in Gujarat, Assam, etc.; is utilized within the respective states.

4. Nuclear:

India produces 272 MW of nuclear energy annually. This constitutes only about 3.4 percent of the total production of electricity in the country. Nuclear power supplied 15.8 billion kWh (2.5%) of India's electricity in 2007 from 3.7 GWe (of 110 GWe total) capacities and this will increase steadily as imported uranium becomes available and new plants come on line. In the year to March 2010, 22 billion kWh is forecast. Major nuclear power plant in India are in Narora(U.P.),Udaipur(Rajasthan), Kakrapar(Gujarat),Tarapur(Maharashtra),Kaiga(Karnataka),Kalpakkum(Tamilnadu)

2.8. Renewable sources:

1. Solar:

India is both densely populated and has high solar insolation, providing an ideal combination for solar power in India. India is already a leader in wind power generation (Wind power in India) and, Suzlon Energy is one of the India-based pioneering industries in world to generate non-conventional energy. In solar energy sector, some large projects have been proposed, and a 35,000 km^2 area of the Thar Desert has been set aside for solar power projects, sufficient to generate 700 to 2,100 gigawatts. In July 2009, India unveiled a $19 billion plan, to produce 20 GW of solar power b2020. Under the plan, solar-powered equipment and applications would be mandatory in all government buildings including hospitals and hotels.

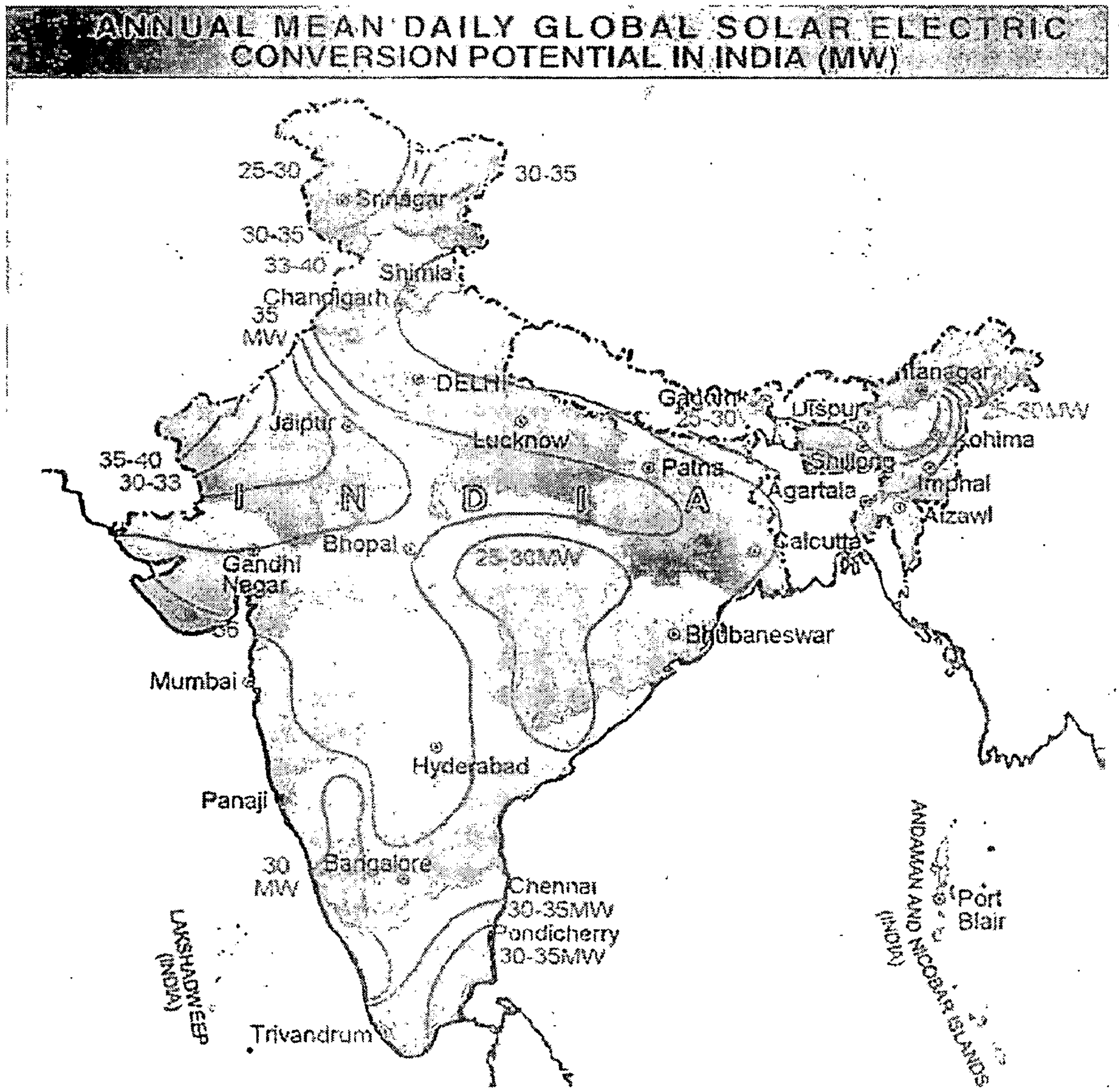


Figure 17: Solar electric conversion potential in India

2. Wind Energy:

The installed capacity of wind power in India was 10,925 MW, mainly spread across Tamil Nadu (4889.765 MW), Maharashtra (1942.25 MW), Gujarat (1565.61 MW), Karnataka (1340.23 MW), Rajasthan (738.5 MW), Madhya Pradesh (212.8 MW), Andhra Pradesh (122.45 MW), Kerala (26.5 MW), Odisha (2MW), West Bengal (1.1 MW) and other states (3.20 MW). It is estimated that 6,000 MW of additional wind power capacity will be installed MW) and other states (3.20 MW). It is estimated that

6,000 MW of additional wind power capacity will be installed in India by 2012.Wind power accounts for 6% of India's total installed power capacity and it generates 1.6% of the country's power.

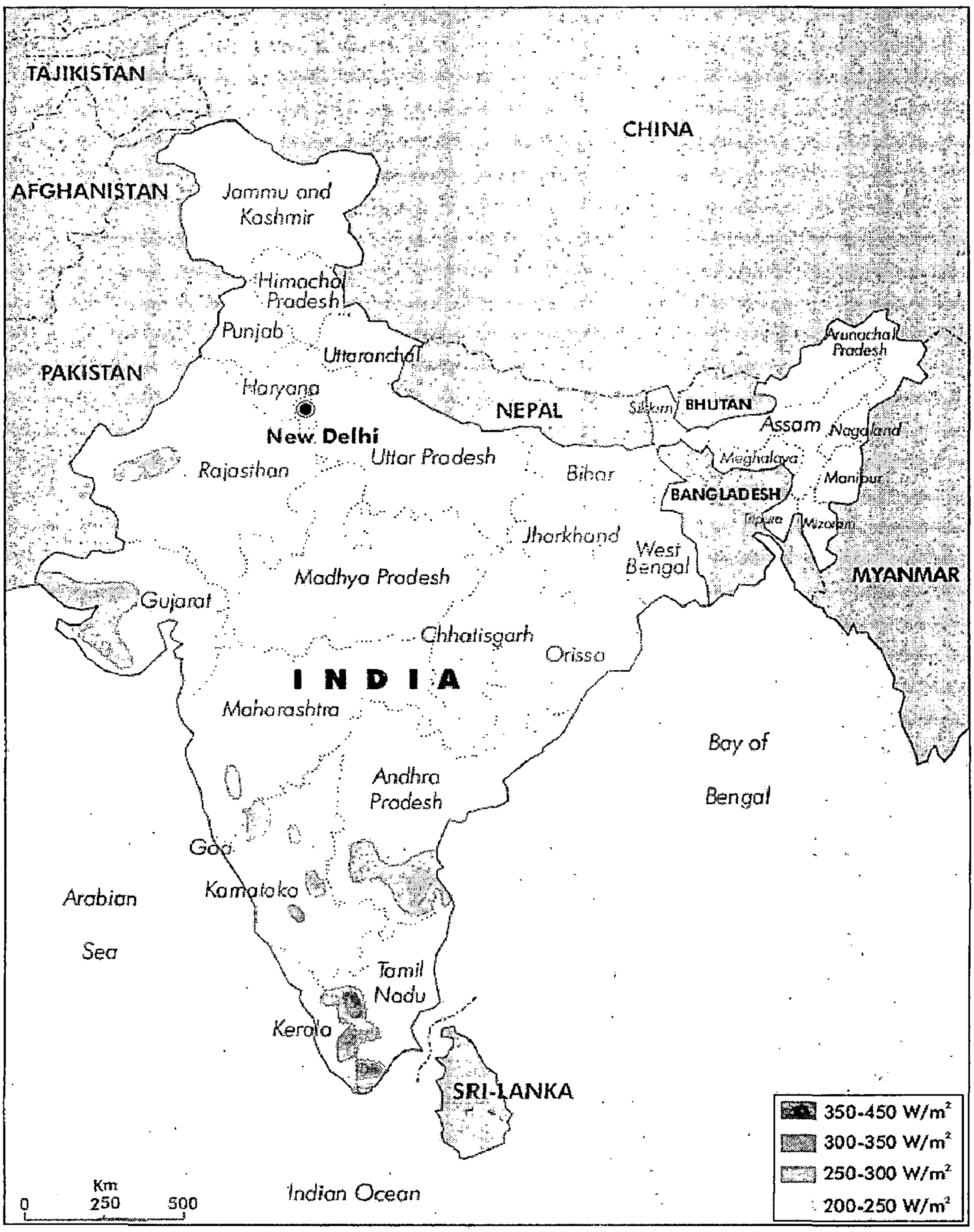


Figure 18: Wind resources in India, Source: IEA, Electricity in India

3. Hydro Energy:

Total 25 major Hydro power plants are working in India. Major are in Himachal Pradesh, J & K and in Uttarakhand.

4. Biomass:

Generation of electricity from Biomass is expensive then from coal. So in India there is only one big power plant of biomass which is of Kalptaru Power Transmission Limited 7.8 MW Biomass based Power Plant.

Figure 19: Hydro power projects in India

5. Tidal power plant:

India has great potential to generate power from Tidal or ocean. But the maintenance and operation cost is very high to generate electricity from tidal power. So in India it is not much use as an energy source.

2.9. Regional and local level Electricity Generation sources in India:

So after the screening of the energy sources in India, there are major seven energy sources are available in India, which are available in Regional scale and local scale. In which renewable are Solar, wind, hydro and biomass, whereas Non-renewable are coal, oil, Nuclear and natural gas.

Regional Level Energy Sources means electricity provides by large scale areas such as 2 or 3 states, more than 1 city. Whereas local level energy sources has limited limit to supply such as for one city .The limit is decide by Generation capacity of the plant.

Table 6: Availability of electricity generation sources in India

Sources In India	Regional Level Available sources	Local Level Available sources
Non- Renewable		
Coal	yes	yes
Oil	Yes	No
Nuclear	Yes	No
Natural Gas	Yes	No
Renewable		
Solar	Yes	Yes
wind	Yes	Yes
Hydro	Yes	Yes
Biomass	No	Yes

2.10. Conclusions:

Cities are constantly transforming to adjust the pressure of economic growth and increasing population. In the process they are struggling to meet energy demand of such developments. Buildings constitute large parts of energy consumption of the city. Approximately one third of the primary energy consumption worldwide is consumed in non-industrial buildings such as residences, offices, hospitals and schools for space heating and cooling, lighting and operation of appliances.

At the time where use of the coal, oil and natural gas is at peak, resources of the same are shrinking day by day and can run out of stock in near future. Among other renewable resources wind, hydro and solar are the most sustainable and easily available energy resources. With the help of efficiency in the use of energy and with the use of renewable energy resources we can try to bridge the gap in supply and demand of energy.

CHAPTER 3

ENERGY POLICIES, INSTITUTIONAL AND STRATEGIC FRAMEWORK IN INDIA

3.1. India's Energy Security Policy: [9]

Under this policy the government of India has put in several measure that could ease the problem of shortage of energy in the country and for the better transmission and distribution of energy to improve the its access to the people keeping in mind the present energy scenario and future prospects. Major Key initiatives along this line are given below:

Regulatory reforms and Structural reforms:

As oil and gas are the major source of energy in the country, these were also the first sector in which level of autonomy by allowing the public sec-tor enterprises to work as corporate entities with their own Boards of Directors that would man-age the companies at an arm's length distance from the Government.

The government also engages private sector participation petroleum oil and gas in exploration and production activities in India. Example is Reliance Industries limited

Enhance private sector participation:

Government made several efforts to encourage private participation in electricity distribution and generation but in response to that private sector participation was quite inadequate. The major reason behind this was inability of the distribution business to generate adequate return in terms of revenues.

[9] http://www.cea.nic.in

3.2. India's Electricity Act 2003: [10]

This act has been enacted by government of India to bring major transformation in the electricity sector of India. The objectives of the Act are "to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity and generally for taking measures conducive to development of electricity industry, promoting competition therein, protecting interest of consumers and supply of electricity to all areas, rationalization of electricity tariff, ensuring transparent policies regarding subsidies, promotion of efficient and environmentally benign policies, constitution of Central Electricity Authority, Regulatory Commissions and establishment of Appellate Tribunal and for matters connected therewith or incidental thereto."

3.3. India's Energy Conservation Act 2001: [11]

To bridge the gap between energy supply and energy demand and to reduce environmental emission, the government of India enacted Energy conservation Act in 2001. Keeping in mind the potential and benefits of energy saving this act provided legal institutional arrangement and framework energy efficiency in the system.

- Important feature of this act are Firstly, Standards and Labeling (S & L) has been identified energy efficient equipment and appliance that would be made available to the consumers.

- Secondly, the government would notify energy intensive industries and other establishments as designated consumers they have to get an energy audit conducted by an accredited energy auditor.

[10] http://www.cea.nic.in

[11] http://www.cea.nic.in

3.4. Accelerated Power Development & Reform Programed [12]

To reduce the technical and commercial losses in the distribution network power system of the country, this act was enacted by the central government of India. Initially in Uttar Pradesh it was started in the two district headquarters namely Muzaffarnagar and Moradabad in the year 2001 & later it was also implemented in Bulandshahr, Baghpat, Sambhal, Meerut, Ghaziabad, Noida, Saharanpur, Amroha, & Rampur.

3.5. UP Power Sector Reforms: [13]

The Government of Uttar Pradesh announced its new power sector reform policy statement in January, 1999. The objective of this policy is to restore the credit worthiness of the power sector and to create an environment which will attract private investments, promote competition and efficiency and facilitate sustainable development of power sector.

3.6. Renewable Energy Policies in India: [14]

Indian cities struggled to meet the growing demand of energies to run various cities infrastructure. Efficient measures can help in reducing the amount of current energy use. So India's search for new and renewable energy resources that would ensure sustainable development and energy security, Government of India's major programs, policies and incentives for the promotion of renewable and non-conventional technologies in India

[12] http://www.pvvnl.org/

[13] http://www.uppcl.org/

[14] http://www.cea.nic.in

3.7. Legal and Regulatory Problems:[15]

1. **Lack of legal framework for independent power producers:**

In many countries, power utilities still control a monopoly on electricity production and distribution. In these circumstances, in the absence of a legal framework, independent power producers may not be able to invest in renewable energy facilities and sell power to the utility or to third parties under so-called "power purchase agreements." Or utilities may negotiate power purchase agreements on an individual ad-hoc basis, making it difficult for project developers to plan and finance projects on the basis of known and consistent rules.

2. **Restrictions on sitting and construction:**

Wind turbines, rooftop solar hot-water heaters, photovoltaic installations, and biomass combustion facilities may all face building restrictions based upon height, aesthetics, noise, or safety, particularly in urban areas.

Wind turbines have faced specific environmental concerns related to sitting along migratory bird paths and coastal areas. Urban planning departments or building inspectors may be unfamiliar with renewable energy technologies and may not have established procedures for dealing with siting and permitting. Competition for land use with agricultural, recreational, scenic, or development interests can also occur.

3. **Transmission access:**

Utilities may not allow favorable transmission access to renewable energy producers, or may charge high prices for transmission access. Transmission access is necessary because some renewable energy resources like windy sites and biomass fuels may be located far from population centers. Transmission or distribution access is also necessary for direct third-party sales between the renewable energy producer and a final consumer. New transmission access to remote renewable energy sites may be blocked by transmission-access rulings or right-of-way disputes.

4. **Utility interconnection requirements:**

Individual home or commercial systems connected to utility grids can face burdensome, inconsistent, or unclear utility interconnection requirements. Lack of

[15] http://www.cea.nic.in

uniform requirements can add to transaction costs. Safety and power-quality risk from non-utility generation is a legitimate concern of utilities, but a utility may tend to set interconnection requirements that go beyond what is necessary or practical for small producers, in the absence of any incentive to set more reasonable but still technically sound requirements. In turn, the transaction costs of hiring legal and technical experts to understand and comply with interconnection requirements may be significant. Policies that create sound and uniform interconnection standards can reduce interconnection hurdles and costs.

5. Liability insurance requirements:

Small power generators (particularly home PV systems feeding into the utility grid under "net metering" provisions) may face excessive requirements for liability insurance. The phenomenon of "islanding," which occurs when a self-generator continues to feed power into the grid when power flow from the central utility source has been interrupted, can result in serious injury or death to utility repair crews. Although proper equipment standards can prevent islanding, liability is still an issue. Several U.S. states have prohibited utilities from requiring additional insurance beyond normal homeowner liability coverage as part of net metering statutes.

3.8. Institutions Framework for Energy in India:[16]

To keep check and to address the various issues related to availability of fuel supplies, environmental impact, climate change, and health externalities, for large country like India it was a necessity to institutions framework that will work for this causes.

Major Institutions of energy in India:

1. BEE (Bureau of energy efficiency):

The mission of Bureau of Energy Efficiency is to institutionalize energy efficiency services, enable delivery mechanisms in the country and provide leadership to

[16] http://www.cea.nic.in

energy efficiency in all sector of economy. The primary objective would be to reduce energy intensity in the Indian Economy.

2. Indian Renewable Energy Development Agency (IREDA):

Indian Renewable Energy Development Agency (IREDA) is a profit making public sector financing company under the administrative control of Ministry of Non-Conventional Energy Sources (MNES).

IREDA extends financial assistance for renewable energy, energy efficiency and conservation projects with the motto: **"energy forever"**.

3. National Productivity Council (NPC):

NPC has been active in the area of energy conservation and management for over three decades and has undertaken numerous studies at macro, sectoral and unit levels through its team of committed professionals. It promotes rational use of energy through: optimization of methods improvement, energy efficiency, technology up-gradation and application of alternative energy sources.

4. The Energy and Resource Institute (TERI)

TERI has been actively working in close association with the Indian industry for developing solutions for the challenges posed by the growing demand for energy. It has conducted energy audits in more than 200 industrial organizations.

5. IIEM:

Indian Institute of Energy Management (IIEM) is a consortium of professionals, industry experts and academicians of eminence. The main objective of IIEM is to provide energy related services to the industry and to develop manpower in the field of energy conservation.

6. Ministry of Non-conventional Energy Sources, India:

MNES is the nodal agency of the Government of India for all matters relating to non-conventional /renewable energy. It undertakes policy making, planning, promotion and co-ordination functions relating to all aspects of renewable energy, including fiscal and financial incentives, creation of industrial capacity, promotion of demonstration and commercial programs, R&D and technology development, intellectual property protection, human resource development and international relations.

7. Department of Atomic energy, India:

The Department of Atomic Energy (DAE) is a department directly under the Prime Minister of India with headquartered in Mumbai. The department is responsible for nuclear technology, including nuclear power and research.

8. Ministry of new and renewable energy:

The Ministry of New and Renewable Energy (MNRE) is the nodal Ministry of the Government of India for all matters relating to new and renewable energy. The broad aim of the Ministry is to develop and deploy new and renewable energy for supplementing the energy requirements of the country.

3.9. Conclusions

While it is evident that there is no unified body to deal efficiency of energy in holistic manner, the end customers of energy has no clear picture to make buildings older or newer fit into perspective of energy efficiency. Now, there is urgent need to provide a single window provision for end customers especially for residential sector, which is largely untouched by reforms in energy efficiency.

BEE however assigned as central body to take account of energy efficiency in institutionalized manner by way of using energy efficient devices. It also needs to collaborate with the building rating systems such as LEED and GRIHA to assess energy efficiency of built environment in integrated manner.

CHAPTER 4

CASE STUDIES

4.1 Energy efficiency in urban areas: a case study of Canadian cities:

Case study category: Energy Efficiency

Energy efficiency improvements in the urban context should take a holistic approach of both supply- and demand-side measures. Public buildings tend to be older and employ inefficient equipment and operations and maintenance practices.

Buildings can consume about 40% of a city's energy and, thus, have significant potential for energy savings with a wide range of options.

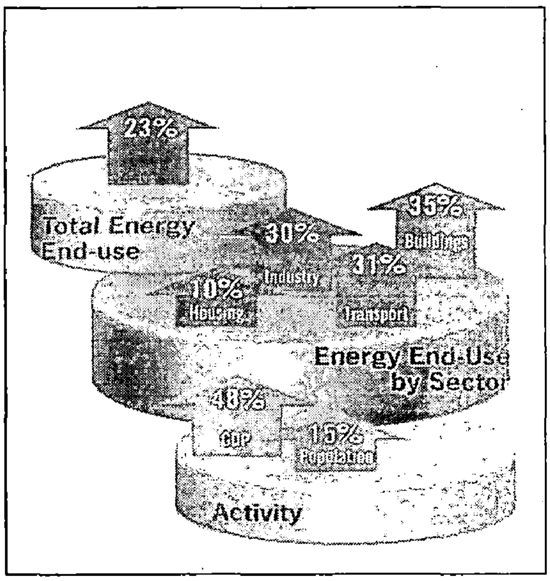


Figure 20: Present energy demand in Canada

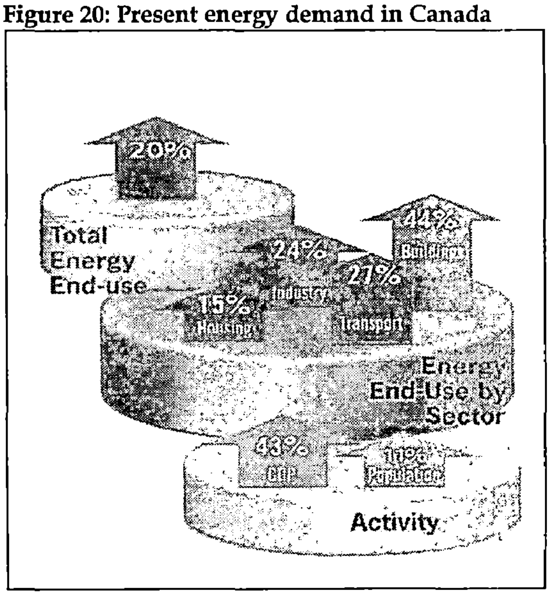


Figure 21: future energy demand in Canada

Cities can often start with relatively low-cost and modulated measures to improve building envelope (e.g., white roofs, sun shading, and weather stripping), electrical appliances, and office equipment. Comprehensive energy efficiency renovations would maximize cost effectiveness and potential savings. New buildings, could adopt energy efficient design standards that would reduce the life cycle cost of buildings.

Cities face major barriers to implementing sustainable energy measures. Even where there is a desire to improve their efficiency levels, cities often lack the requisite information and support for the cause.

4.1.1. Introduction of need of energy efficiency concept in Canadian cities:

- Energy conservation and Energy efficiency are two powerful ways to help meet our future energy needs and reduce the necessity for new energy development. Energy efficiency can help Canada to expand its economy while managing its current and future energy demands.
- Total.energy demand in Canada has increased by 23% from 1990 to 2004 this increase has largely been compel by the growth in both economic activity and population.

Figure shows the energy use in every sector is increased at a different rate. In significant changes in behavior, energy demand is expected to continue to increase as the Canadian economy and population continue to expand. Population of Canada is projected to increase by 11% between 2005 and 2020 while expected growth of GDP will be another 43%. This increasing population and activity growth in Canada is expected to contribute towards a 20% increase in energy use between 2005 and 2020.

4.1.2. Reasons for requirement of energy efficiency:

1. **Environmental:** Development for energy and its use generates over 80% of greenhouse gas emissions in Canada and also smog pollutants such as sulphur dioxide and nitrogen oxides.
2. **Energy security**: The relative gap between supply of electricity and demand is a major issue of concern for some regions in Canada.
3. **Economic and social**: Rising energy demand coupled with hike energy prices in resent past puts pressure on consumers.

4.1.3. Energy efficiency Action plans in Canada:

Cross-cutting action:

Cross-cutting action means reducing wastage of energy and getting maximum amount of energy from the energy sources. Wastage of energy from one sector can be utilized in other sectors. It's altogether an integrated approach for the consumption of energy in most efficient manner. Crosscutting opportunities such as these can be overlooked because they require an integrated approach, typically involving multiple players, not just the energy user but also neighboring energy users, utilities and governments. For example, community are planned in a way to have mixed land use uses and high density development will reduce the demand for personal transportation, and will facilities the public transport systems walking and cycling. Other examples of cross-cutting opportunities include:

- **Cogeneration** – Cogeneration is a process where heat and power are produced simultaneously from the same energy source and utilizes, for example, the waste heat from an HVAC building boiler can be used for producing electricity for use or for sale.

- **Heat recovery** – Heat recovery is a process where the waste heat from chillers or generated in the industrial process can be used for cooling and/or heating purposes somewhere else in nearby neighborhood. For example, near industrial areas commercial building can be constructed as they can fulfill their heating and cooling requirement from the waste heat of factories.

- **Integrated on-site processing** – from raw materials to more completed or finished products - to reduce transportation costs. Examples include processing lumber into furniture or pre-fabricated building products in one facility. Compact packaging for consumer products also reduces shipping load sizes and weights, therefore reducing transportation energy use.

- **Community and sustainable energy planning** – Integrates the needs of all sectors and can be used to find ways to use waste energy appropriately and to incorporate innovative energy systems. These plans should include smart planning for compact, mixed use communities where land-use planning designates higher density nodes reducing transportation requirements and allowing more efficient transportation such as public transit, and is conducive to walking and cycling.

4.1.4. Energy efficiency Activities by sectors:

4.1.4.1. BUILT ENVIRONMENT:

All the like buildings, housing, infrastructures, fixed equipment and communities comes under built environment.

Figure 22: Built environment in Toronto city

In Built environment Canadian government have introduce a concept of Model National energy codes for Buildings. In which Canadian Commission on Building and Fire Codes decided that there is a need of up gradation of Model national energy codes for to achieve energy efficiency in 2012. It was estimated that if the energy code will up-graded to 25% more than the current level then it could led to energy and pollution saving up to a great extent.

Key Tools, Technologies and practices:

- Community energy plans could increase the capacity of municipalities to implement a renewable energy and energy efficiency at the community level, and to reduce and limit urban sprawl by supporting smart growth principles, lower infrastructure costs, make transit more viable, increase walk ability and green spaces, and improve overall quality of life.

- For the New buildings and houses there should be integration of air tightness and energy efficient insulation systems; windows and doors; new buildings system integration through commissioning; lighting and day lighting technologies; and there should strict check by monitoring and control systems and high performance metering over heating, ventilation and air conditioning equipment,.

- For improving the energy performance of these houses and buildings on-site generation of energy can be having combination of conventional and alternative energy sources, e.g., using combined power systems with solar photovoltaic technology.

- For achieving energy efficiency in the already existing buildings and houses usage of high degree of new technologies and innovative material and ideas can be incorporated.

4.1.4.2. INDUSTRIES IN CANADA:

- The industrial sector can be divided into two groups: the one which consumes energy (mining, manufacturing, and construction); and the one which produces energy (upstream oil and gas, heavy oil upgrading and electricity

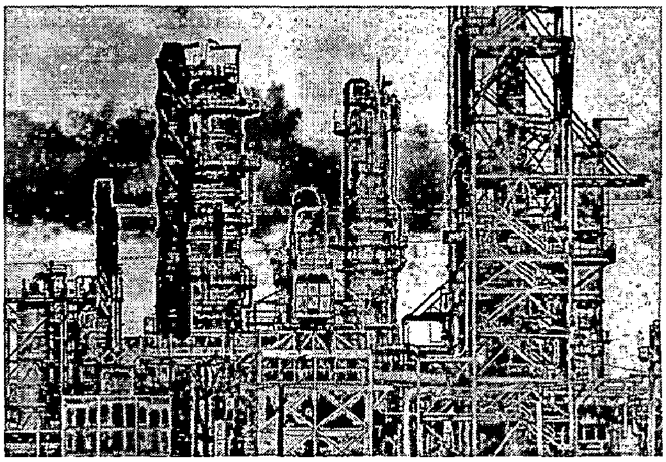


Figure 23: Energy producing industry

generation).

- From 1990 to 2004, the industries which were consuming had cut short the energy intensity intake up to 45 per cent. On the other hand in 2004, Canada's mining; construction and manufacturing sectors used 24 per cent less for the production of same unit they produced in 1990. This was achieved by the investments of funds in energy efficiency. Analysis shows that investments done were efficiently for overall energy intensity improvements 70 per cent.

- In contrast, energy producing industries become 15 per cent more energy incentive from 1990 and 2004. As production increased to 33 per cent, energy usage also increased by 53 per cent.

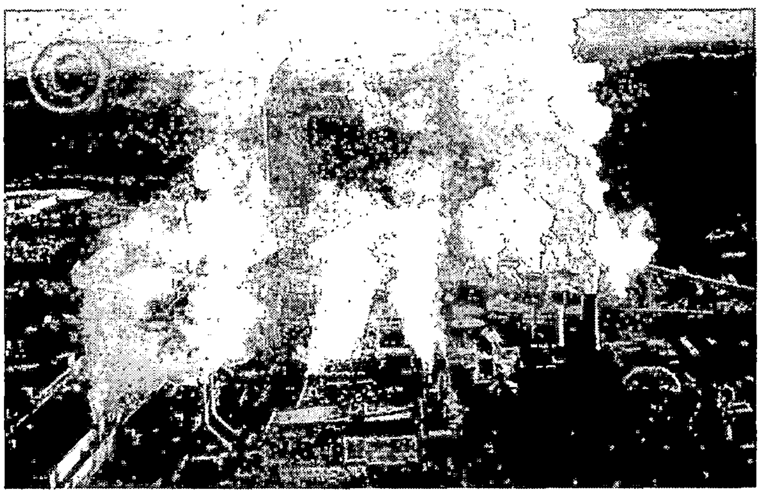


Figure 24: Industrial consumption

- This is because in the electricity producing sector, the raised energy intensity was a result of a decrease in electricity generated from non-energy-intensive hydroelectric sources relative to the more energy-intensive coal and natural gas-fired generation.

Key Tools, Technologies and Practices:

- **Motor Driven and Motors Systems** - In Motor Driven and Motors Systems there was a potential of saving up to 30% to 60% of the energy consumed by motors, this can be achieved by optimizing compressor and motor size, managing air compressor leaks using and variable frequency drives. This area consumes about 20% to 30% of total industrial energy use.

- **Direct Process Heat** - In Direct Process Heat it was estimated that there was a potential of savings energy up to 10% to 35% from the energy consumed by direct process heat equipment. Improvements can be made installing heat recovery, boiler upgrades and replacement as well as other process-specific opportunities. In Canada this area consumes about 20% to 40% of industrial energy use.

- **Gasification technologies**: It can provide the upstream oil and gas sector with electricity, heat and hydrogen by using fuels from the waste such as municipal solid waste and biomass, residues from oil refineries instead of natural gas, with achieving efficiencies greater that can be greater than the use of natural gas.

4.1.4.3. TRANSPORTATION:

Canada has basically five modes of transportation: air; rail; off-road transportation and on-road and marine. In Canada they appear to consume approximately 30% of

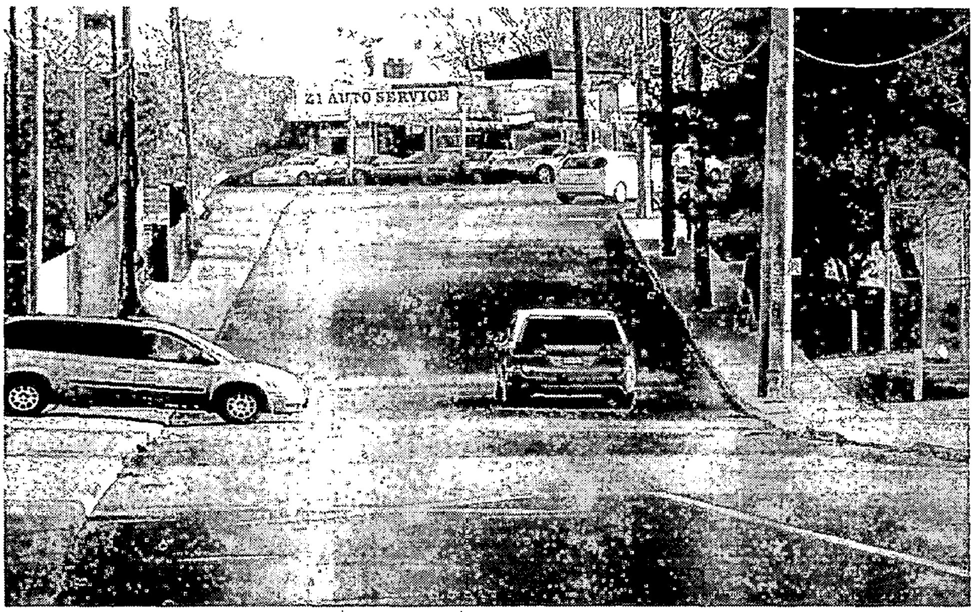


Figure 25: On- road transportation

total secondary energy use. The on-road transportation, accounts for 78% of transportation energy use, and which is projected to grow five times faster than the next closest mode, which is air travel. So, there is a need of energy efficiency majorly in on-road transportation.

Key Tools, Technologies and Practices:

- Improved availability and production of energy efficient vehicles from manufacturers and suppliers and development of infrastructure specially required for this cause.

- For the energy efficiency performance of the vehicles, improvements in the driving and maintenance practices of drivers, owners and mechanics is acquired up to optimal level.

- Innovation and improvement in the design of roadways and communities to minimize energy demand in transportation.

- Amending and/or strengthening policies that are responsible for the usage roadways are to be enhanced and improve to gain energy efficiency (e.g., stricter penalties to control aggressive driving or mandatory inclusion of bicycle lanes on roadways).

- Replacing energy-intensive private vehicle travel with lower intensity vehicle options, such as ride-sharing, multi-modal trips and mass transit.

- Increased use of innovative options in planning that reduce overall transportation trip requirements, including home-based offices, workplace day care programs, online shopping and telecommunications.

4.2. Building energy codes in the city of Tianjin - China

Case study category: Energy Efficiency

The City of Tianjin in China is although working multidimensionality in the field of energy efficiency in the city, the following two case study examples teaches us the efficiency in residential buildings through Energy efficiency codes and utilization of landfill gas as nonconventional source of energy.

Residential Building energy codes enforcement.[17]

Sector	**Buildings**
Type of project	Building energy codes
City and country	Tianjin, China
City population	12.28 million, 2009
Area	11,760 square km
Capital cost/initial investment	Estimated incremental cost for energy efficiency: 750 million yuan (US$90.6 million)
Reduction in annual energy use	870 GWh heat energy at building level
Project status	Completed between 2005-2009

BUILDING ENERGY EFFICIENCY CODES (BEECS) was enforced most successfully in the Tianjin city of China. Results of recent annual national inspections organized by (MoHURD) indicate that compliance of BEECs in new residential and commercial buildings in Tianjin is close to 100 percent. In terms of building envelope thermal integrity, the currently enforced residential BEEC in Tianjin is 30 percent more stringent than what is required by the pertinent national BEEC.

From 2005 to 2009, about 70 million m^2 of new residential buildings were completed in the urban areas of Tianjin. This puts the upper range (assuming full construction compliance) of the calculated space heating energy savings of these new buildings at about 870 GWh/year, compared with the baseline of complying with the code. Heat energy saved would be sufficient to provide winter space heating for about 200,000 apartments (at 100 m^2 each) built to comply with the code.

Compared with the baseline, the estimated simple payback period for the agreement with the code, based on avoided cost of heating service is less than seven years, attractive even if the energy efficiency (EE) measures have a lifespan of 15 years.

[17] ESMAP EECI Good Practices in Cities, 2011

Tianjin has demonstrated the importance of the following factors in achieving BEEC agreement:

- A well-established building construction management system,
- Structured and Standardized procedures for agreement enforcement,
- Broad-based capacity of the construction trades to meet compliance requirements, including availability of materials and parts and technical skills for work to be carried out ,
- Consumers ability and willingness to pay for the costs of BEEC compliance, and
- Local government resources, support, and commitment to implementing increasingly stringent BEECs.

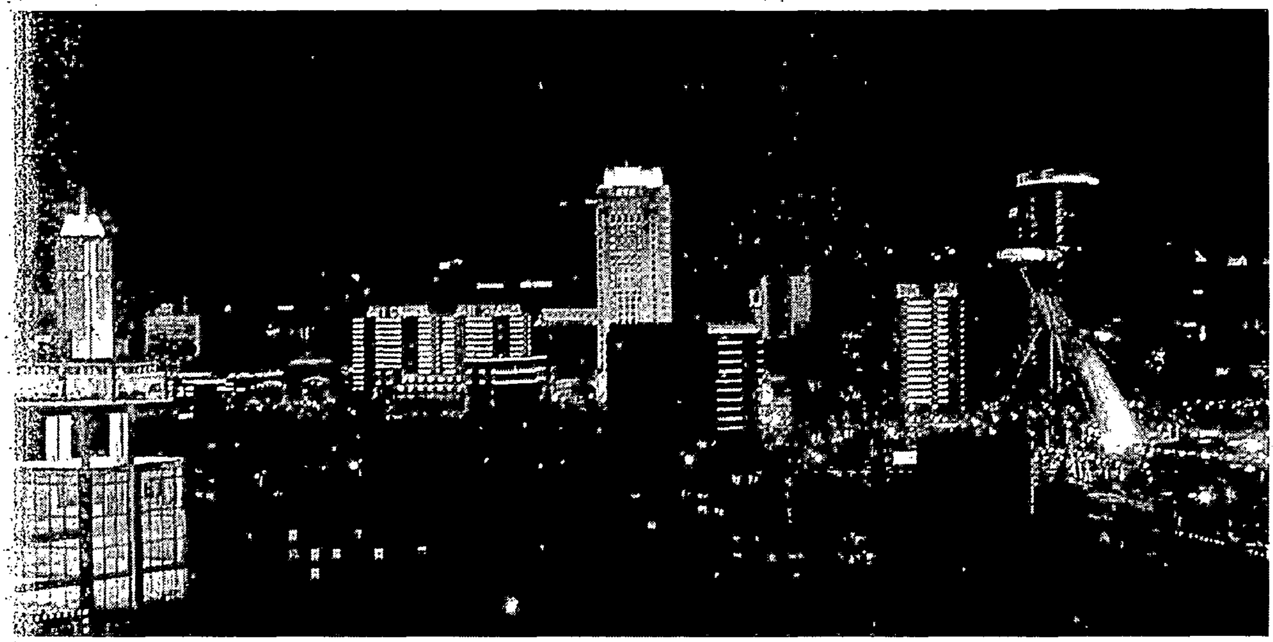


Figure 26: View of Tianjin City at night: the glare of the city is energy efficient too.

4.3. Installation Energy Efficiency Street Lighting in city[18]- Akola

Case study category: Renewable Energy, energy efficiency in street lighting.

Project	**Installation of Energy Efficient Street Lighting**
City and country	Akola, India
Sector	Public Lighting
Type of project	Performance Contracting
City population	443,184 (2007)
Capital cost/initial investment	INR5.7 million (US$120,000) (Estimated)
Energy Saving	2.1 million kWh (56% in annual energy savings) and INR6.4 million (US$133,000) in cost savings
Project status	Retrofit completed late 2007

Akola relatively small town of in Maharashtra, more than 11,500 street lights (standard fluorescent, mercury vapor, sodium vapor) by Akola Municipal Corporation were replaced with efficient, fluorescent tube T5 lamps as part of the energy efficient street lighting project. Energy savings performance contracting approach was used for the project, which means the contractor, Asia Electronics Limited (AEL), will give funds for all costs required for implemented the project, maintained of installed lamps, and in return a portion of the energy savings will be received by the company to recover its investment. AMC was able to improve the service level and the condition of street lighting with lower electricity bills and lower costs with the help this project and the participation of (AEL).

2.1million KWh (56%) annual energy savings was achieved from this project, representing reduced electric bills for the city totalling INR (Indian Rupee) 6.4 million (US$133,000) per year. The total project cost came out to be only INR5.7 million (US$120,000), 11 months was the project payback period. Because the total

[18] ESMAP EECI Good Practices in Cities, 2009

cost of the project was entirely financed by AEL, acting as an Energy Service Company (ESCO), AMC had to make no upfront investment or assume performance risks under the project. With the help energy savings performance contract (ESPC), compensation to AEL was based on a shared savings approach in which AMC paid AEL 95% of the energy bill savings over the contract's 6 year duration and for maintaining the lamps and fixtures AEL was also paid an annual fixed fee.

The success of this project has already led the beginning of implemented of similar type projects in the states of Maharashtra and Madhya Pradesh which contributes towards saving more energy and active working of municipal corporation for this cause.

Figure 27: A Street at night illuminated by Energy efficient lighting

4.4. Recovery of landfill gas in Tianjin, China

Case study category: Renewable Energy

Tianjin city in China has initiated a project for recovering landfill gas (LFG), which gets wasted as it is being released into the atmosphere. This landfill gas can be used for electricity generation by burning this pretreated LFG. Tianjin has five municipal waste landfills and Shuangkuo Landfill is one of them, where the project is located. The installed capacity of the project is 4.3 MW which is being constructed in number of stages. On May 2008 the operation of first generator with installed capacity of 1.03 MW was started, currently utilizing 500-600 cubic meters of landfill gas. The electricity generated from this is being sold to the North China Power Grid under a long-term contract and the city was able to use waste to generate revenues and gain local environment benefits with this Land fill gas project.

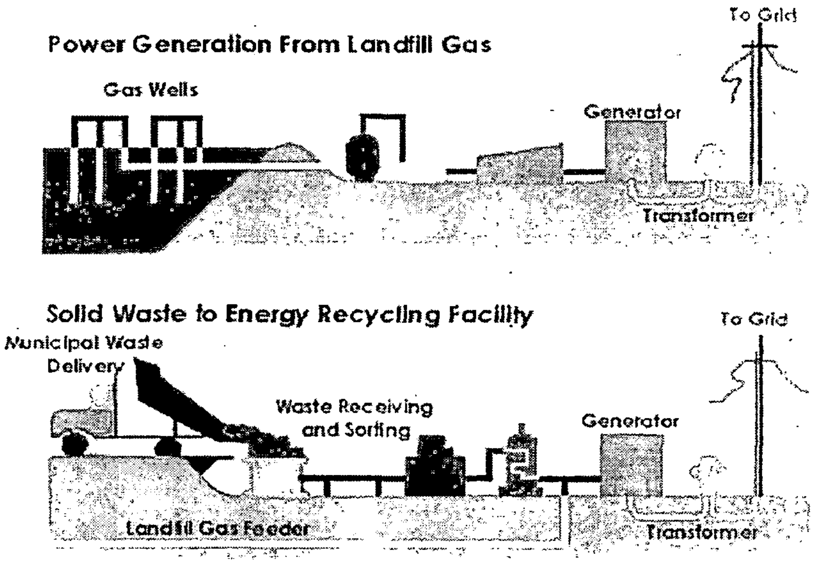


Figure 28: Energy generation from LFG system

The successful installation and working of the project demonstrates an excellent Planning, working and coordination of technology and the institutional mechanisms for LFG recovery and electricity generation, which is currently being applied in many other large cities in China.

4.4.1. Background:

The project will collect landfill gas, which primarily consists of methane (50%) and other gases (50%), such as carbon dioxide and additional gases including non-methane organic compounds, and generate electricity by installing LFG collection, electricity generation, and flaring systems on site. The generators installed will combust the methane in the LFG to generate electricity which is sold to ("NCPG").

During periods when electricity is not generated, excess LFG as well as the gas collected will be flared.

4.4.2. Technology:

In China, the technology to use landfill gas to produce electricity or heat is in its beginning. Therefore, existing landfills with gas utilization systems generally employ foreign technology. The Tianjin project uses state-of-the-art technology and innovative ideas from overseas to assure that the emission reductions from the project are measurable, qualified and real.

The project includes the following systems:

- Gas collection system - At present, a total of 42 gas-venting wells are installed at the site in a rectangular formation. These wells were constructed in 1000mm diameter with Φ200mm high density polyethylene (HDPE) pipes inside, which are raised as waste fills up.

- Gas pre-treatment system -Before electricity generation and flaring is done, LFG must be pre-treated so that its impurities are removed for better efficiency. Pre-treatment is also important as it will help to prevent corrosion in the flaring and generators system. The pre-treatment process consists of:

    - Separation of leachate condensation
    - Filtration, dewatering and removal of solid impurities and moisture
    - Drying and pressurization.

- Grid connection and Electricity generation system - The project will required four electricity generators (1.03 MW each) constructed in different stages of the project. The generated electricity is being sold to NCPG under a long-term

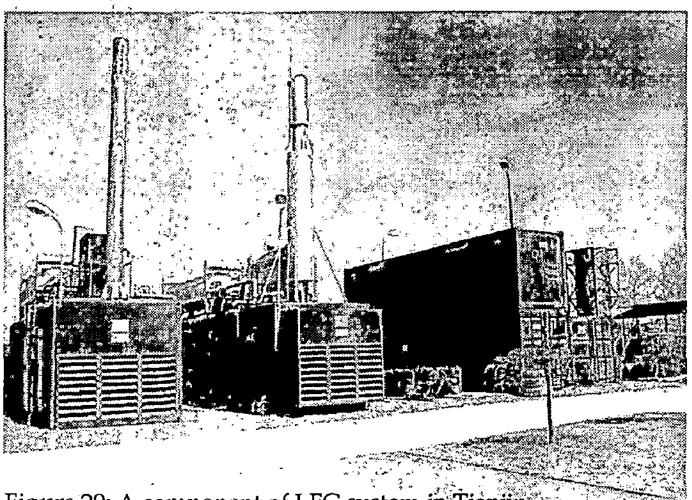


Figure 29: A component of LFG system in Tianjin

power purchase agreement.

- Flaring system - LFG not used for electricity generation is flared. When methane is converted into carbon dioxide, the greenhouse effect caused by LFG is substantially reduced.

- Protection and Monitoring system - The monitoring and protection of the project is firmly based on the CDM monitoring methodologies. In this project CDM monitoring methodologies provides monitoring and protection facilities for landfill gas pre-treatment, power generation, and public grid connection.

4.4.3. Cost, Financing, Benefits, and Effects:

The total investment cost for the LFG recovery and power generation project is US$6.9 million and the operation and maintenance costs over the lifetime of the project are estimated to be US$24.1 million. The project will obtain revenues from the sale of electricity to NCPG at US$0.074/kWh which over the project life will amount to US$36.2 million. The pre-tax net profit (after other local taxes) is US$5.1 million.

4.4.4. Results and Benefits:

On May 2008 the project was successfully launched. The current LFG utilization is 500-600 m3/hour (50% of which is methane). On August 27, 2008 the project was registered as a CDM project and was able to earn CERs. Under the purchase agreement with the World Bank, the Bank will purchase 635,000 tons.

Overall, the project benefits include the following:

- Increased revenues to the municipality from electricity sold to the CERs and grid.

- Reduction of local and regional pollution

- Reduction of GHG emissions from the landfill and electricity production

- Enhanced safety from reduced risks of explosion from high methane concentrations

- Creation of local jobs, since the project was designed, constructed and operated using local resources; while jobs were created during both the project construction and operation periods, they were not quantified
- Improved site management and reduction of potential threat to local groundwater resources and soil contamination.

4.5. Solar city, Daegu, Korea

Case study category: Renewable Energy

Daegu is the fourth largest city in South Korea with a population of 2.5 million. It has a mixed industrial and services economic base.

Daegu derived its interest in solar city concept from a cooperative program called the solar heating and cooling of International Energy Agency. In 2003 Daegu joined the International Solar Cities Initiatives (ISCI)

Daegu made a master plan (SCD 2050) to increase renewable energy use to 5% by 2010 and to develop and promote new and renewable energy industries. It includes:

1. Public investment for research of renewable energy technology
2. Installing photovoltaic and solar water systems on public facilities.
3. Establish center for solar city Daegu at Kyungpook National University- to initiate
    - New projects
    - Building institutional capacity to develop policies
    - Enlisting business and citizen's participation.
        - Sewage disposal plant - powered by 479kWp unit.
        - University campuses - 166Kw of building- integrated PV.
        - City water purification facility-80kWp PV unit.
        - City's convention center (EXCO) has installed 60kWp of PV.
        - Elementary and high schools total capacity of – 76kWp PV

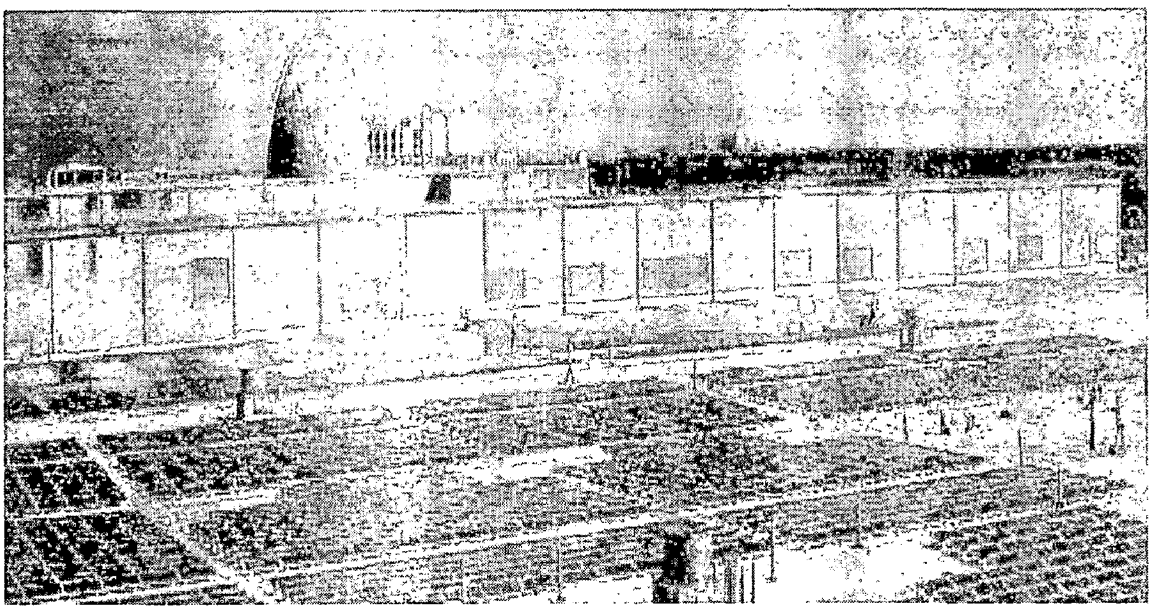


Figure 30: Daegu City's PV system development.

- Public perks are using 12kWp of PV.
- Headquarters of NGO powered by 5kWp PV.

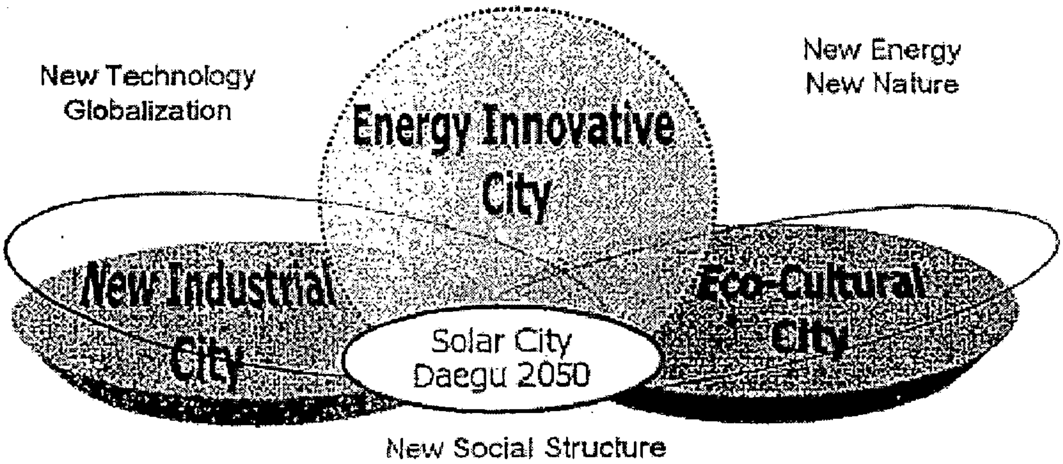


Figure 31: Three dimensions of urban life are addressed in an integrative manner.

Energy Innovative City

Key projects of energy innovative city are to reduce residential energy costs, introduce green buildings, promote PV solar roofs and construct solar villages. The project encourages citizens' voluntary efforts to reduce energy use.

The green buildings projects seeks to minimize energy consumption and peak loads in public and private buildings through the use of renewable energy and high efficiency envelops and technologies. All public buildings to be made green and all non-public buildings will be obliged to meet citywide standards.

The 10,000 solar roof project aims to accelerate residential PV use through the standardization of PV roofing systems. Ten thousand 3kW solar roof systems will be mounted on detached homes and apartment buildings.

The New Industrial city

Key projects of the New Industrial city include building an energy-efficient industrial structure by promoting emergence of energy services companies (ESCOs), a recycle industry

and renewable energy industry. A city-based renewable energy industry to be attracted through incentive programs for new technology businesses. Priority for city purchase of products of local companies will be instituted. The energy innovative city project will be linked through this project to the new Industrial city initiative.

The eco-cultural city

The key action plans for the Eco-cultural city are to promote a healthy city life and the U-solar city concept. The program will improve indoor and outdoor environments throughout the city. Building eco-roads such as bicycles and pedestrian friendly roads will support the healthy city project and solar-powered communication systems will underpin the U-solar city efforts. Ubiquitous solar City refers to the creation of an infrastructure for linking solar city projects via fast developing information and communication technologies. Construction of an integrated electronic information system will facilitate civil society discourse on pathway to a healthy urban environment.

Planning methods to support Solar City Daegu Project

The research institute for energy, environment and Economy at Kyungpook National University has developed a forecasting model to measure the cities progress against the business as-usual trajectory.

4.6. Solar city, Oxford, UK

Case study category: Renewable Energy

The Oxford Solar Initiative was started in 2002 as a partnership between the city, Oxford Brooks University, and the local community. The primary target of the initiative is to convert 10% of all homes in the city to have solar energy by 2010. Some short term targets such as installation of energy efficiency measures, solar hot water system, reduction of CO2 emission, capacity building for the local government are also included in the initiatives.

The Oxford solar city has three primary goals as mentioned below.

1. To add a sustainable energy element to urban planning strategies.
2. To set targets, conduct baseline studies, and develop long-term scenarios; and
3. To develop sustainable urban energy technologies.

As part of the initiative, Oxford has been conducting analyses of the CO2 emission of its built environment using geographic information systems (GIS) to predict baseline energy use for each house.

Oxford has also introduce the concept of "solar street" in which all the homes on one street have solar hot water and solar power. These solar power systems are connected to the electric grid via a "power gate" that allows the community to obtain Renewable Obligation Certificates (ROC) from the utility for the power generated.

As far as the availability of financial assistance to homeowners are concerned

- For renewable energy, the grants cover up to 50% of the full cost of solar electric systems and up to $500 for solar hot water systems.

4.7. Rabi Rashmi Abasan- Solar housing Complex, India

Case study category: Renewable Energy, Energy

4.7.1. Efficiency in Residential Buildings

Location – New town Kolkata, 1.76 acres plot area. 25 bungalows, Conceived by WBREDA (West Bengal Renewable Energy Development Agency.)

Solar Passive architecture is incorporated which reduces the buildings' energy requirement by meeting its daily cooling and Lighting needs through maximum use of natural light and proper ventilation

- walls have built in air cavities that act as insulators
- water pool cools the breeze flowing into the house through
- Adjustable louvers.

4.7.2. BIPV - Building integrated Photovoltaic system

- BIPV replace conventional building materials such as roof tiles, shingles, facades and normal glazing with Photovoltaic Building materials.
- These can be so manufactured as to be almost, blending harmoniously with the conventional building material.

Figure 32: View and schematic roof plan of Rabi Rashmi Abasan(Sun Rays Houses)- solar housing in New Kolkata

- 2kW of power from solar tiles will be generated by each house – that will be 40 per cent of the power required to run the electrical appliances for a standard household.

- If there will be necessity owner will also get power from the grid line.
- On net monthly metering the utility will pay the house owner and vice-versa.
- Every house will have its own solar signage and solar water heaters and the common area lighting will be done by installed solar streetlights.
- The development is composed of 464 units of solar modules, customized to fit the roofs of each building. By utilizing solar power, the houses can reportedly save up to 100 kilowatts of energy each day.

Figure 33: View of Rabi Rashmi Abasan(Sun Rays Houses)- solar housing in New Kolkata

4.8. Vishal paper industries generates its own power from biomass

Case study category: Renewable Energy

Vishal Paper Industries, situated at Village Khusropur in Patiala, Punjab, produces different types of writing and printing papers. The total production capacity is about 100 tons per day. The steam requirement for the company is around 12 tons per hour and the power requirement is about 4 MW. Due to irregular supply of power, the company has installed a 5.4 MW biomass co-generation (non-bagasse) project to meet their full requirement of power and steam, which is saving a large quantity of conventional electricity and diesel for the operation of their paper mill. The project is utilizing about 200 tons per day of rice husk. The pressure of steam boiler is 65 bar, and the turbine is of back pressure type, so as to extract steam also for their process requirement. The total cost of the project is about Rs 130 million. The project was commissioned in August 2008 and is running satisfactorily. The energy generated is being utilized for captive use to meet their total heat and power requirement. With the installation of 5.4MW co-generation project, the paper mill has become self-dependent for its captive energy requirement. The payback period of project is about 5 years.

4.9. Giriraj rice mill powered by rice husk

5. Case study category: Renewable Energy

Giriraj Rice Mill is situated at Bamunpara in Burdwan District of West Bengal. The production capacity of the mill is 80 000 tons of paper per annum. In the process, the rice mill requires both electricity and steam. Due to irregular supply of power and frequent cuts, the mill has installed an 800 KW rice husk-based co-generation project for captive use to meet their full requirement of power and steam. This is saving a large quantity of conventional electricity and diesel for the operation of the rice mill. The project is utilizing about 70 tons per day of rice husk, which is available from their own rice mill. The pressure of the boiler is 32 bar, and the turbine is of back pressure type, so as to extract steam for their process requirements.

The project was commissioned in May 2008 and is running satisfactorily. The energy generated is being utilized for captive use to meet their total steam and power requirements. With the installation of the 800 KW co-generation project, the rice mill has become self-dependent for its energy requirement. The payback Period of the project is about four years. The performance of the project has encouraged a number of other rice mills in the state of West Bengal to install similar projects.

5.1. Solar Village - Iqbalpur, Gurgaon

Case study category: Renewable Energy

Village Iqbalpur is located near the famous Sultanpur Bird Sanctuary.

It is about 15 km from Gurgaon, and comprises of about 120 families engaged in farming and related activities, such as dairying and animal husbandry. Though located near Gurgaon, the village is not different from any other remote village as far as electricity is concerned. It faces several power cuts at crucial hours. The Sultanpur branch of GGB (Gurgaon Gramin Bank), after getting a call from its corporate office, decided to popularize SHLS (Solar Home Lighting Systems) in its operational area. Initially, it was a stupendous task to motivate the people of nearby villages to install SHLS. So, to demonstrate the utility and effectiveness of SHLS, the branch decided to install a system in its own premises so that villagers can themselves see and realize the advantages of SHLS. The Village Pradhan of Iqbalpur also visited the Sultanpur Branch. The Branch Manager convinced him about the utility and working of SHLS. Together, they decided to hold a meeting in the village and demonstrate the SHLS. Subsequently, a demonstration was organized in the village with the assistance of TATA BP Solar Pvt. Ltd. Apart from the demonstration of the working of the systems; the credit scheme of the Bank for purchase of such systems was also explained in detail. Initially, about 10 units were installed. Soon, other villagers also

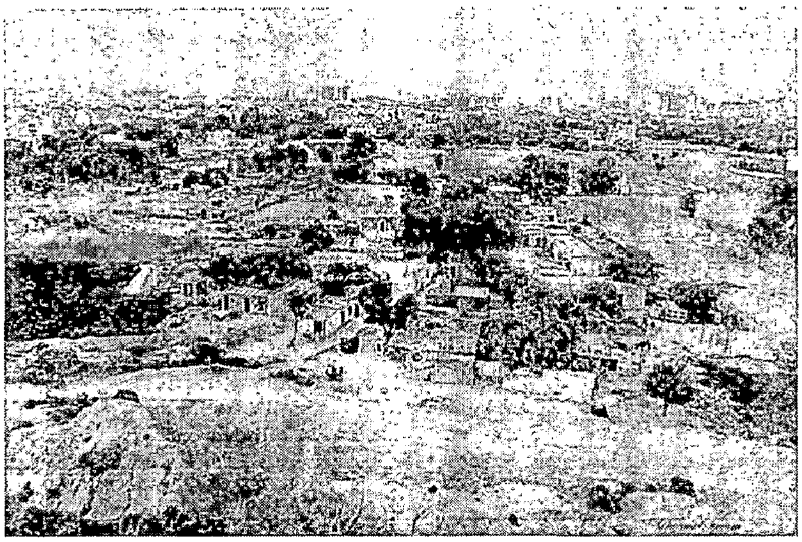


Figure 34: View of Iqbalpur village

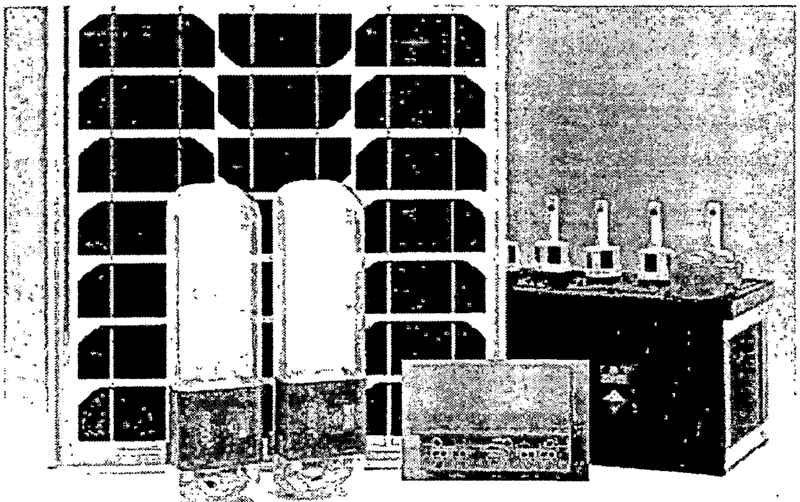


Figure 35: Solar home lighting systems.

came forward to install SHLS with the financial assistance provided by the Sultanpur Branch of GGB. Collateral-free, hassle-free, and without margin credit facility was extended under 'GGB Saur Vidyut Scheme' of the bank. Now every household in the village has installed a SHLS.

CHAPTER 5

PROFILE OF GHAZIABAD CITY

5.1. Regional setting of Ghaziabad:

Ghaziabad is one of the important towns in the National Capital Region. It acts as a gateway to Delhi for all parts of U.P., Bihar, West Bengal, Assam, and other Eastern states. The greatest resources of Ghaziabad lie in its situation at the junction of three important routs coming from Calcutta, Dehradun, and Moradabad.

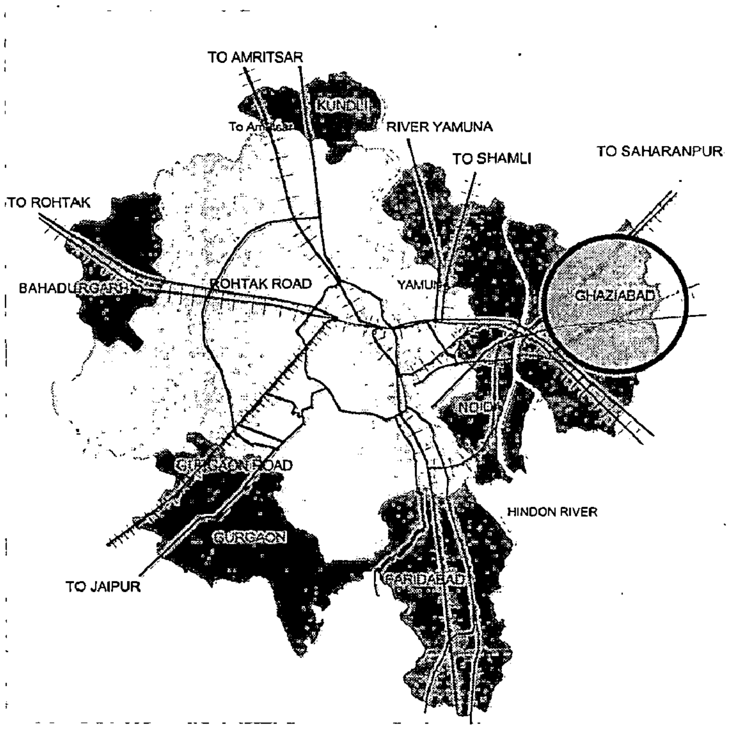


Figure 36: Map of National capital region.

The district is served by rails as well as by roads. The railway track in the district runs to a total length of 172 kms. National Highways account for 84 kms. State Highways 93,64 kms., main district roads 266 kms. and other district roads 298 kms. On an average every thousand sq. km. of area of the district is served by 288 kms. of road length

5.2. Regional Linkages:

- National Highway no. 24 - Delhi, Moradabad, Lucknow,
- National Highway No. 58 - Meerut-Haridwar and Uttranchal and Delhi Bulandshahar, Kanpur highway passes through the town.

- State highway no. 48 connecting the town with Delhi-Shamli, Sharanpur, and Yamnotri passes through the western part of Ghaziabad Developed area.

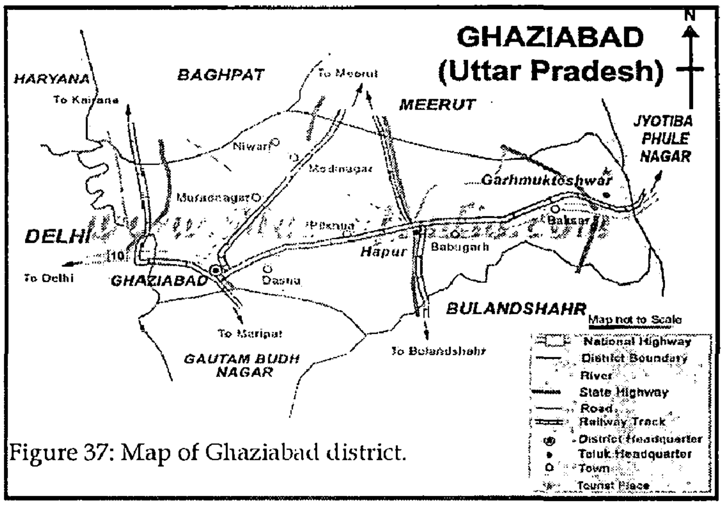


Figure 37: Map of Ghaziabad district.

5.3. Boundary, size and Extent of Area:

The regulated area of Ghaziabad lies in the latitude 28°-35′ to 28°-45′ and longitude 77°-30′ and the East and adjacent to the boundaries of the state of Delhi. This area consists of a large town of Ghaziabad and a number of villages located into the short distance from one another. From the earliest times the origin and growth of Ghaziabad has been linked to Delhi. This has been due to the fact that Delhi has been connected to the East of sub-continent principally through Ghaziabad.

Directions	District/State
North	District Meerut
East	District Jyotiba Fule Nagar
South	District Bulandshahar & Noida
West	Delhi

5.4. Area:

Ghaziabad Master Plan 2001 was formulated for an area of 100.4 sq. km, of which by 2001, about 84.8 sq. km was developed where 60 percent of the land is under residential use followed by industrial areas.

There are no agricultural areas within this development area. The gross density of the population is 130 persons per hectare. The Ghaziabad Master Plan 2021 has been formulated to an area of 155.54 sq. km with 60 wards.

5.5. Demographic Profile:

Ghaziabad is the fastest growing urban center in Uttar Pradesh. It has experienced unprecedented population growth during last forty years. The highest growth rate of population was registered as 124.28% during 1971. High- population growth rate after independence is attributed mainly to the induced development activities in the city region and agricultural development in the adjoining areas as a result of green revolution. The study of Population reveals that from the year 1911 to 1941 there was repaid increase of Population. The reason for population growth in 1941 was due to the emigration of people from rural areas who are attracted to the high standards of living.

After independence, the refugee settled in Delhi or in the nearby areas of Delhi, the reason for further increase in the population. The short distance of 20kms from Metropolitan Delhi affected the whole city. The shortage of Housing and land in Delhi, Leads the population to shift to the nearby areas around Delhi, therefore, a ribbon development is taking place on Delhi - Ghaziabad road. It is noted that location or establishment of large-scale industries in Delhi was discouraged and the Government of Uttar Pradesh established planned industrial estates followed an Industrial friendly policy to attract more industrial activities in the light policies of NCT and NCR. It helped rapid growth of industries in the area during the decade of 70's and 80's. The multiplier effect of these policies was a steep upward movement of population growth. Census data's indicate that population growth was much higher in Ghaziabad than any other town of the state.

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 Govt. to Utter Pradesh also encouraged in developing the city by encouraging industrialization, which has also led to population migration to the city. The total land proposed to be developed at Ghaziabad under the provision of Delhi Master Plan by 1981 was, 3223.62 Hect. For a population of 3,57,000.

Table 7 : Growth of Population in Ghaziabad

Yrs.	Total	Male	Female	U.P. State (Urban) Decadal Growth Rate	National (Urban) Decadal Growth Rate	Ghaziabad Decadal Growth Rate (%)
1901	11275	6205	5070	---	---	---
1911	11304	6346	4958	-8.89	+0.35	+0.23
1921	12343	6791	5552	+0.61	+8.27	+9.19
1931	18831	11003	7828	+12.81	+19.12	+52.56
1941	23834	13457	10287	+26.00	+31.97	+26.57
1951	43745	23687	19878	+22.93	+41.42	+83.54
1961	70438	39014	31424	+9.90	+26.41	+61.02
1971	127700	70033	56567	+30.68	+38.23	+81.29
1981	287170	160382	126788	+60.62	+46.39	+124.88
1991	511000	322000	253000	---	+46.14	+100.22
2001	1040000	583440	45650	---	+36.19	+80.86

Source: Census of India 1991.

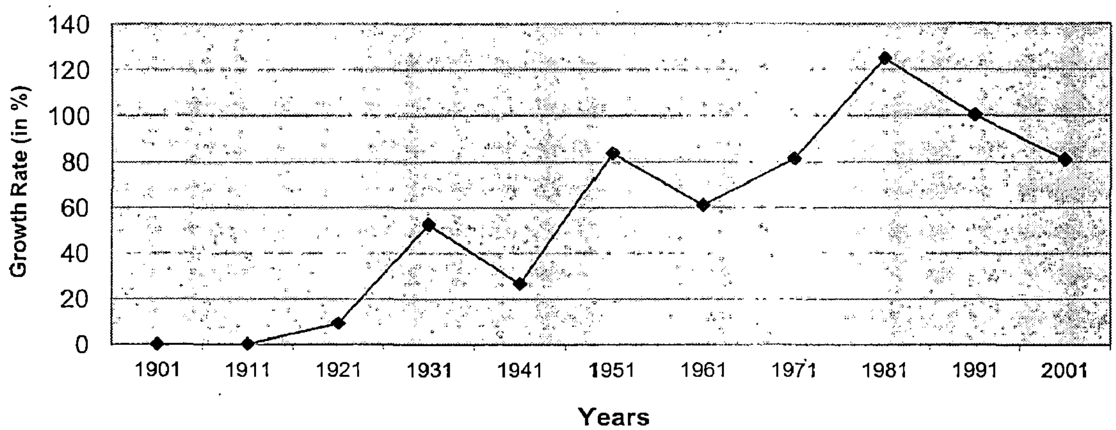


Figure 38: Growth Rate of Ghaziabad (1901-2001)

Table 8 : Population and density

Type	1981	1991	2001	2011
Population	2,87,170	5,11,759	9,68,521	16,36,068
Density (km^2)	4366	7066	5650	5868
Growth Rate%		78.21%	89.25%	66.05%

Source: Statistical outline

The population within the Ghaziabad city showing continuous increase in growth rate and is still growing. The density has decreased in the year of 2001 as the area of the city has spread and new ward were added to the city area in Master plan 2001.

5.6. Land Use

Land use for Master plan 2021

For the year 2021, there is a proposal of 14550 hectare area at the density of 160 people per hectare for the population of 23 laces. Beside present land area approximately 6000 hectare of extra land area has been proposed for development in the proposal. In the proposal, it has been tried to exploit the benefits come out of need of future population and the trends comes out of the future population.

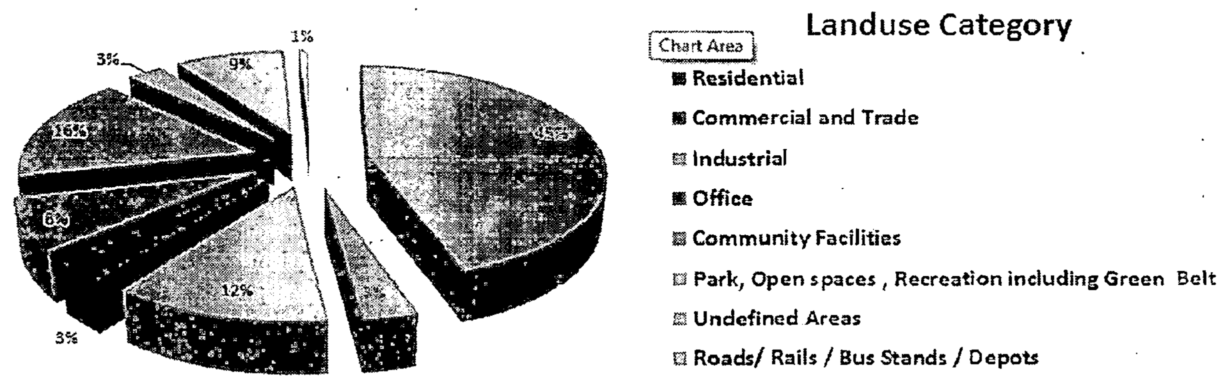


Figure 40 : Land use Category for Master Plan 2021.

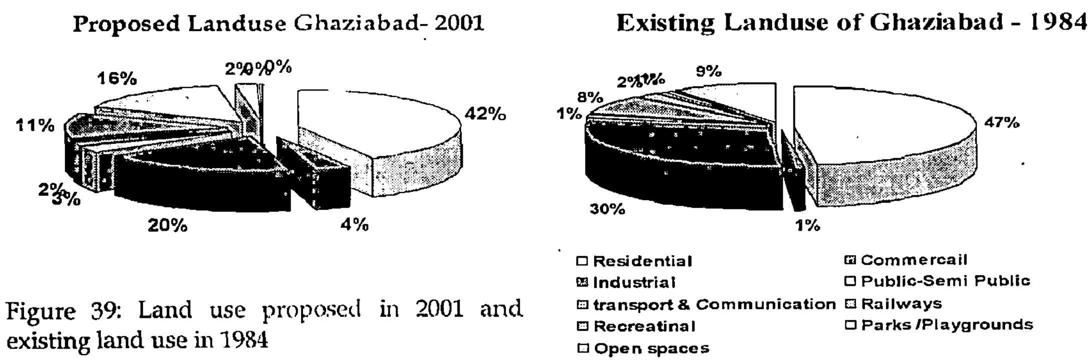


Figure 39: Land use proposed in 2001 and existing land use in 1984

Table 9: Land use comparison between 2001 and 2021

S. No.	Land use Category	Master plan 2001	Master plan 2021	
		Percentage	Area (hectares)	Percentage
1	Residential	42.71	6975	44.84
2	Commercial and Trade	3.58	491	3.16
3	Industrial	19.8	1933	12.43
4	Office	5.55	501	3.22
5	Community Facilities	1.52	1201	7.72
6	Park, Open spaces, Recreation including Green Belt	15.55	2484	15.97
7	Undefined Areas		452	2.91
8	Roads/ Rails / Bus Stands / Depots	11.29	1392	8.95
9	Others		125	0.8
Total		100	15554	100

Comparison between the land use of Ghaziabad city from 1984 to 2001

- Due to Rapid Growth of Population leads to increase in residential land of Ghaziabad
- Due to Proximity to Delhi the Real estate market influenced by Delhi's Land market.
- Built up area of Ghaziabad increase from 534 hectares in 1961 to 7202 hectares in 1989.
- Level of Industrialization is very high.

Comparison between the land use of Ghaziabad city from 2001 to 2021

- Similarly again due to Rapid Growth of Population increase in residential land of Ghaziabad can be observed.

- There has been reduction in other land use percentage of areas except in Residential sector percentage in proposed master Plan of 2021.
- Proposed industrial land use has shown tremendous reduction, due to the fact that industrial development started declining in 1991 and no new industries were set during 1991-2001.
- Within the city limit, there is no agriculture land left, almost all the land is converted into residential or other usage for the development.

5.7. Climate of Ghaziabad City:

The climate of the city is dry and healthy; intensely hot during summer and quite cold during winter. The temperature is highest in May - June. The minimum temperature generally ranges from 7 degree C (January) to 26 degree C (May) and the maximum temperature from around 23 degree C (January) to 42 degree C (May). Westerly hot winds blow with great intensity in these months. The average rainfall is 732 mm and is generally limited to the months during June to September. Dust and thunderstorms occur frequently in summer season while occasionally fog occurs in the winter. Geologically, the town forms a part of the Indo-Gangetic alluvium.

5.8. Energy supply in Ghaziabad city:

5.8.1. Electricity Supplier in the city:

- In Ghaziabad city there is mainly one energy suppliers. Ghaziabad gets electricity from Muradnager 400KV Sub Station, which get power from Northern Grid in Uttar Pradesh.
- Another Sub Station of next category of 220KV is under-construction in Loni.
- Sahibabad Sub Station of 220KV gives supply tor Sub Stations of 132 KV. From there electricity is supplied to the 33/11 KV Sub Stations located at various parts of the city.

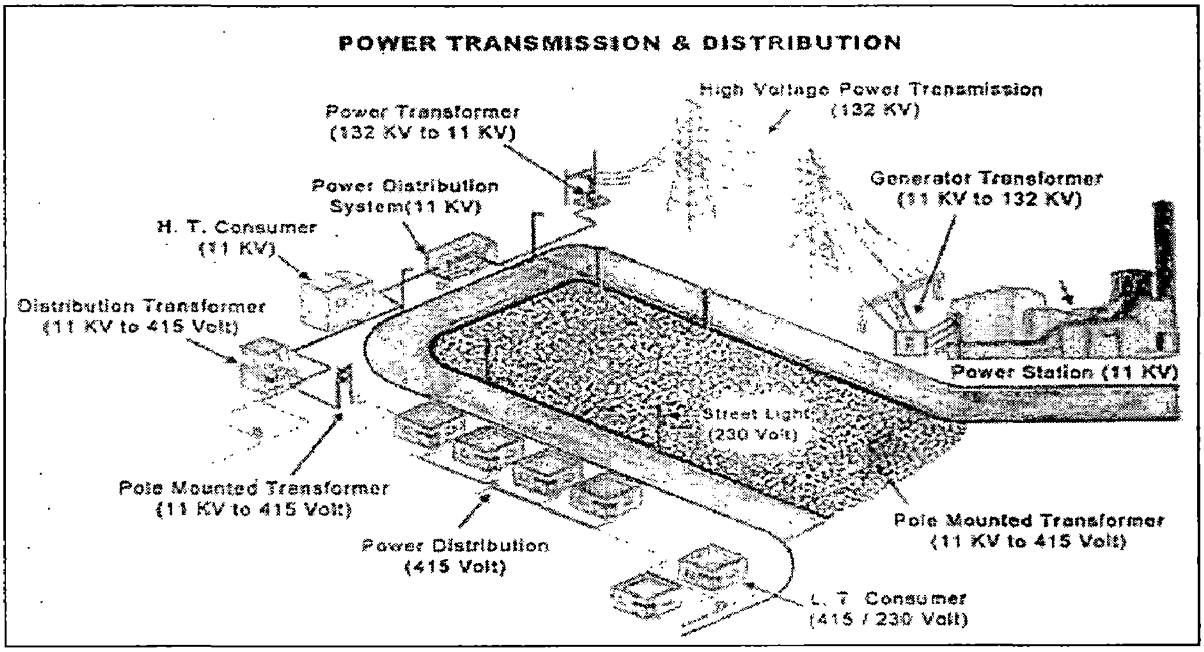


Figure 41: Power transmission and Distribution in Ghaziabad city.

Sub-Station which provide electricity to Residential, Commercial and Industrial sectors in the city are:

- Meerut Road 132KV Sub Station.
- Bulandsheher Road 132KV Sub Station.
- Kavi Nagar Industrial Area 132KV Sub Station.
- 4Mohan Nagar 132KV Sub Station.(Under-construction)
- Loni 132KV Sub Station.
- Vaishali 132KV Sub Station.
- Govindpuram 132KV Sub Station.

Table 10: Number of electrical connections in different sectors.

Sectors	No. in year 1980	No. in year 2003
Residential	36124	1,80,000
Industrial	3062	6,000
commercial	6256	20,000

- According to the total electricity supply in the city, 200 MVA is given to Residential sector, 200MVA to commercial sector, and 400MVA to the industrial sector. This shows that 50 percent of electricity is consumed in the in Industrial sector.

- **Tariff details:**

  1. RESIDENTIAL SECTOR: Rs.1.80 – 2.80 per unit.
  2. COMMERCIAL SECTOR: Rs.4.25 per unit.
  3. INDUSTRIAL SECTOR: Rs.4.25 per unit.

- According to UPPCL 23 percent electricity loss took place during the transmission process.

5.9. Monthly climatic change and its effect on electricity demand.

A study was done to understand monthly climatic variation and its effect on the electricity consumption in Delhi city for 2009.

As we know that Ghaziabad is located in the north-eastern part of National Capital Region, about 20 km east of Delhi. Monthly temperature variation would be same as that of Delhi.

Impact of increase in AT on electricity consumption under three different scenario			
Based Electricity Demand	Year 2009		
	23809		
Month	+1°C	+2°C	+3°C
Jan	-24	-44.5	-63.9
Feb	-7.7	-9.7	-8.8
Mar	32.6	72.1	124.4
Apr	81.1	157.2	227.8
May	52.8	103.3	153.8
Jun	46.5	92.6	134
Jul	48	92.5	132.8
Aug	49.2	97.3	139.9
Sep	51.7	101.1	150.2
Oct	77.2	153.6	230.1
Nov	16	37	68
Dec	-18.5	-31	-10.3

According to National Sample Survey Organization surveys,with increasing electricity access and rising income level, the number of households owning temperature control devices (such as air conditioners and air coolers) is increasing very rapidly in India.

From the study it was found that:

- Higher temperature increases electricity demand in summers (led by April and May), monsoon (led by September) and post monsoons (led by October) and decreases demand in winters (led by January). It is observed that the maximum impact is likely to be felt in the hot month of April with average apparent temperature of 30°C, followed by, October and May.
- The results are displayed in Table 1°C increase in apparent temperature (Apparent temperature is the general term for the perceived outdoor temperature, caused by the combined effects of air temperature, relative humidity and wind speed.) (over average apparent temperature 2000-2009) increases net electricity demand (Net electricity demand increase means increase in electricity demand due to climate warming net of decrease in electricity demand in winters.) by about 405 Million kWh (1.7%) in 2009 over its base electricity demand of 23809 Million kWh.
- Although a 1°C increase in temperature increases net electricity demand by 1.7% in 2009, demand increases by 4.2% in April, by 4% in October, by 2.3% in September and by 2% in May and March. On the other hand, a 1°C increase in temperature decreases electricity demand by 1.5% in January, 0.5% in February and 1.2% in December. Since, electricity saved in winters cannot be stored and used in summers, global warming could result in serious disequilibrium in some of the months in the future[19].

Inferences

The environmental threat arises due to the adoption of energy-intensive solutions in constructing a building and meeting its demands for heating, cooling, ventilation and lighting. However, buildings can be designed to meet the occupant's need for thermal and visual comfort at reduced levels of energy and resources consumption.

[19] Climatic change and demand for electricity, Eshita Gupta, Indian institute of statistics , Delhi

Energy efficiency in buildings can be achieved through implementation of energy efficient building systems and effective utilization of renewable energy sources to power the building.

CHAPTER 6

DEMAND AND SUPPLY SCENARIO OF ENERGY IN STUDY AREA GHAZIABAD CITY

6.1. Electricity Consumption scenario for Ghaziabad City:

With rise in population due to population growth rate and other important factor such as migration, steep rise in demand of power supply is inevitable. PVVNL is responsible for distribution of power in Ghaziabad and also to the other parts of western Uttar Pradesh. In Ghaziabad urban development area electricity is supplied by two Substations of 440 KV, one is in Muradnagar and Greater Noida.

Electrical consumption in Ghaziabad urban area						
Year	Residential (million kwh)	Commercial (million kwh)	Industrial (million kwh)	Other (million kwh)	Total (million kwh)	population
2003-04	568.04	378.69	757.38	189.35	1893.45	11,47,428
2004-05	589.60	393.07	786.14	196.53	1965.34	11,97,097
2005-06	652.44	420.93	820.81	210.46	2104.63	12,48,917
2006-07	677.95	437.38	852.90	218.69	2186.92	13,02,980
2008-09	741.08	463.18	880.03	231.59	2315.88	13,59,383
2009-10	789.72	493.57	937.79	246.79	2467.87	14,18,227
2010-2011	920.36	557.79	1031.92	278.90	2788.96	14,79,619
2011-2012	1055.41	620.83	1117.49	310.41	3104.14	15,44,873

Above table shows the total electricity consumption and sectoral electricity consumption from year 2003 to 2012. In this, from year 2003 to 2012 total electricity consumption has increased by about 170%.[20] Below is the population growth rate scenario of the city.

[20] Pashchimanchal Vidut Vitran Nigam Limited

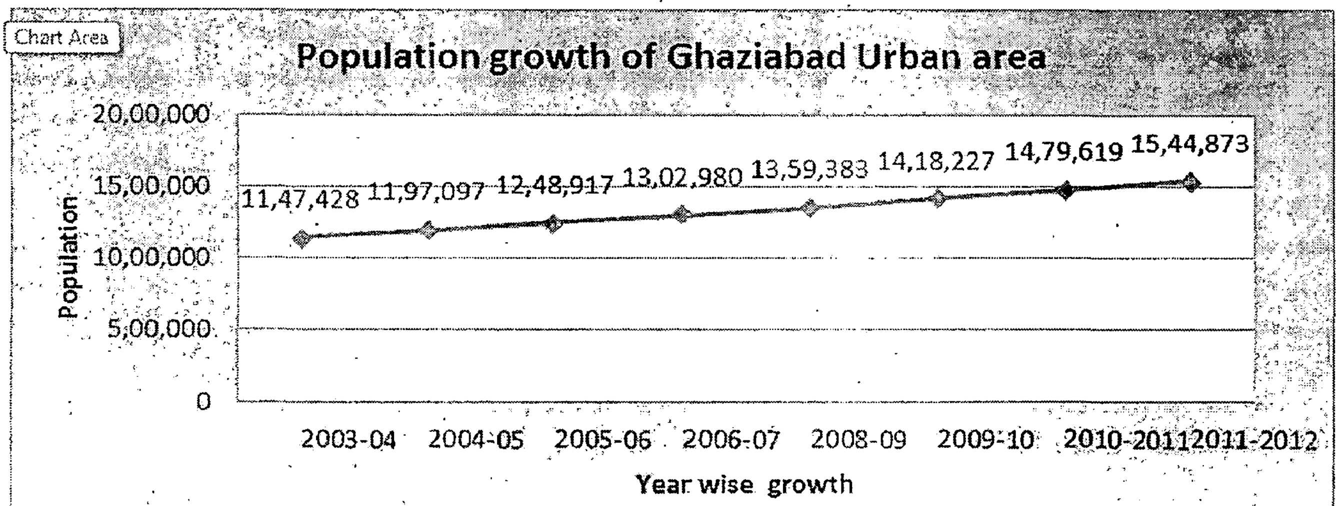


Figure 43: Yearly growth of population in Ghaziabad City.

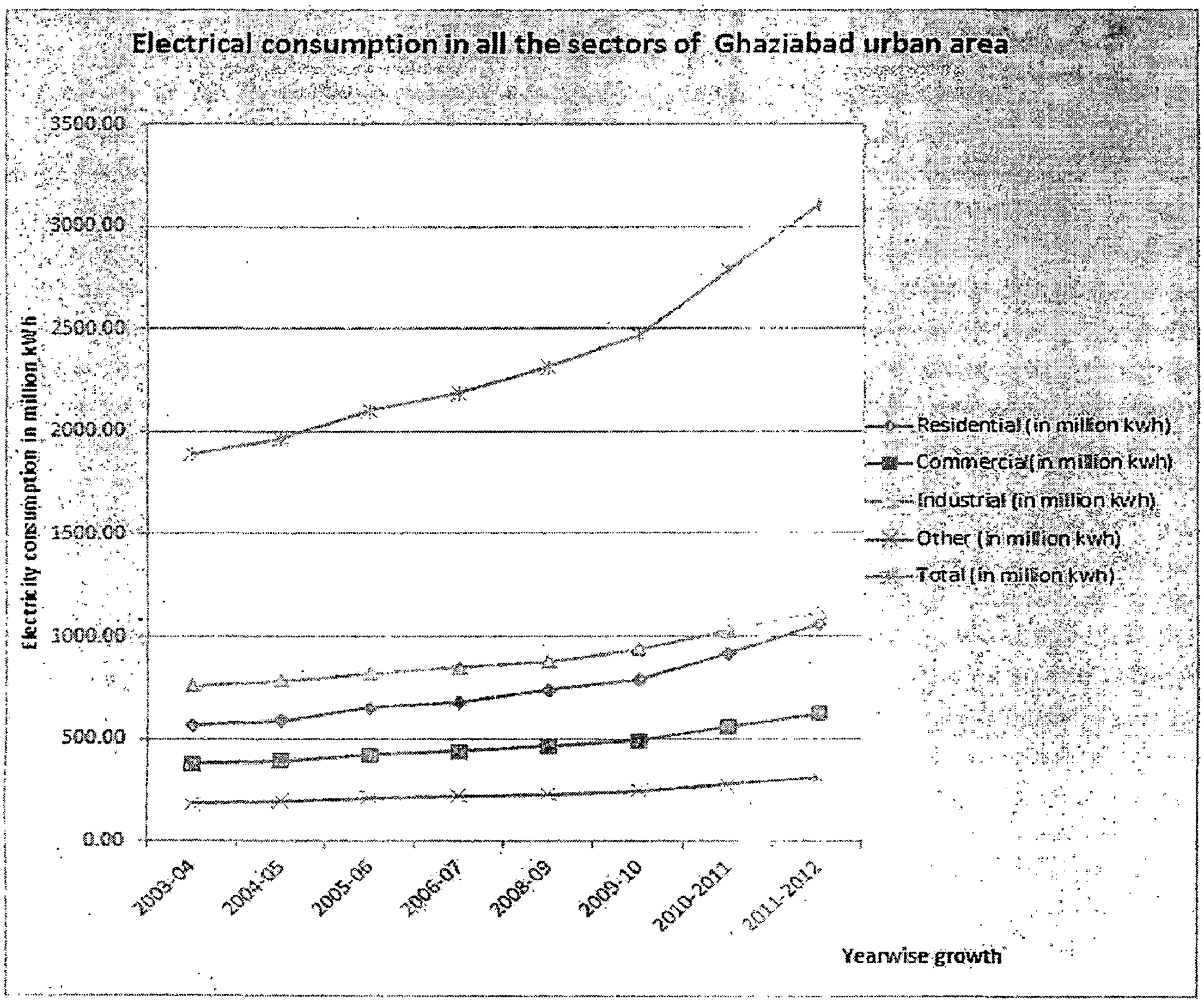


Figure 42: Total electricity consumption in Ghaziabad

The graph shows trend of rising electricity consumption in city from year 2003 to 2012. It shows a sudden increase in last 6 years since some new areas has been developed by GDA in the starting of the decade 2001-2010. Notably these new areas mainly devoted for residential land use. Hence, of all the sectors, residential one has most steep rise and accounts for most of the electricity demand.

6.1.1. Sectoral electricity consumption: Residential area

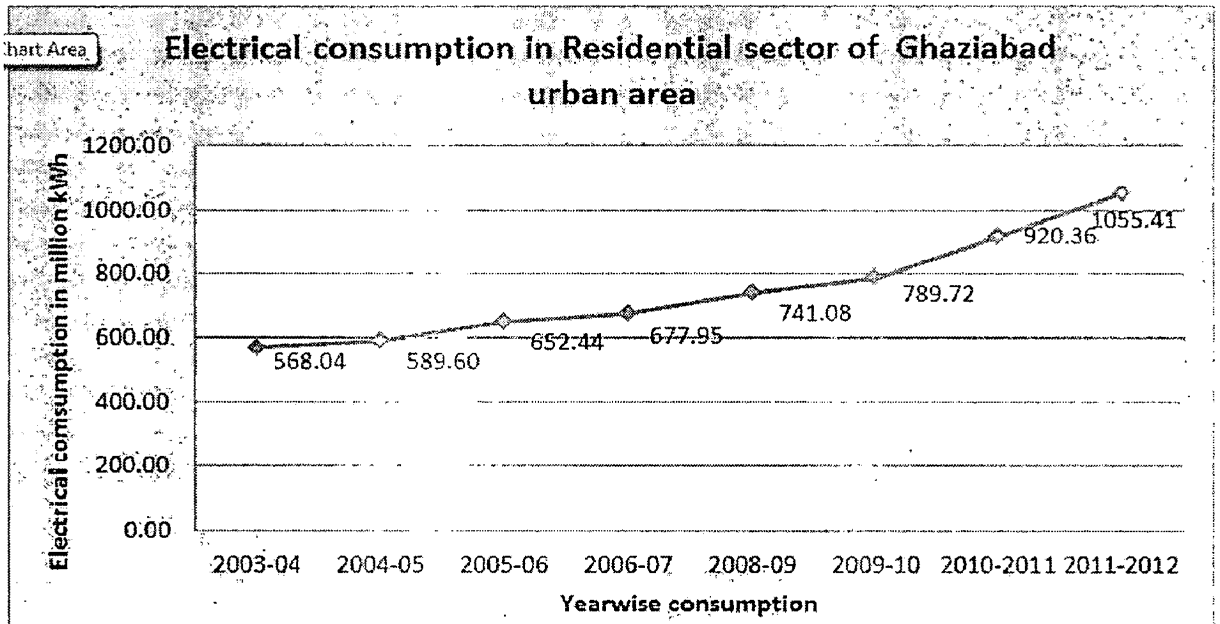


Figure 44: Electricity Consumption in Residential areas

The above graph shows the rising trend in residential areas in Ghaziabad city, mainly due to newly developed residential colonies and housing societies in the current and previous decade.

6.1.2. Commercial areas:

The graph below shows the rising trend in commercial areas in Ghaziabad city, mainly due to population and migration of people to newly developed residential colonies and housing societies in the current and previous decade.

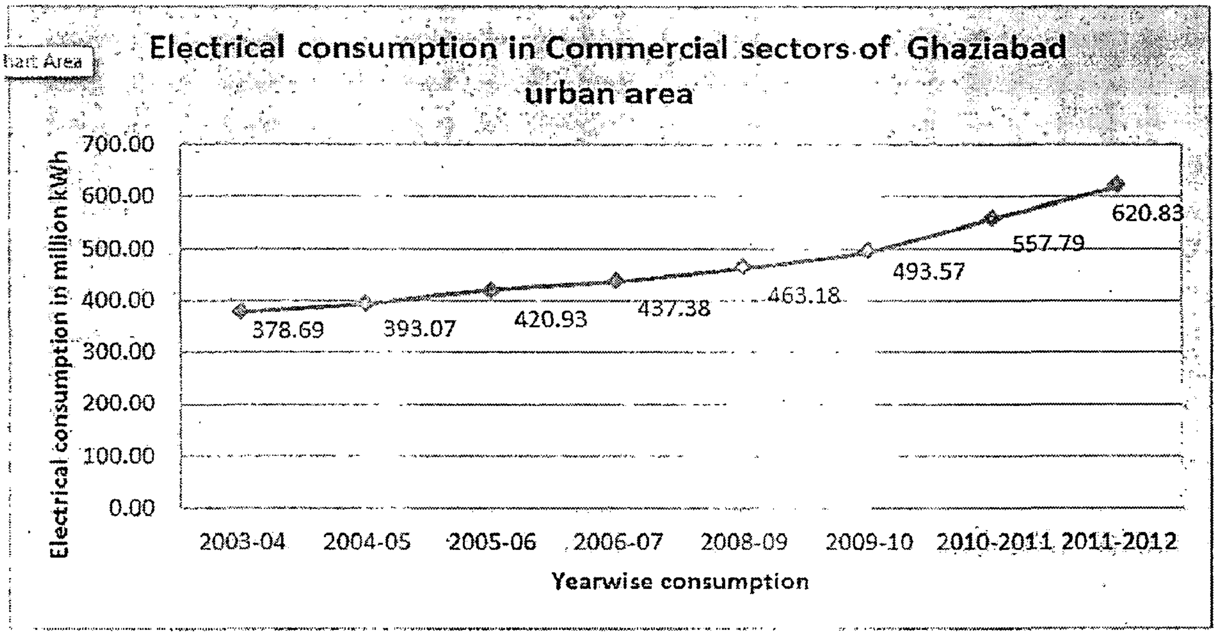


Figure 45: Electricity Consumption in Commercial areas

6.1.3. Industrial areas:

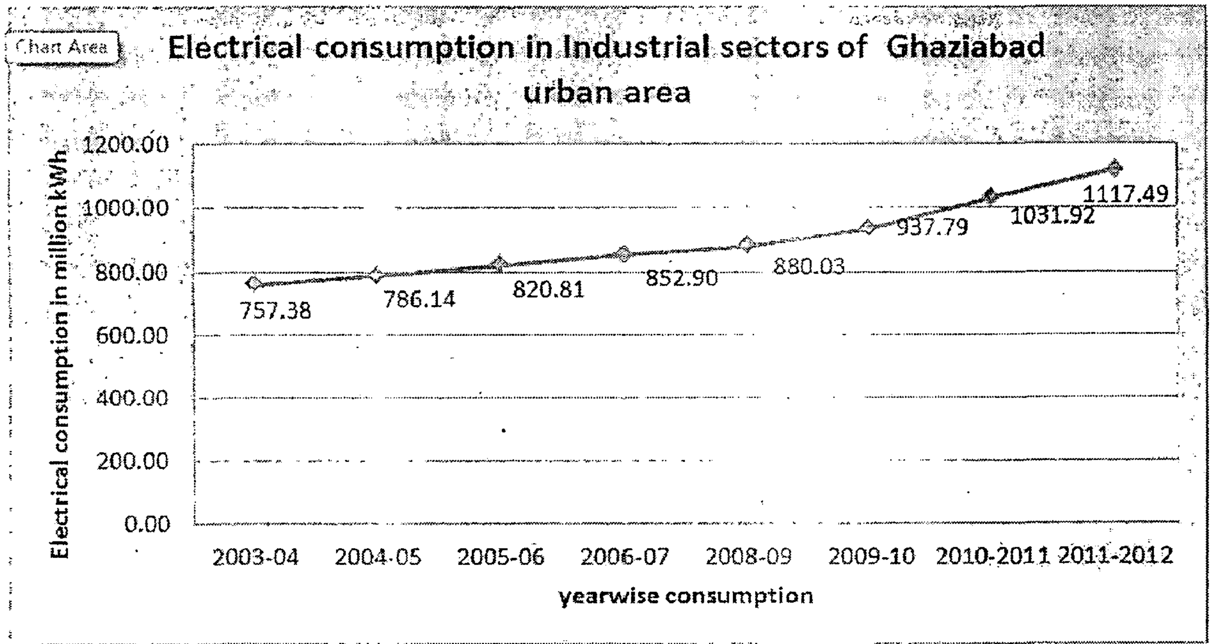


Figure 46: Electricity Consumption in Industrial areas.

The above graph again shows the rising trend in industrial areas in Ghaziabad city

6.1.4. Other areas:

The graph given again shows the rising trend in other areas in Ghaziabad.

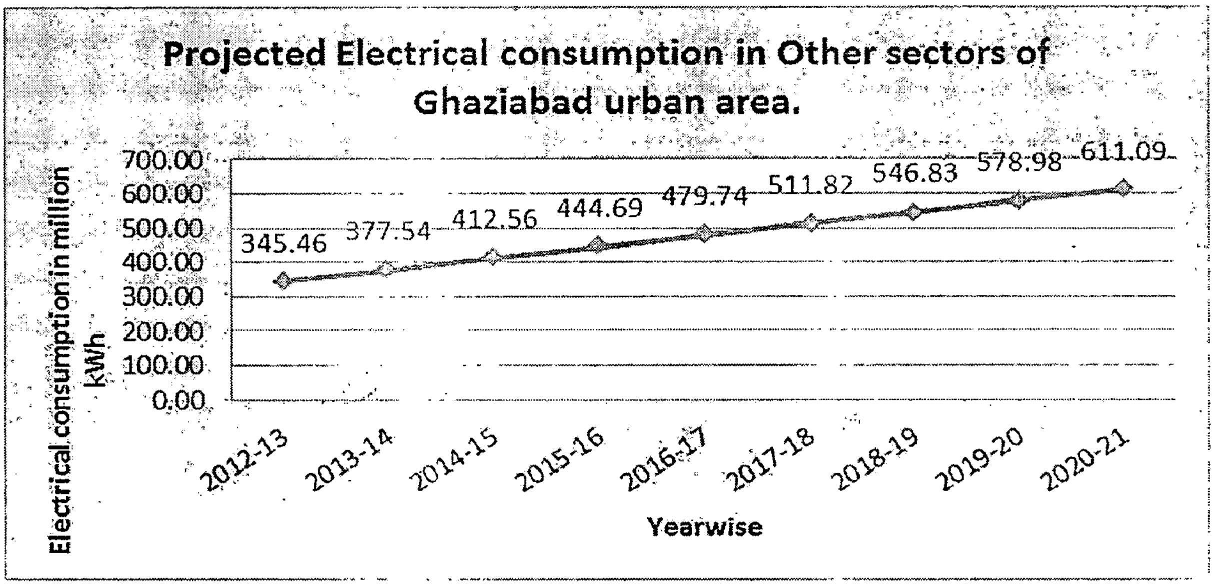


Figure 47: Projection of electricity demand in other areas.

6.1.5. Total projected demand (2021):

Below graph shows the electricity demand from year 2012 to 2021. It is also shows the total electricity consumption in different sectors like residential, commercial, industries and others. For that per capita electricity projection of all sectors has been calculated. The graph again shows the rising trend in all the sectors of Ghaziabad city

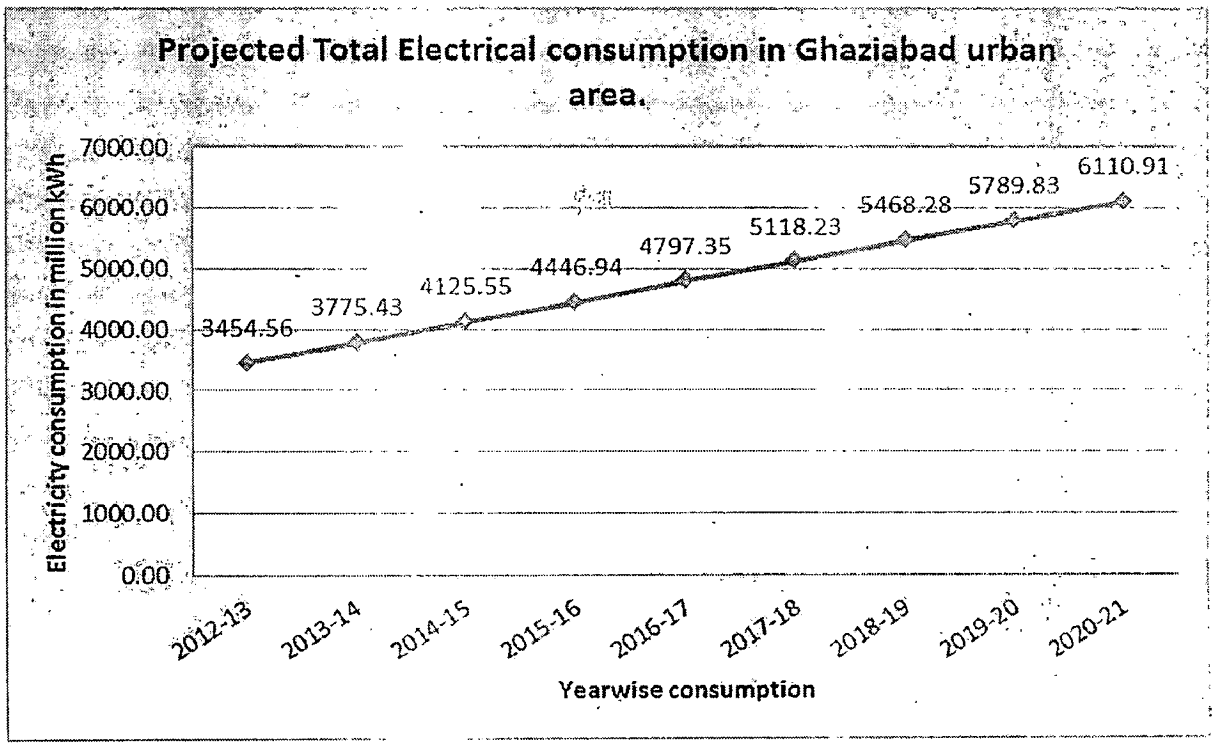


Figure 48: Projection of total electricity demand

6.2. Per capita electricity demand projection:

Graph shows the total per capita electricity demand projection from 2012 to 2021.The trend shows the increasing demand of industries and others are highest.

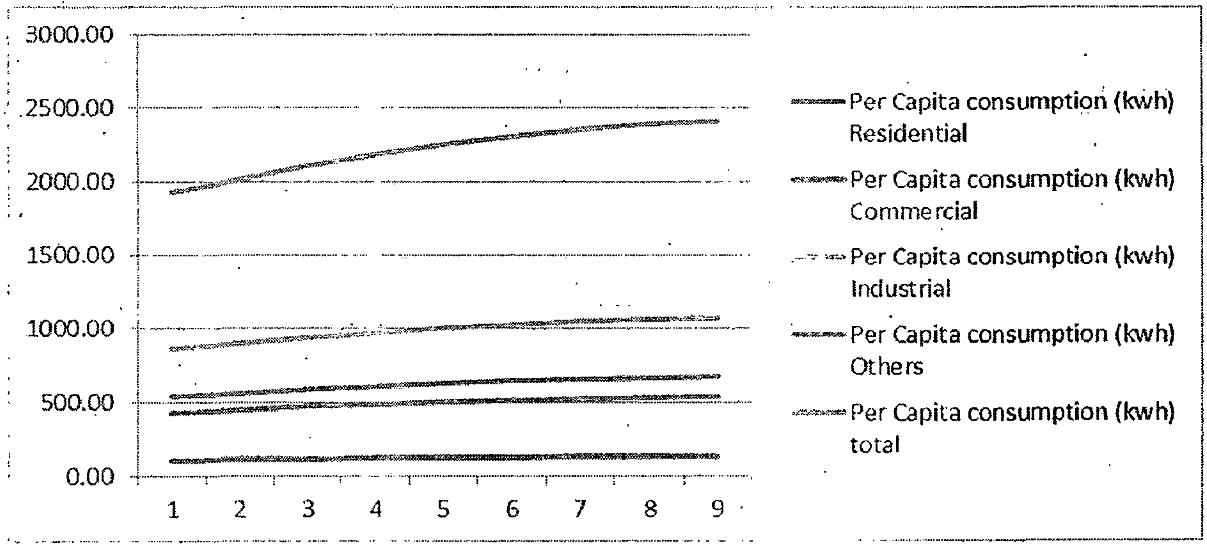


Figure 49: Total per capita electricity demand projection from 2012 to 2021

6.2.1. Per capita electricity demand projection of residential areas:

Graph trend shoes the future electricity demand in residential sector of Ghaziabad city. The times increment from 728.18 kWh to 912.03 kWh could be estimated from the year 2012 to 2021.

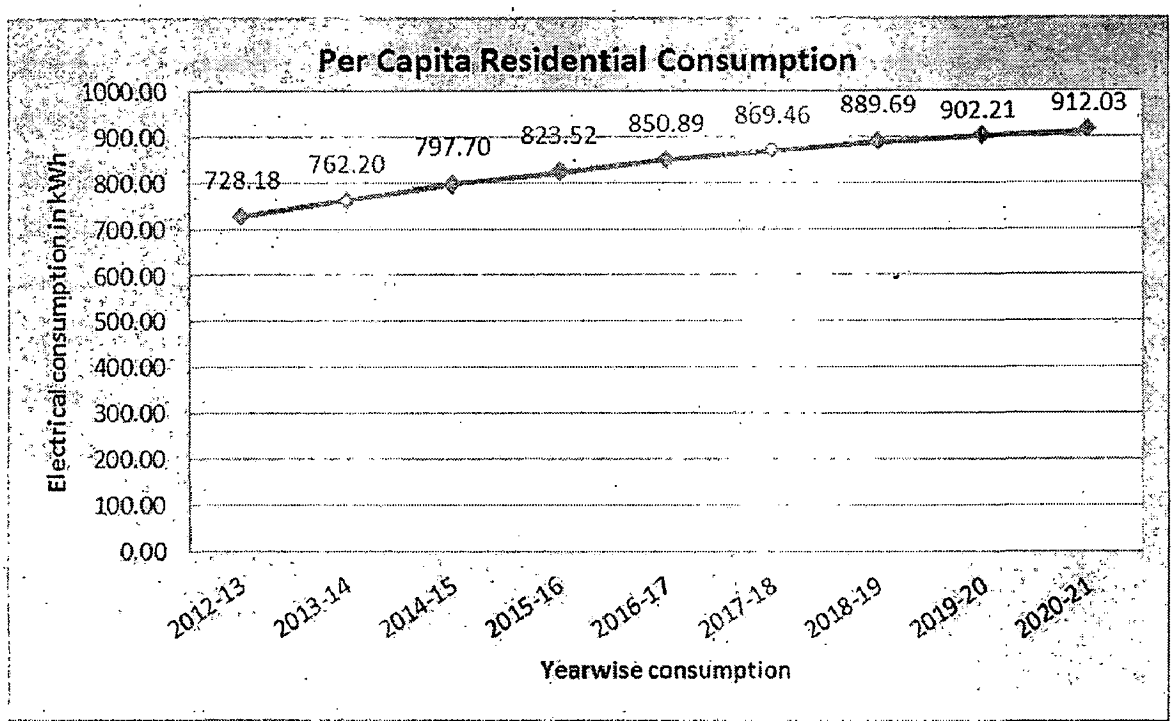
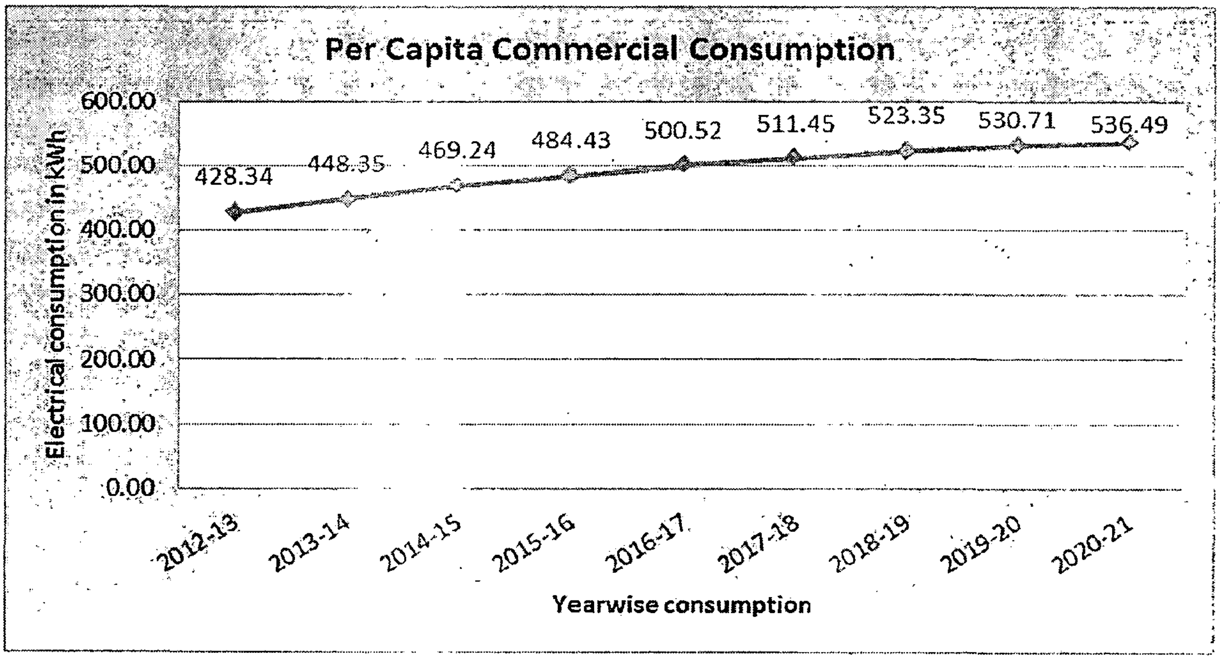


Figure 50: Per capita electricity demand in 2021- Residential area.

6.2.2. Per capita electricity demand projection of commercial areas:

Graph trend shows the future electricity demand in commercial sector of Ghaziabad city. It increases from 428.34 kWh to 536.49 kWh,



6.2.3. Per capita electricity demand projection of Industrial areas:

Graph trend shows the future electricity demand in Industrial sector of Ghaziabad city. It increases from771.9 kWh to 965.67kWh,

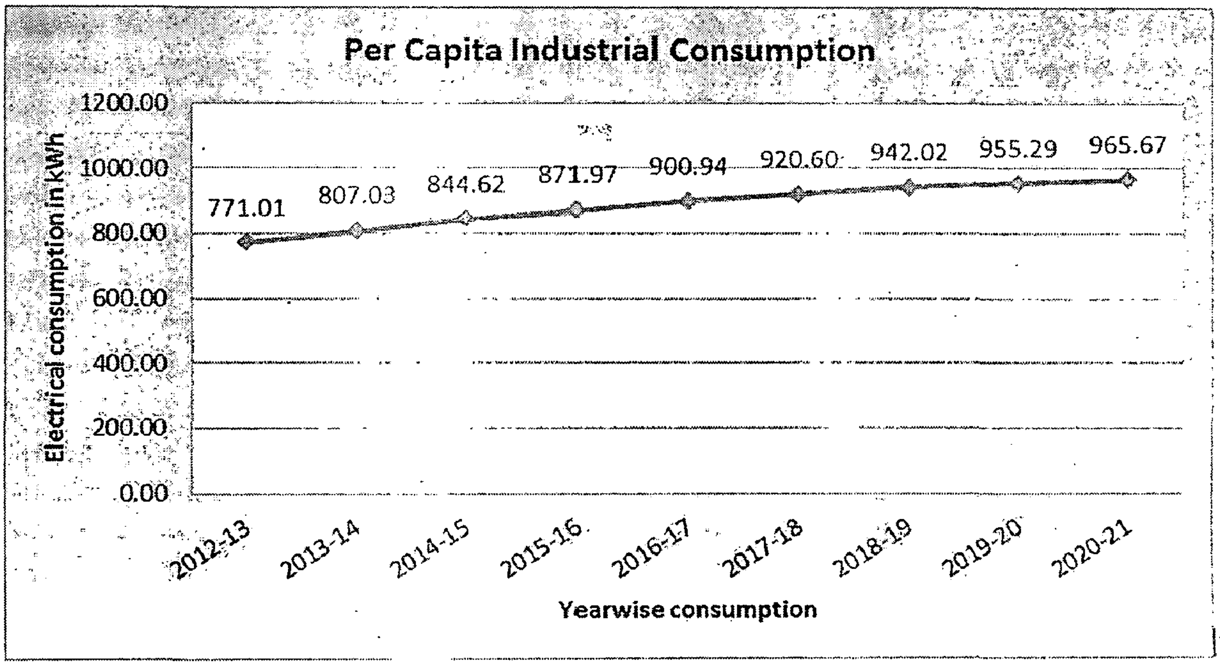


Figure 51: Per capita electricity demand in 2021- Industrial area

6.2.4.Per capita electricity demand projection of other areas:

Graph trend shows the future electricity demand in other sector of Ghaziabad city. It increases from 214.17 kWh to 268.24 kWh,

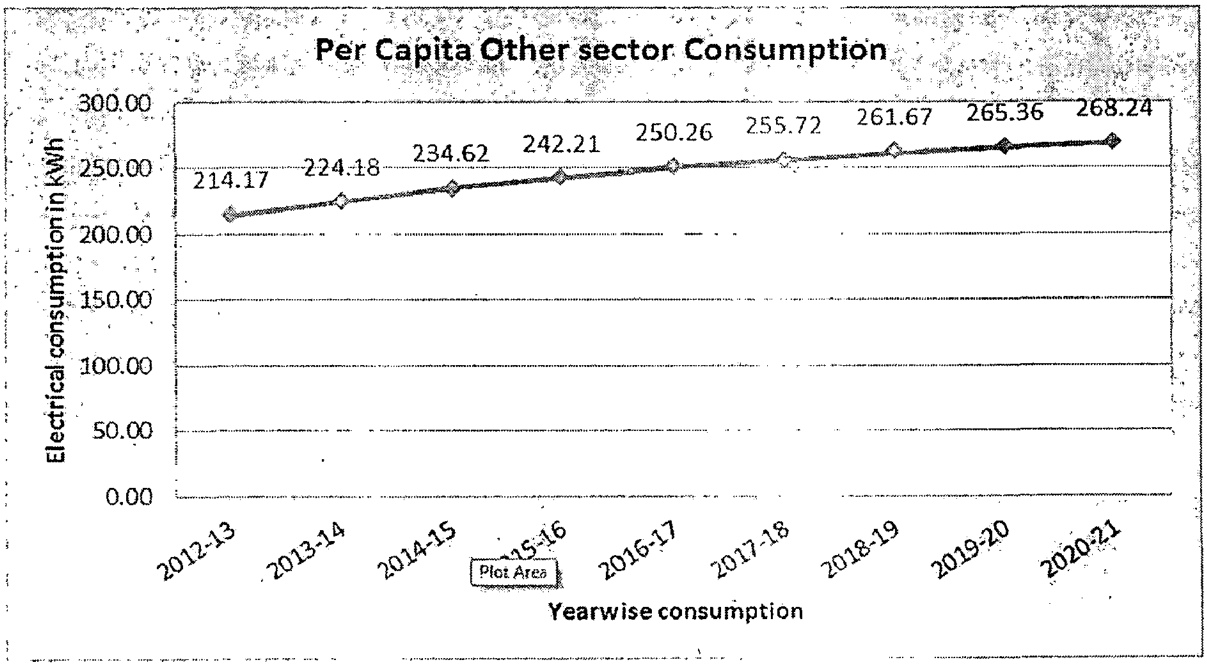


Figure 52: Per capita electricity demand in 2021- other area

6.3. Summary:

Table 11: Summary table of electricity demand

Total Electricity Consumption(million kwh)	Residential	Commercial	industrial	Others	Total
2003	1300	650	2450	30	4460
2021	78162	93586	104605	36012	312365
Per capita electricity consumption (kwh)					
2003	186	78	320	7	471
2021	506	290	998	39	1833

Electricity demand and Supply Gap in Ghaziabad:

Below table shows the demand supply gap of the electricity in future. In which power plant have installed capacity of 1362MW, and generation capacity in recent year is 3,906 million kWh. As shown in the following table there will be a constant demand supply gap irrespective of the power suppliers. Hence, alternative energy sources need to be tapped on. Alternative energy sources have been dealt in detail in the following chapter.

year	Installed capacity MVA	demand in 2021 MVA	Demand-supply gap in MVA
2012	1362	2800	1438

6.4. Inferences

- The above data analysis shows that the from year 2003 to 2012 total electricity consumption has increased by about 170%.
- The graph of Electrical consumption in all the sectors of Ghaziabad urban area shows trend of rising electricity consumption in city from year 2003 to 2012. It shows a sudden increase in last 6 years since some new areas has been developed by GDA in the starting of the decade 2001-2010. Notably these new areas mainly devoted for residential land use. Hence, of all the sectors, residential one has most steep rise and accounts for most of the electricity demand.
- The rising trend in residential areas in Ghaziabad city, mainly due to newly developed residential colonies and housing societies in the current and previous decade.
- The rising trend in commercial areas in Ghaziabad city, mainly due to population and migration of people to newly developed residential colonies and housing societies in the current and previous decade.
- The rising trend in industrial areas is not as much greater as that of residential areas as growth in the sector has not been registered for last 10 years (as stated in the master plan).

- The rising trend in other areas is a reflection due to cater the need of increased residential development.

- Ghaziabad has been facing power shortage for many years now, but in the past couple of years the situation has deteriorated due to mushrooming of residential colonies and apartments in areas like Kaushambi, Vaishali, Vasundhara and Indirapuram adjoining Delhi. Thousands of flats have come up in these areas but the power supply situation remains the same, leading to massive shortage.

- However, the power crisis in Ghaziabad has been aggravated due to uncontrolled construction activities going on in the city. The Power Department has refused to grant new connections to upcoming projects as the local supply network is unable to take any more load.[21]

6.5. Future demand projection for year 2021:

- The rising trend in residential areas in Ghaziabad city will continue, mainly due to newly developed residential colonies and housing societies in the current and previous decade.

- The rising trend in commercial areas in Ghaziabad city, mainly due to population and migration of people to newly developed residential colonies and housing societies in the current and previous decade.

- The rising trend in industrial areas in might get a boost, if proposed land areas for industrial land use function as per desire.

- The total per capita electricity demand projection from 2012 to 2021 shows the demand of industries among the others is highest

21

- The future per capita electricity demand in residential sector of Ghaziabad city increases from 728.18 kWh to 912.03 kWh.
- The future per capita electricity demand in commercial sector of Ghaziabad city increases from 428.34 kWh to 536.49 kWh.
- The future per capita electricity demand in Industrial sector of Ghaziabad city increases from771.9 kWh to 965.67kWh,
- The future per capita electricity demand in other sectors of Ghaziabad city increases from 214.17 kWh to 268.24 kWh,
- The demand supply gap of the electricity in future seem to get widen as power plant have installed capacity of 1362MW, and generation capacity in recent year is 3,906 million kWh.
- There will be a constant demand supply gap irrespective of the power suppliers. Hence, alternative energy sources need to be tapped on. Alternative energy sources have been dealt in detail in the following chapter.
- Based on the above projection, the existing demand supply gap is only to get widen if we continue to use energy on the current trend. It is not possible to cut energy use at end level without understanding the very nature of energy generation or energy cycle.
- Hence, to lessen the demand supply gap, we not only have to reduce the exiting demand, but to use the available energy efficiently and to reduce dependence against non-renewable resources by opting renewable energy.

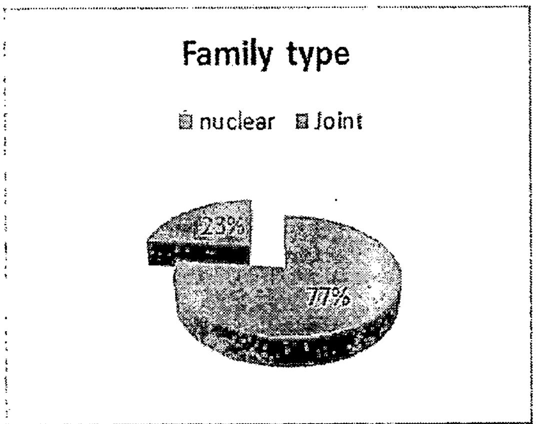
6.6. Residential sector survey

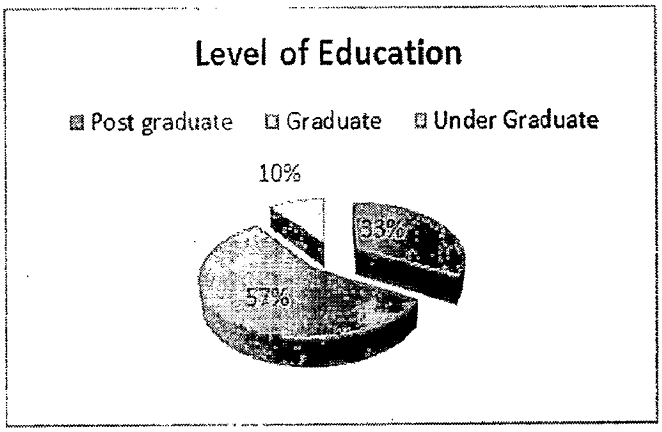
As per the mentioned study and finding, the major consumer of energy is the industrial sector which is followed by transport, residential, and commercial sector. Considering the scope of the study is limited to residential and individual household, it is important to focus our study on this sector for our motive because unlike other sector, the use of energy is controlled by more no. of people in this sector.

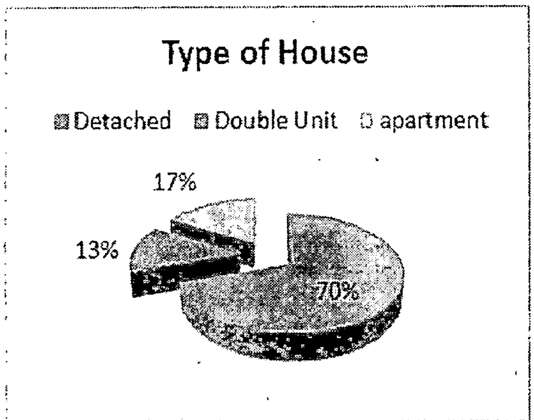
6.6.1. Impact of socio-psycho-economic condition of household on Energy usage

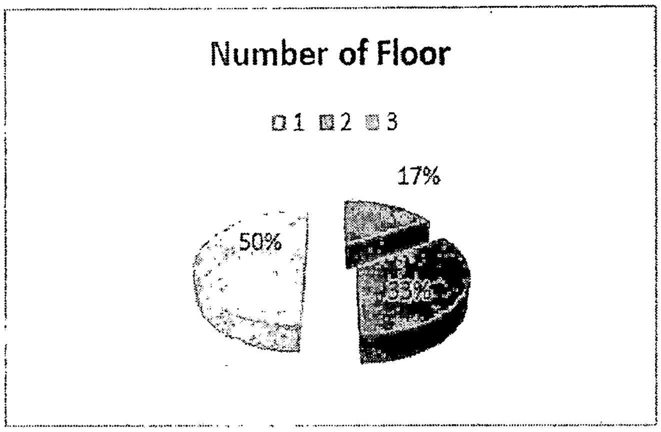
Study is done to understand the pattern of energy usage in residential household. How it is affected by various parameters such as construction and type of dwelling unit, economical condition of household, no of electrical appliances in the house, their power rating etc.

A survey has been conducted to analyze above virtue and it has been tried to establish a relation between various parameter to see whether there is a connection in between. The sample size of the survey was 60 families located in a posh colony of

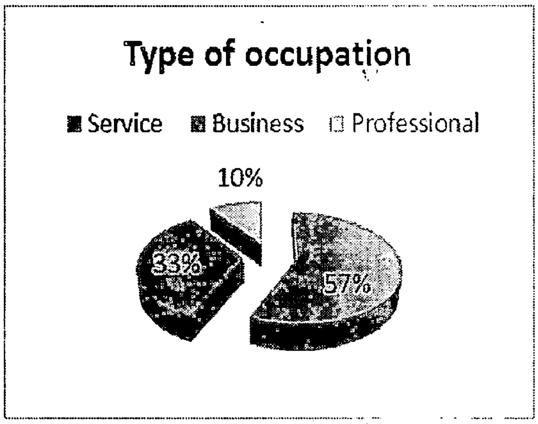








Ghaziabad. The survey has addressed questions about the households such as no. of electrical appliances in a house, house area; size of household, occupation of the family, level of education etc. It also includes the questions to know the awareness of the people towards climate change, energy, environment and building. **Profile of Surveyed people**



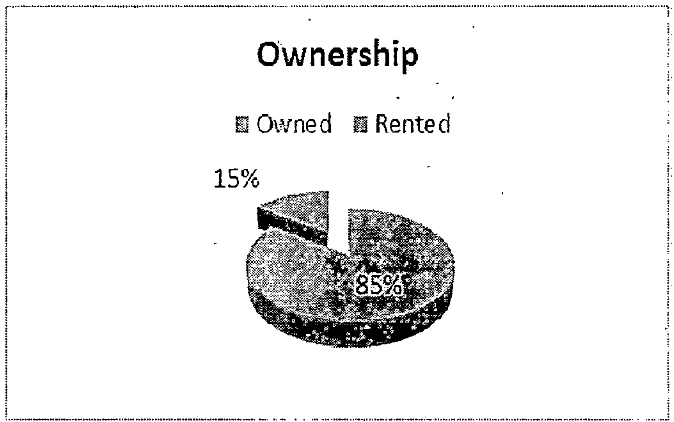


Figure 53: Profile of surveyed household

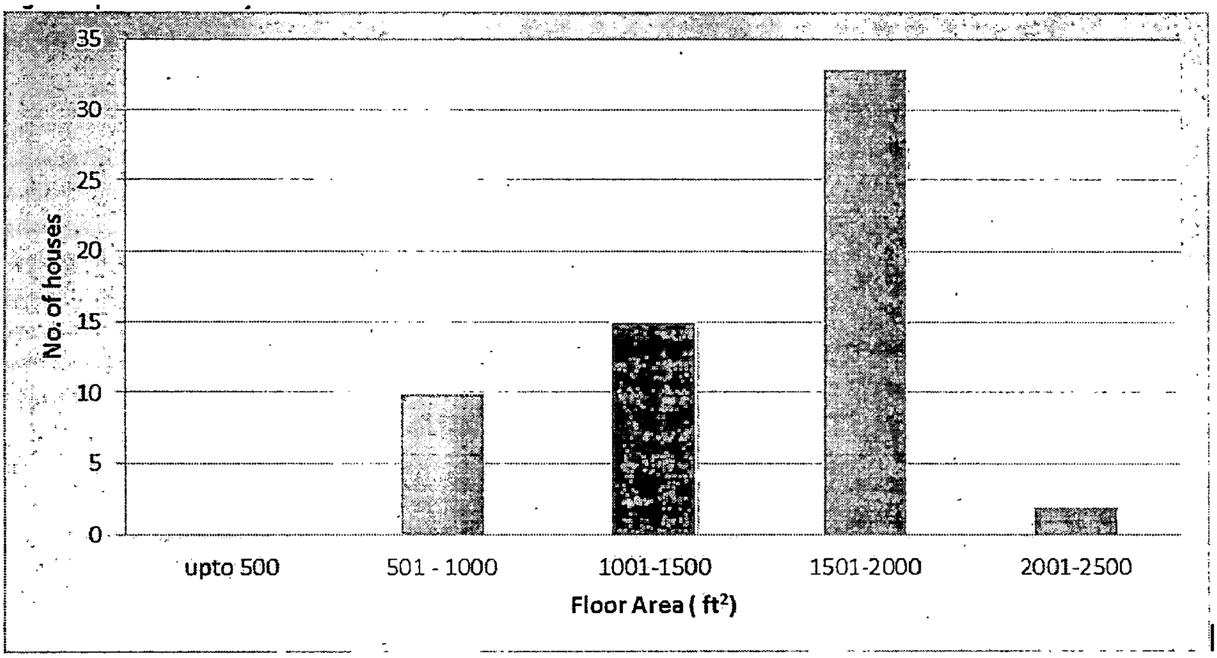
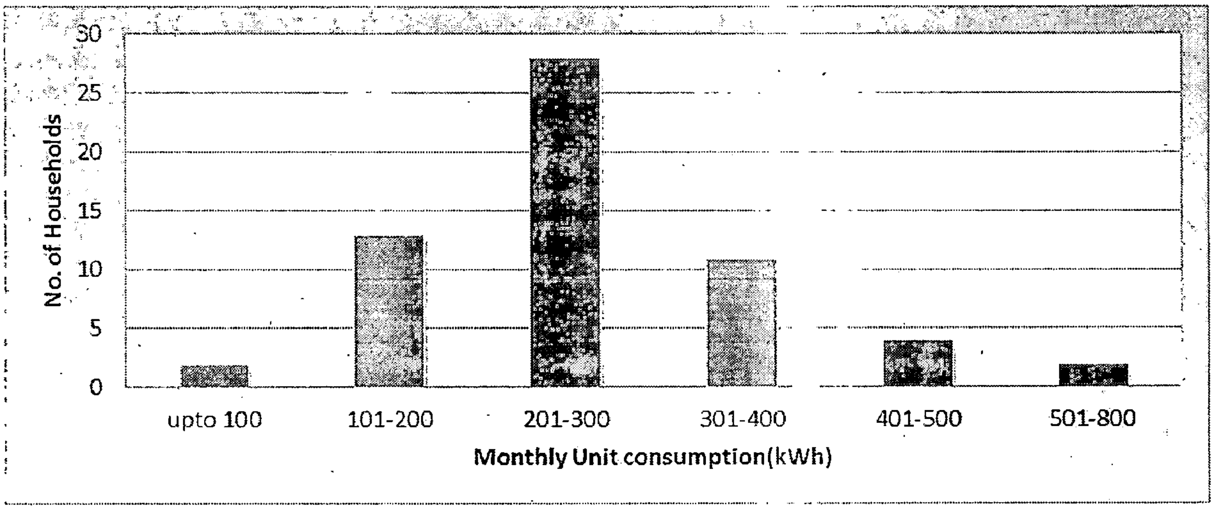
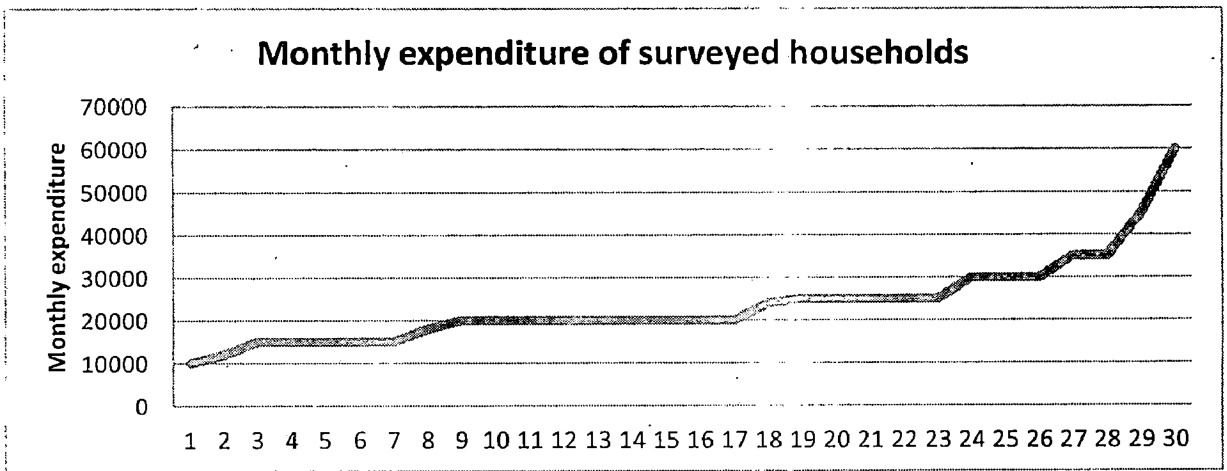


Figure 54: Floor area analysis of surveyed household



6.6.2. Role of economic condition on household energy usage:

The graphs represent the relation between the monthly household expenditure and monthly energy consumption.



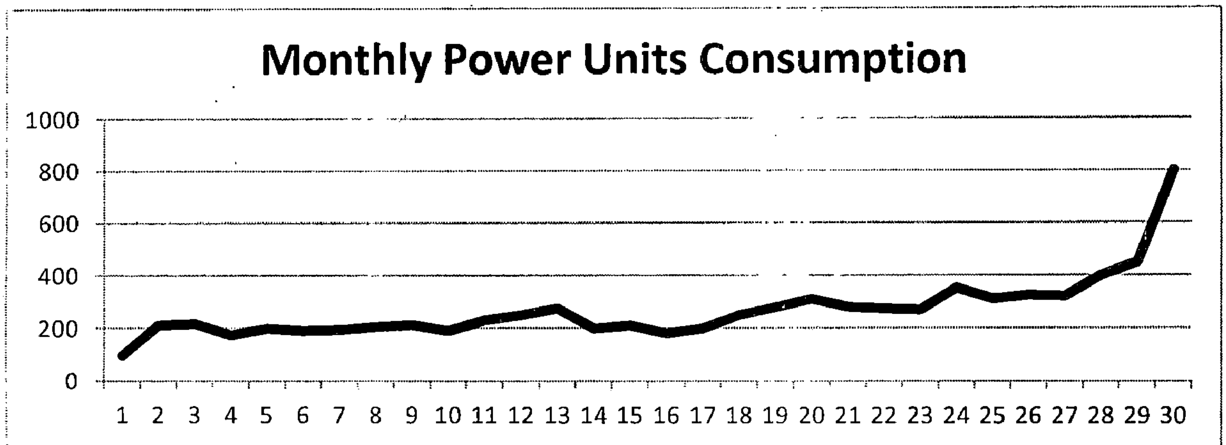
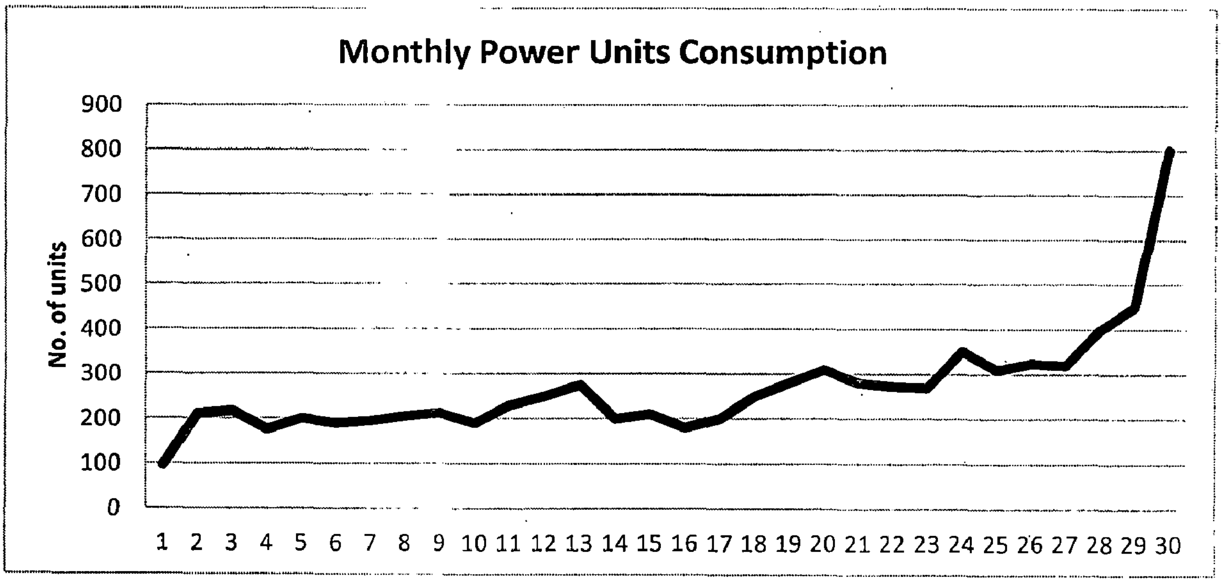


Figure 55: Relation between monthly energy consumption and monthly household expenditure

While the varying figures in power units is obtained for the same expenditure group, the energy consumption graph overall is proportional to the monthly expenditure of the household.

Role of household size on household energy usage

The next two graphs represent the relation between the household size and the monthly energy consumption. The graph however represents no direct relationship between these two factors. It also establishes the fact that individual habits are the controlling factor for energy consumption.



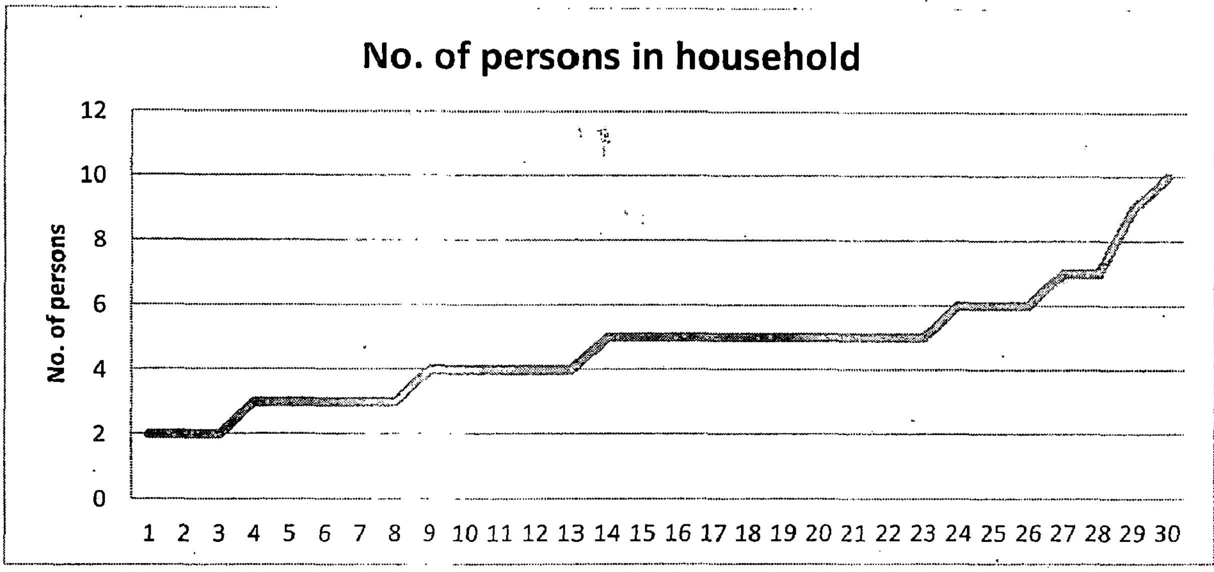


Figure 56: Relationship between monthly energy consumption and Household size

Role of floor area on household energy usage

The following graph represents the link between the floor area of the house and the monthly energy consumption. The results show a direct relation between floor area and energy consumption. However variation is found in energy consumption for same floor area but on whole, energy consumption is found proportionately increasing with increased floor area. It can be understood that the more the no. of rooms, there will be more no. of power points and hence more points to drain electricity.

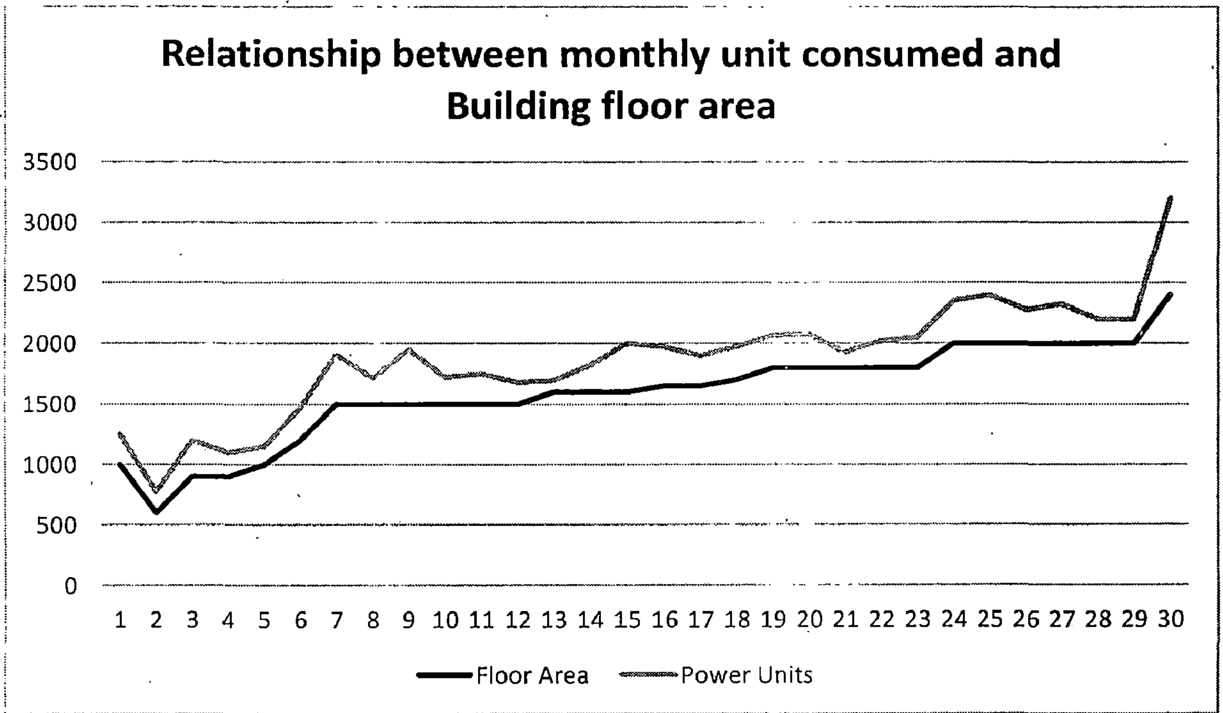
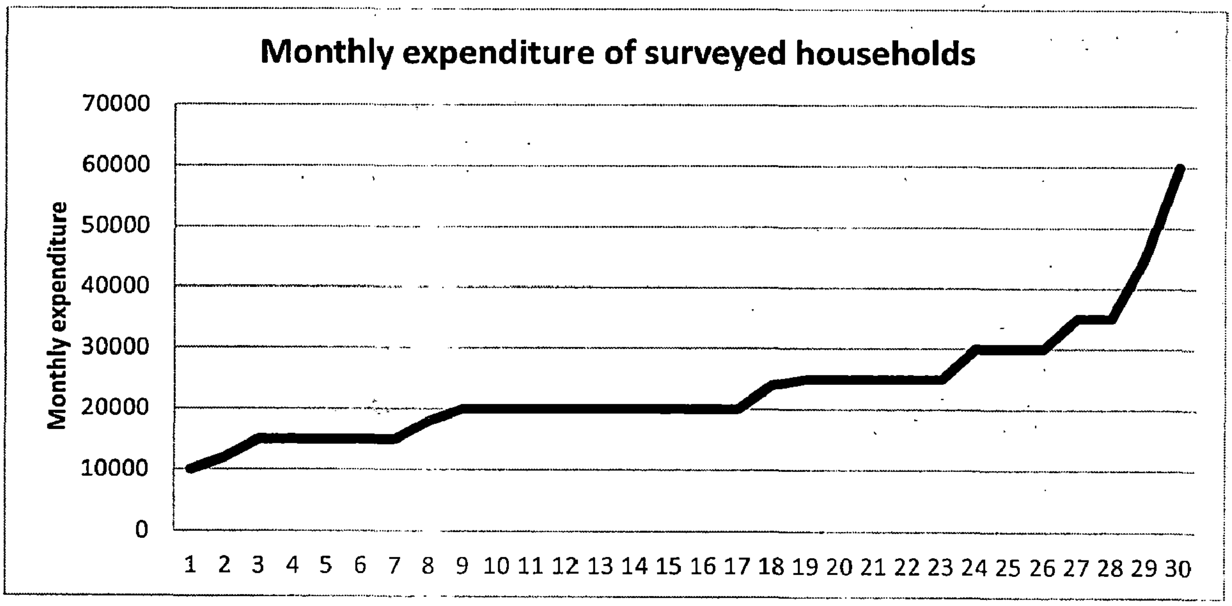


Figure 57: Relationship between floor area and monthly energy consumption.

Role of economic condition on number of appliances in household

The following graphs represent the link between the economic condition of the household and number of appliances. The results show that as the monthly expenditure is increasing the number of appliances owned by that particular household is also increasing. However variation is found in monthly expenditure for same house hold and the number of appliances owned but on whole, monthly expenditure is found increasing with increasing number of electricity appliances in households.



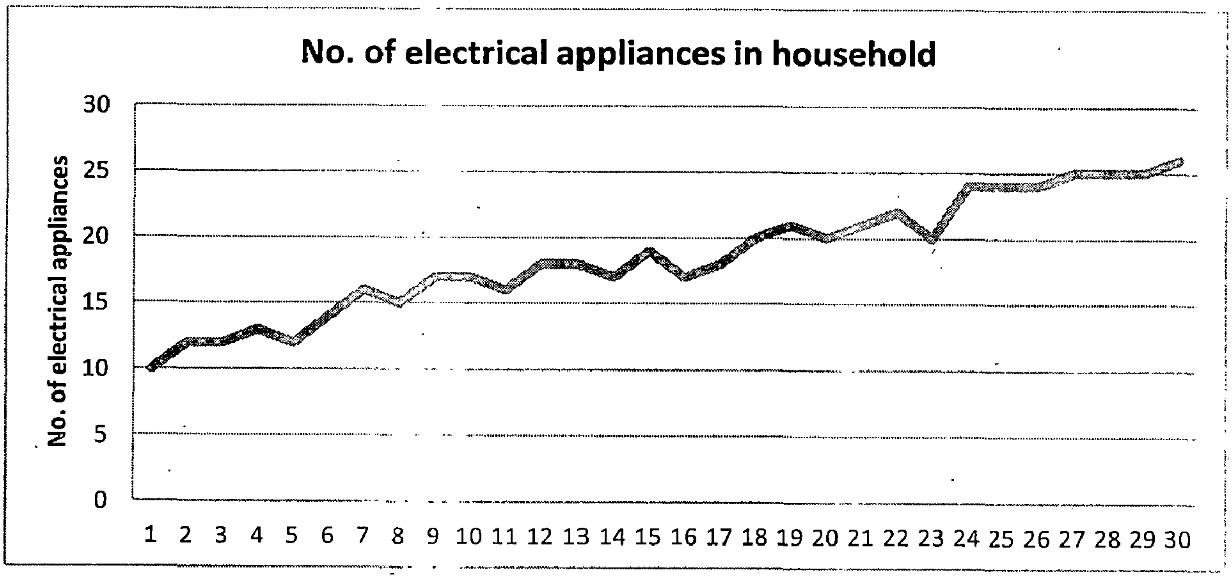


Figure 58: Relationship between monthly expenditure and number of appliances owned by the household

6.7. People awareness towards Energy, Building and Energy Efficiency

Following graphs below displays the result of the survey which is conducted to know the people's attitude and awareness towards building's energy consumption.

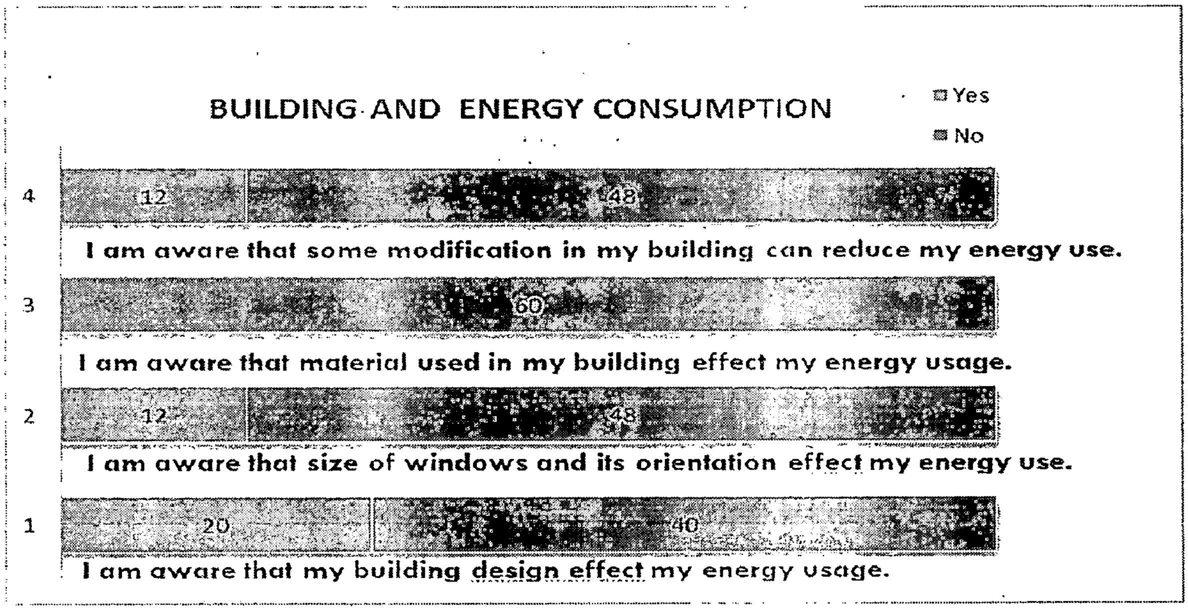


Figure 59: Building and energy Consumption

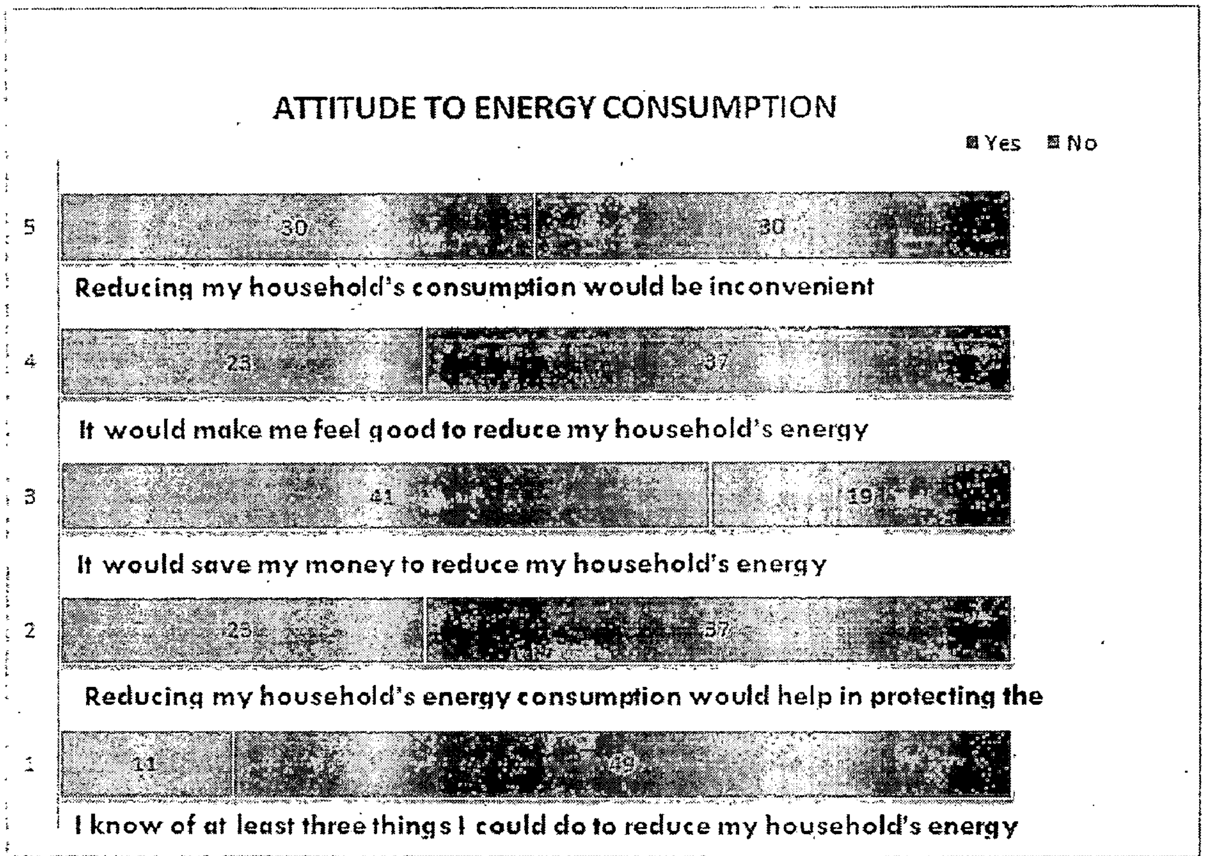


Figure 60: Attitude towards energy consumption.

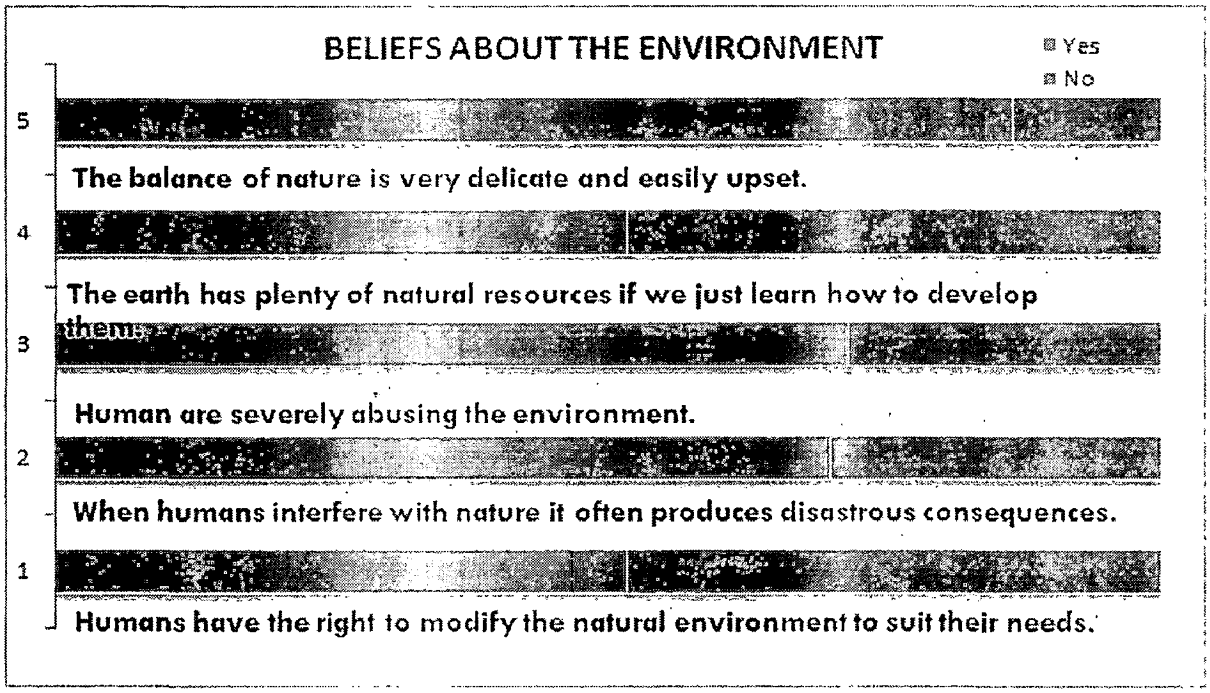


Figure 61: Beliefs about the environment

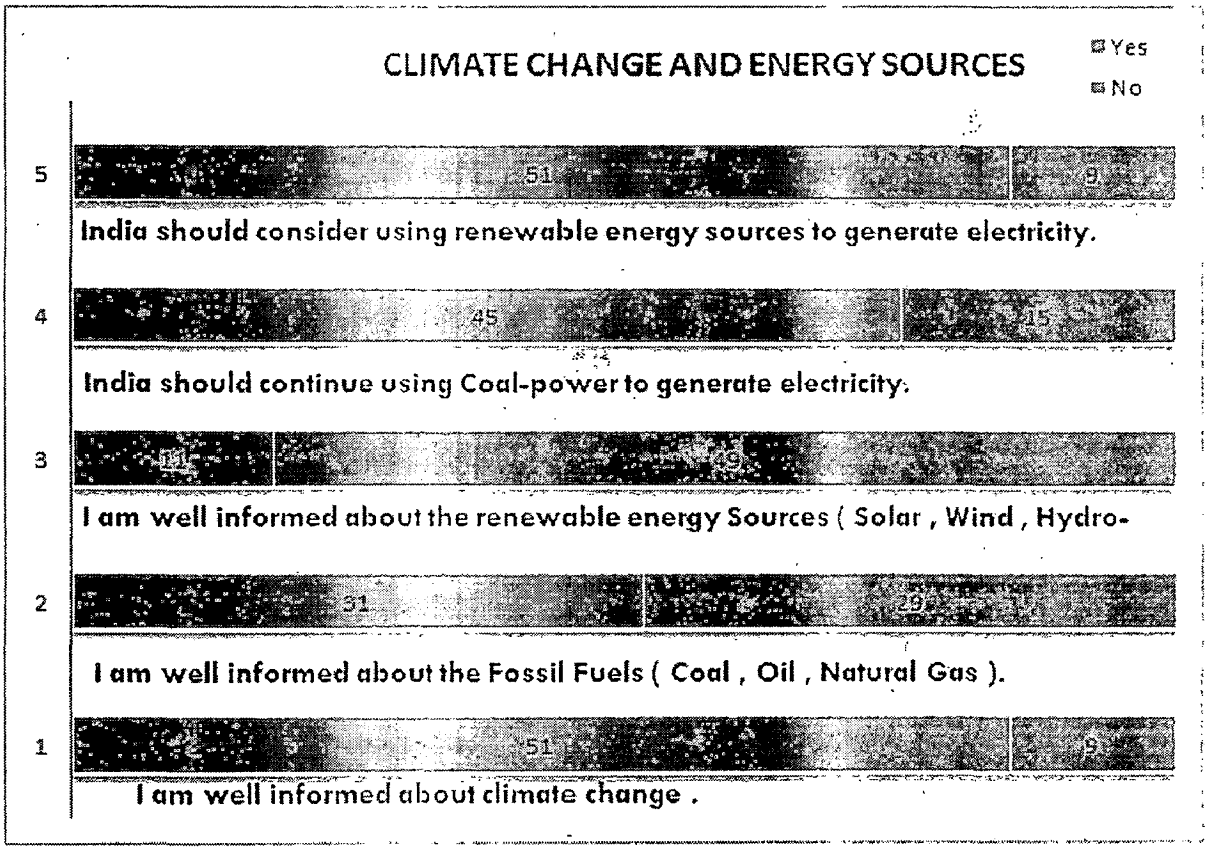


Figure 62: Climate change and energy.

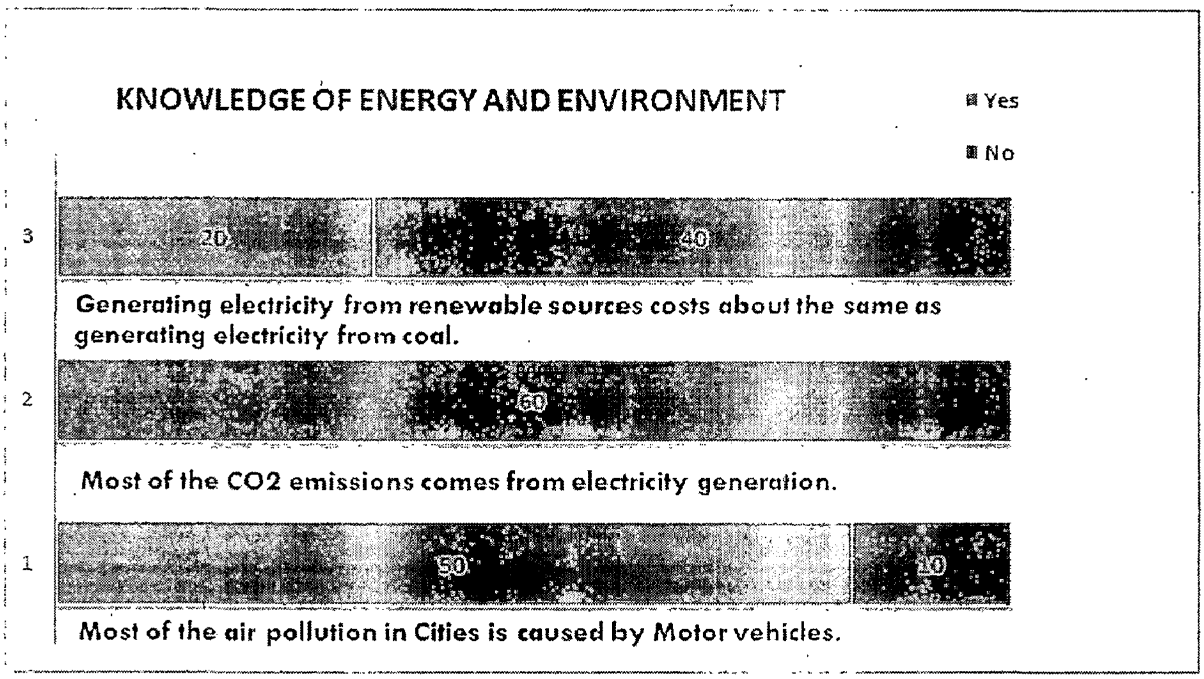


Figure 63: Knowledge of energy and environment.

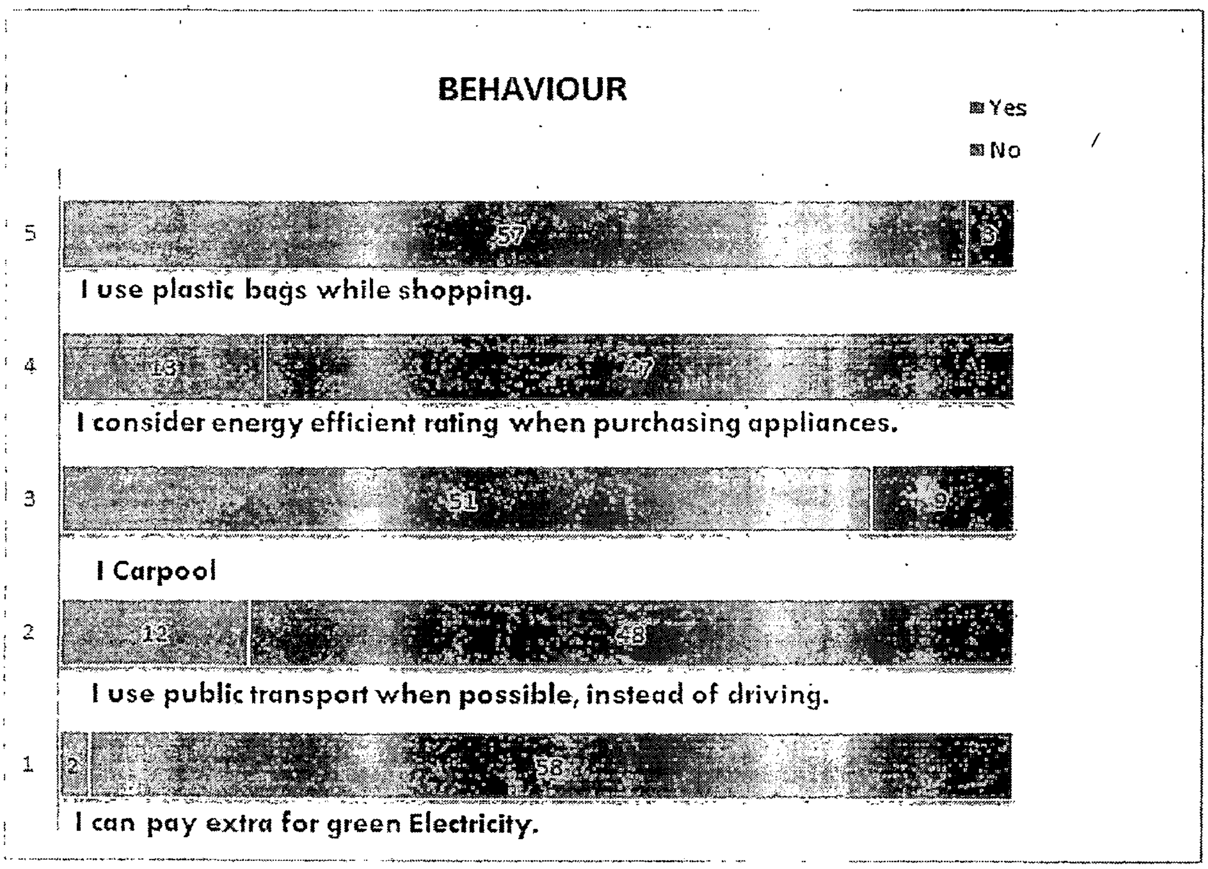


Figure 64: Behavior of people towards energy conservation issues

The first set of questions reflects that the knowledge about the connection between building and energy is low among the masses and they accept this ignorance. In second sets of questions people said they are willing to reduce energy consumption and want to save money but maintain that reduction in consumption (assumed conventionally) will cause inconvenience. The third and fourth set of questions address people attitude for environment and climate change in which they responded positively and awareness and concern have been seen in majority. The knowledge about the renewable energy is found very low. In next sets of questions they seem a little more alert and accuse transportation as the chief cause of air pollution. They also agreed that the most of CO_2 emission comes from power generation.

However, the questions which address their behavior pattern gave answers in contrast to their said awareness. That can be understood because of many factors such as lack of proper, comfortable and reliable public transport, economically less viability of renewable energy etc.

CHAPTER 7

STRATEGIES AND RECOMMENDATIONS FOR ENERGY SAVING IN GHAZIABAD CITY

7.1. Strategies for reduction in energy consumption:

As per result of the presented survey and the known causes of the energy consumption discussed in the theory chapters, we can see that the knowledge penetration about energy among the mass is very low and conventional way of using energy is still contemporary. Seeking this point of view, we will now be discussing options for energy efficiency in urban household.

7.1.1. Energy saving in existing and future households

Energy conservation can be achieved through the following measures:

Reduce the energy demand for HVAC (Heating-ventilation-air conditioning) and Day lighting through Energy Efficient and Climate Responsive Architecture

As we know the knowledge penetration about the energy efficient building is very low among the masses, which are the primary end customer of energy. The knowledge dissemination of energy efficient building (or architecture) should be done by GDA or other stakeholders through multimode e.g. workshops through Experts to the residents, sector wise campaign etc. Along with the above, an institutional framework (described further) can help the knowledge reaches to the primary source of energy consumption. The following fundamentals can be suggested for energy responsive buildings in the study area.

Basic guidelines for energy efficient buildings:

- Orientation of building towards east west ensures less radiation falling on walls and hence less heating and thus less need for cooling.
- Lesser opening on West side and broader opening on North side would allow maximum daylight and less radiation inside of the building.

- Shading devices on windows and other outside openings would prevent direct radiation generated heat to come inside.
- Usage of less energy absorbing material in construction.
- Usage of insulating material and techniques.
- Assisting natural ventilation through building design.

The various studies conducted by research organizations and expert group reveal that primary electrical consumption can be reduced as much as 60% and overall can be brought up to zero if we have designed energy efficient buildings.[22]

7.1.1.1. The barriers which prevents adoption of "Green Building Guidelines ".

In the survey responses, there are many different points of view, as to what exactly are the barriers which hinder the growth of green buildings in the country. But, summarizing them it can be seen that there are 4-major issues or barriers to the green concept, which is shown in the above graph. These barriers are according to the green consultants or architects or people associated with green building design, so can be seen as one perspective to the barriers of the concept. The most common barrier to adaption of green buildings is cost. Many of the builders or clients don't go for Green because of the upfront cost that it requires. The second most imp barrier is lack of incentives. The other Barriers are:

- Attitude of government agencies.
- Cost
- Lack of incentives.
- Lack of financing from bank
- Lack of training / education.
- Lack of interest of clients
- Lack of technical understanding

[22] www.teri.in.org

- Unreliable green building

7.1.1.2. Institutional support required for the development of Energy efficient residential buildings.

- Municipal building bye-laws are need to revised to be compliant with norms of resource conservation (energy) and RE integration (solar water heating, meeting part electricity/energy demand by use of renewable energy resources such as solar, wind, biomass etc.)
- Green building courses should be easily accessible and offered by universities/colleges.
- Financial products to support the industry to be developed with public/private financial institutions.
- Simpler legal approval process for green buildings.
- Establishment of eco cell in urban development bodies of states to offer advisory services.
- Strengthening of implementation and monitoring mechanism.
- Incentives can be provided by Local authority for increasing energy efficiency. Extra floor space to developers or service tax rebate on leases for certified green building are some incentives that could motivate the development of more energy efficient buildings and stimulate demands for them.

7.2. Energy saving using energy efficient household devices.

A significant amount of energy can be saved if conventional energy extensive household appliances get replaced by modern energy efficient devices. The preference should be given to higher (BEE) rated appliances.

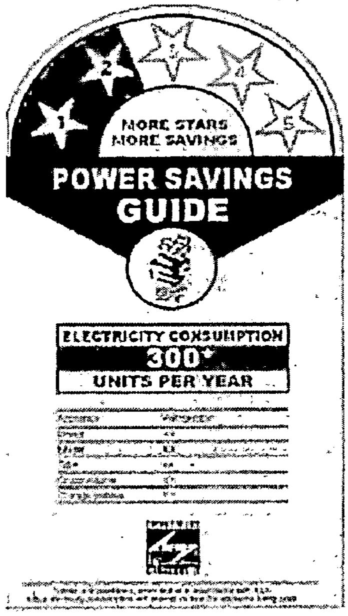


Figure 65: A typical BEE label showing star rating and possible annual saving.

- Replacement of all tubular Fluorescent Lamps (TFL) of 48 Watt/36 Watt lamps and electromagnetic ballasts (copper chokes) to energy saving T-8 or T-5 TFL of 28watt/33 watt and electronic ballasts.
- Replacement of all general Lighting Service (GLS) bulbs of 100 watt/ 60 watt to compact Fluorescent (CFL) of 20watt/16watt.
- Replacement of all existing ceiling fans that consume 60 watt to 80 watt, varying with size and age to energy efficient 50 watt ceiling fans.
- Replacing of existing refrigerators with BEE labeled refrigerators.
- Replacement of household electrical irons that consume 1100 watts to energy efficient 750- watt irons.

Calculation of daily energy saving proposition by using Energy Efficient devices

Table 12: Electricity consumption pattern in an average HIG Household.

Appliance	Wattage of regular device kW	wattage of energy efficient device in kW	Appliance per house hold	Use per day (hrs.)	Power consumption/day kW	Power consumption after conservation measures/day kW
Tube Light with regular ballast	0.048	0.033	5	3.5	0.84	0.5775
Incandescent lamps	0.06	0.02	2	2	0.24	0.08
Television	0.1		1	10	1	1
Fans	0.075	0.05	3	8	1.8	1.2
Refrigerators	0.2	0.12	1	24	4.8	2.88
Geysers	2		1	0.75	1.5	1.5
Electric iron	1	0.75	1	0.2	0.2	0.15
Washing machine	0.5		1	0.5	0.25	0.25
Computer	0.1		1	2	0.2	0.2
Mixer grinder	0.5		1	0.5	0.25	0.25
Air cooler	0.25		1	6	1.5	1.5
TOTAL					12.58	9.5875
Total Energy saving per day						2.9925
Annual Energy saving per HH in kW						1092.27

Table 13: Device wise electricity consumption pattern by an average MIG household.

Appliance	Wattage of regular device kW	wattage of energy efficient device in kW	Appliance per house hold	Use per day (hrs.)	Power consumption /day kW	Power consumption after conservation measures/day kW
Tube light with regular ballast	0.048	0.033	2	4.5	0.432	0.297
Incandescent Lamps	0.06	0.02	3	2	0.36	0.12
Fans	0.075	0.05	2	8	1.2	0.8
Television	0.1		1	8	0.8	0.8
Refrigerator	0.20	0.12	1	16	3.2	1.92
Geyser	2		1	0.5	1	1
Mixer Grinder	0.5		1	0.5	0.25	0.25
TOTAL					7.242	5.187
Total energy saving in kW						2.055
Annual Energy saving per HH in kW						750.075

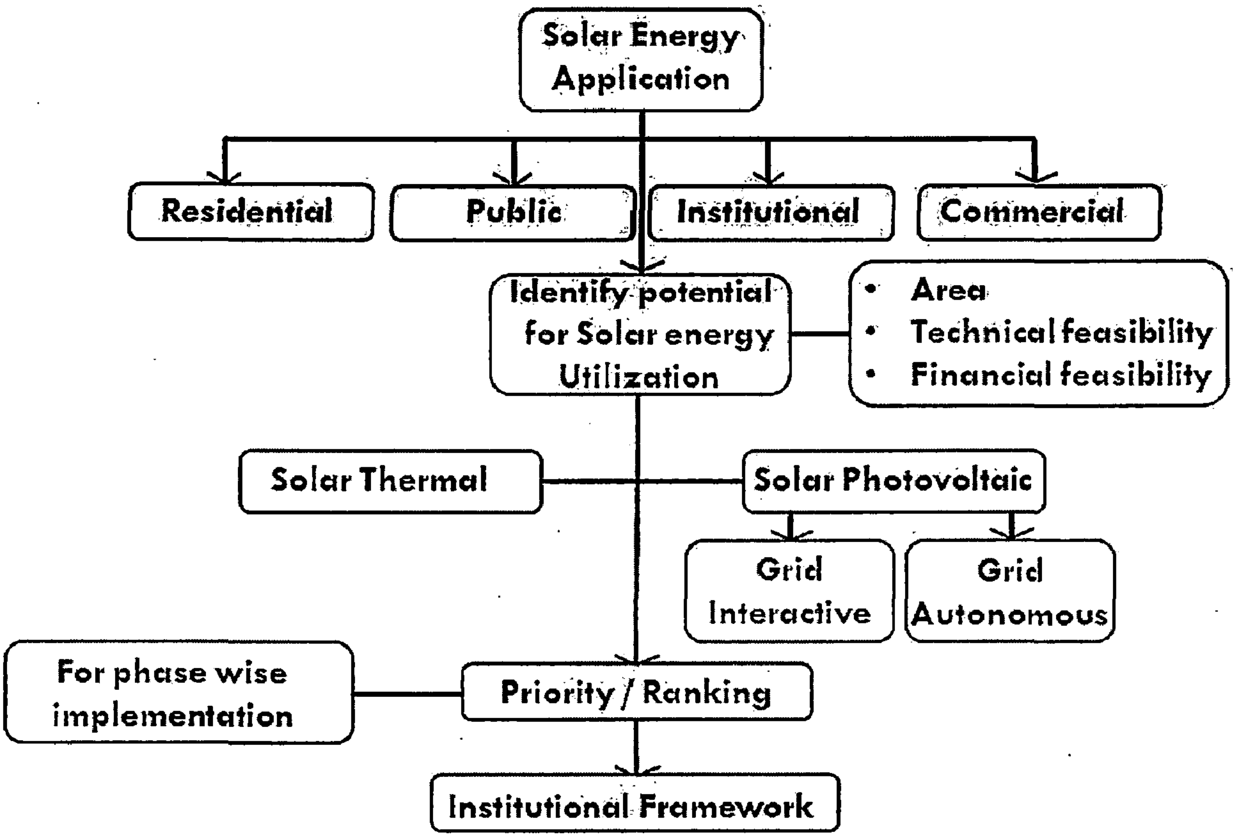
Table 14: Device wise energy consumption pattern be an average LIG household

Appliance	Wattage of regular device kW	wattage of energy efficient device in kW	Appliance per house hold	Use per day (hrs.)	Power consumption /day kW	Power consumption after conservation measures/day kW
Tube light with regular ballast	0.048	0.033	2	3.5	0.336	0.231
Incandescent lamps	0.06	0.02	2	3	0.36	0.12
Television	0.1		1	6	0.6	0.6
Fans	0.075	0.05	1	9	0.675	0.45
Mixer grinder	0.5		1	0.2	0.1	0.1
TOTAL					2.071	1.501
Total energy saving per day						0.57
Annual Energy saving per HH in kW						208.05

- We cannot rely only on to fulfil the demand of electricity by conventional means. For energy efficiency, we also have to focus on the reduction of electricity demand of the city. Therefore, there is need for interventions in favour of energy efficiency to household level. Such as to apply green building architecture, which can include providing solar cell to individual building complex, Percolation wells in some built up areas. Amendments in Building Bylaws and Building Architecture are also required.
- Offering some policies on green building application in city, X% of residential buildings can be converted into Green Buildings. Which can reduce total electricity demand of residential area reduces up to Y% by 2021.

7.3. Integration of renewable energy in urban context.

Framework for Solar energy Application



The study includes preparing a framework to make systematic approach towards implementing solar energy in the potential sectors of urban areas. With present level of technology, solar energy resource cannot completely satisfy the large requirements of industrial sectors. **The study is focused to access energy utilization potential for four sectors namely:**

a. Residential

b. Commercial

c. Institutional and

d. Public.

Solar energy is majorly utilized in two forms, as solar thermal and solar photovoltaic. Solar thermal finds its potential into residential sector, where there is hot water requirement. Solar photovoltaic has wide application.

Solar photovoltaic has wide range of application. There are two ways of utilizing the output.

- **Grid Autonomous**
- **Grid interactive**

Grid autonomous works without the support of the conventional grid. The output is stored in the battery. For example solar street light and in Grid Interactive the panel's output is connected to the mail utility grid with help of converter.

Further Solar energy utilization depends on various factors like:

- Space available (roof top) for solar panel installation
- Technical feasibility
- Financial feasibility
- Awareness and willingness to adopt solar energy.

Within each sector the potential differs with the scale. To identify highest potential, sector wise ranking has to be done. Ranking helps to prioritize the area for implementation of solar energy projects.

7.3.1. Ranking of potential for SPV application in Commercial sector

Spatial Hierarchy

- Scale of commercial activities in urban areas has a wide range.
- Small corner grocery shop in a residential colony - mixed land use.

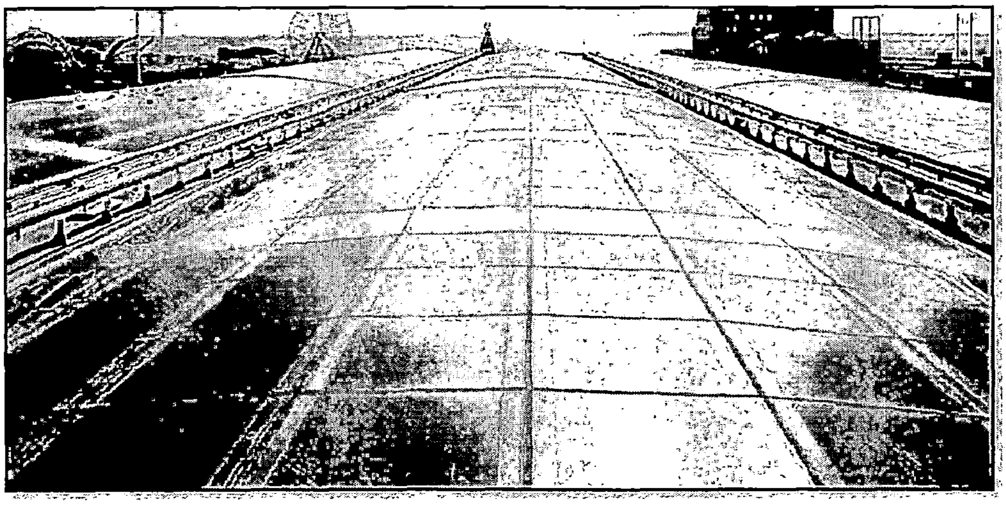


Figure 66: Example c Solar roof on terminals This first-of-its-kin application, low cost thin-film PV panels (21 kW) were combined with clear glass in custon glazing units to provide the right balance o shelter, lighting, and electricity generation a Coney Island's Stillwel Avenue Terminal in New York.

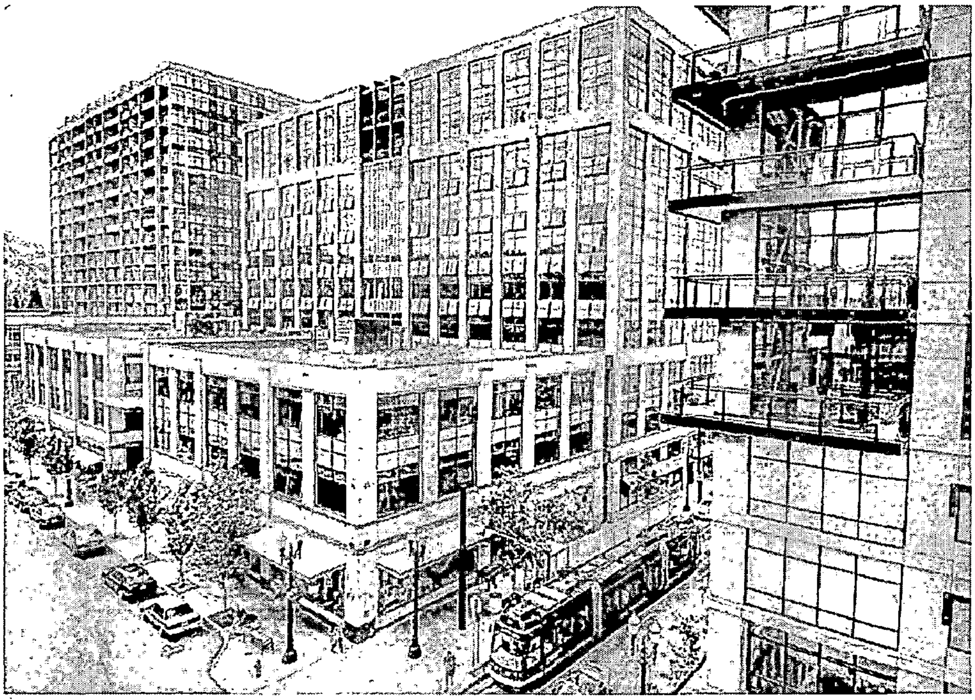


Figure 67: Commercial building includes a rooftop PV array, in addition to building-integrated PV modules that are mounted on the southern facade between each of the window panels.

- Commercial complex - dedicated space for commercial and office activities.
- Shopping Malls - dedicated space for commercial and recreational activities.
- Stand-alone single entity commercial spaces - Petrol pumps, Star hotels, Banks etc.

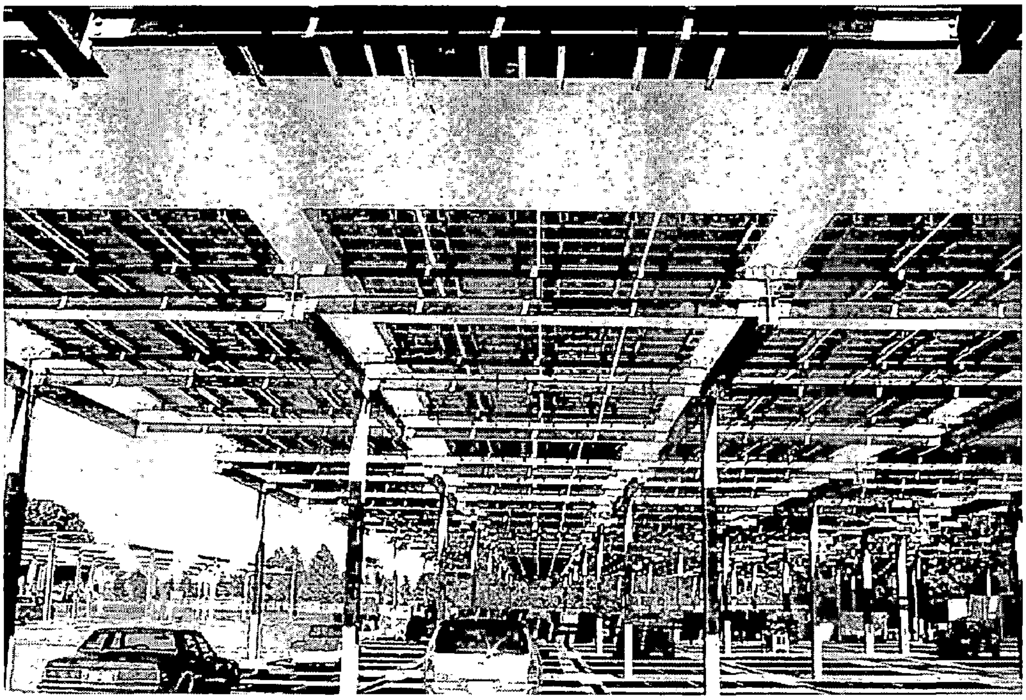


Figure 68: Solar Panel at Parking lots.

- Commercial street – commercial activity along both side of the street.
- Elevated Metro –Stations, Bus Terminals and Parking Lots.

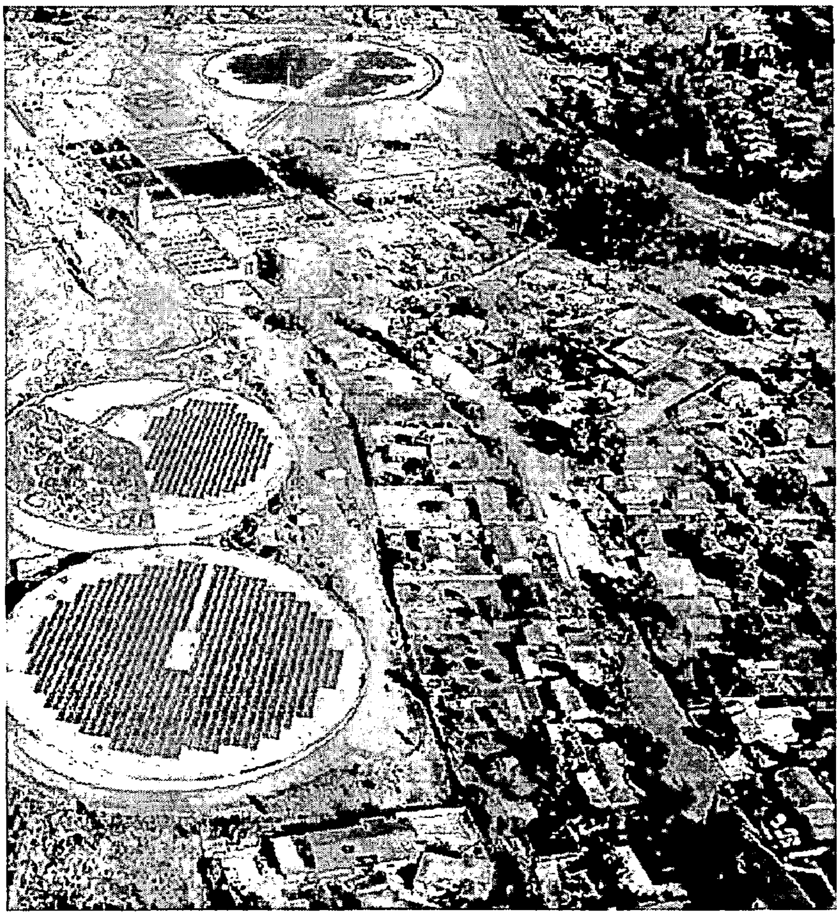


Figure 69: San Diego Alvarado Water Treatment Plant

Factors and concerns of Grid interactive Solar Photovoltaic systems in commercial sector

FACTORS	CONCERNS
1. SITE AVAILABILITY	One 1 kW capacity panel requires 15m² area.
2. TECHNICAL FACTORS	a) Safety concerns in grid connection b) Penetration in grid and losses
3. FINANCIAL FACTORS	Present Cost of installation of 1kW capacity panel is Rs. 2.5 lakhs.
4. SOCIAL WILLINGNESS	No of decision makers involved

Analyzing the matrix given below, we can see that a Grid interactive SPV system has highest potential for stand-alone high end single entity commercial establishments. If an urban area has a well-defined commercial zone, where commercial establishments are along both side of the major road, it can be a high potential commercial street to be prioritized for SPV system application.

Proposal for a shopping mall

A shopping mall of 40000 sqft built up area was surveyed to assess SPV systems feasibility. It has a monthly consumption of 90000 kW. If 50% of the roof area is considered available for solar paneling, then at the rate of 15m² area for 1 panel, 333 panels can be installed. It will give an output of 1332 kW per day which satisfies 44.5 % of the mall's energy requirement.

Unit consumption per day	Roof area for paneling m2	No of panels that can be installed	Total units produced by panels per day kW	% of energy saved per day
3000	5000	333	1332	44.5 %

Cost of panel installation(2012) Rs.	Net profit per annum Rs.	Payback period
72594000	2801877	17 years

Proposal for commercial entity - petrol pump

A petrol pump is a stand - alone single owned commercial entity. The canopy area shading the petrol pump has high potential for solar panel installation. Six petrol pumps within the study area were surveyed to find out the energy demand pattern.

Average consumption per month kW	Consumption per day kW	Roof area m^2	Area required for 1kW panel in m^2	Total units produced by I kW panel per day in kW	Total energy produced (saved) per month kW	% of energy saved per day
1357	45.26	50	15	12	360	26.51%

Cost of panel installation(2012) Rs.	Net profit per annum Rs.	Payback period
72594000	2801877	17 years

Proposal for Solar Street lighting

Alternative 1

Considering Ghaziabad has around of 5000 No. of sodium vapour lamps installed for street lighting in residential areas. One alternative is to replace 250W sodium vapour lamp with 50W LED lamps. It will reduce the energy requirement of 12000 kW per day and a cost saving of Rs.48000.00 per day.

Table 15: Energy and cost saving by LED street lights

	No. of bulb	capacity kW	Total consumption in 12 hrs. kW	energy saved in one day kW	Cost savings per day in Rs.
Sodium Vapour lamp	**5000**	**0.25**	**15000**	**12000**	**48000.00**
LED light	**5000**	**0.05**	**3000**		

Alternative – 2

Second alternative is to replace sodium vapor lamps with LED based Solar Lamps. Total energy saved per day will be 15000kW. The total cost of installation of solar street lights will be Rs.100000000.

Table 16: Energy and cost saving by solar light

	No. of bulb	capacity kW	Total energy saved per day in kW	Total cost of installation of solar lamp in Rs.	Cost recovery period
Sodium Vapour lamp	**5000**	**0.25**	**15000**	**10000000**	**4 Years 6 months.**
Solar Lamp	**5000**	**0.05**			

Similarly, installation of solar signals, solar hoardings and lighting in sector parks, Replacement of 2500 lamps can give an energy saving of 7500.00 kW

Financial sustainability

As we have learned through the case study example of Akola (Art. 4.4), a public private partnership can be maintained. The good proposition about any scheme is the huge amount of saving that goes for electricity bills. This saving can be basis for such joint venture.

Proposal for common area lighting

Primary survey results give that out of the total energy consumed by a building, 5% is utilized for common area lighting. For example the parking lights, walk way lights and staircase lighting. Installation solar panels for common area lighting of residential, commercial and institutional areas can save large amount of per day.

Factors and Concerns for solar thermal installations

Factors		Concerns
1. Site availability		SWH of 100 lit capacities requires a minimum of 2sq m of roof area for connection to the overhead tank.
2. Technical Factors	Installation on existing structures.	SWH installation on existing structures may require external plumbing for hot water connections in the utility areas if the facility is not made at designing stage for services.
	Installation on multi story structures	It involves pipeline to run down till the ground floor for connection in utility area, thereby making losses in the water temperature.
3. Economic factors		Installing SWH systems involves high initial investment and with an increase in plumbing area and alterations in the services the cost raises.
4. Awareness		Low awareness among individuals for economic and environmental benefits of SWH in long run.

Grid VS BIPV cost analysis

Decentralized SPV technology helps reduce peak power demand and the burden on the utility supplying electricity, thus preventing setting up of new power plants. SPV systems can be integrated as a part of the building in the form of tile, offsetting some of the construction material costs.

With increased dependency on fossil fuels like coal for power generation, good quality coal needs to be imported. This will lead to constant rise in the cost of grid supplied power in future. Today, the cost of power generated from SPV is higher than conventional grid power, owing to limited supply and high cost of solar cells.

However with private players getting in the competitive market for manufacturing of solar cells, the cost will go down. Thus in future the cost of generation from SPV will virtually match the cost of grid supplied power.

If we analyze, in 2009 the cost of per kWh of a grid supply is Rs.4.96 and that of BIPV is Rs.6.67.By the year 2012 - 2013, cost of SPV generation will be Rs.5.56 against Rs.5.74 of grid supply.

After 2012, initiating investment in BIPV systems becomes a feasible decision. The solar energy implementation can be done in two phases depending on the technical and financial feasibility[23].

Phase 1

Action steps	Responsibility	Priority	Time Frame
Solar street lighting	GNN	High	2012-2014
Solar Water Heater installation for 15510 households	Individuals + solar city cell	High	2012-2014
SPV panel installation on roof top for common area lighting in commercial, institutional and residential buildings	Individuals + solar city cell	Medium	2012-2014
Installation of solar signals, solar lighting for hoardings, lighting for public parks. Etc.	GNN	Medium	2012-2014

Phase - 2

Action Plan post 2014

Post 2012 focus should be on BIPV systems. The target will be to achieve installation of 200200 panels of 1kW capacity. It can be achieved through local government and private initiative by entering into the following categories of buildings on priority.

- Government buildings.
- Commercial establishments owned by single entity

[23] Source: February – June 2006. "Solar cities initiatives- making urban cities greener", Alternative, Volume 6, Issue 4-6

- Educational Institutes

For demonstration purpose the Government buildings can be installed with SPV systems in the first year.

7.4. Proposal of Electricity generation From Landfill Gas

Waste to energy plant:

Methane, the primary warming gas emitted by landfills, is about 20 times more potent than carbon dioxide, the gas released by burning garbage. Many studies also concluded that waste-to-energy plants produced lower levels of pollutants than the best landfills did, but nine times the energy.

Existing and projected waste generation in Ghaziabad City

Year	GNN	Other areas	Total GDA	Per capita waste/day	Waste from GNN area	From outer area	Total GDA
	Nos			Kg	MT/day		
2001	968521	358809	1327330	-	-	-	-
2009	1359383	495776	1855159	0.55	748	273	1020
2011	1479619	537501	2017120	0.57	837	304	1141
2016	1835963	646114	2482077	0.61	1114	392	1506
2021	2278126	776083	3054209	0.65	1482	505	1987
2026	2721455	966195	3686650	0.70	1898	674	2573
2031	3248668	1201383	4450051	0.75	2431	899	3330
2041	4423355	1711170	6134525	0.86	3808	1473	5281

Source: Analysis: population figures of 2011 and 2021 are from Ghaziabad Master Plan

Assessment of Energy Recovery Potential:

A rough assessment of the potential of recovery of energy from MSW through different treatment methods can be made from knowledge of its calorific value and organic fraction, as under:

In thermo-chemical conversion all of the organic matter, biodegradable as well as non-biodegradable, contributes to the energy output:

Total waste quantity: W tonnes

Net Calorific Value: NCV k-Cal/kg.

Energy recovery potential (kWh) = NCV x W x 1000/860 = 1.16 x NCV x W

Power generation potential (kW) = 1.16 x NCV x W/ 24 = 0.048 x NCV x W

Conversion Efficiency = 25%

Net power generation potential (kW) = 0.012 x NCV x W

If NCV = 1200 k-Cal/kg., then

Net power generation potential (kW) = 14.4 x W

Energy generation from existing accumulated solid waste in Ghaziabad city area (2011):

Total quantity of MSW generated is-Approximately 837 MT.

(NCV=796.26 k-Cal/kg)

Net Power generation potential (kW) =0.012x796.26x837= 7997.63544 kW =7.997 MW per day, with 240 MW per month and 2880 per annum.

Energy generation from future generation (2021) of solid waste in study area:

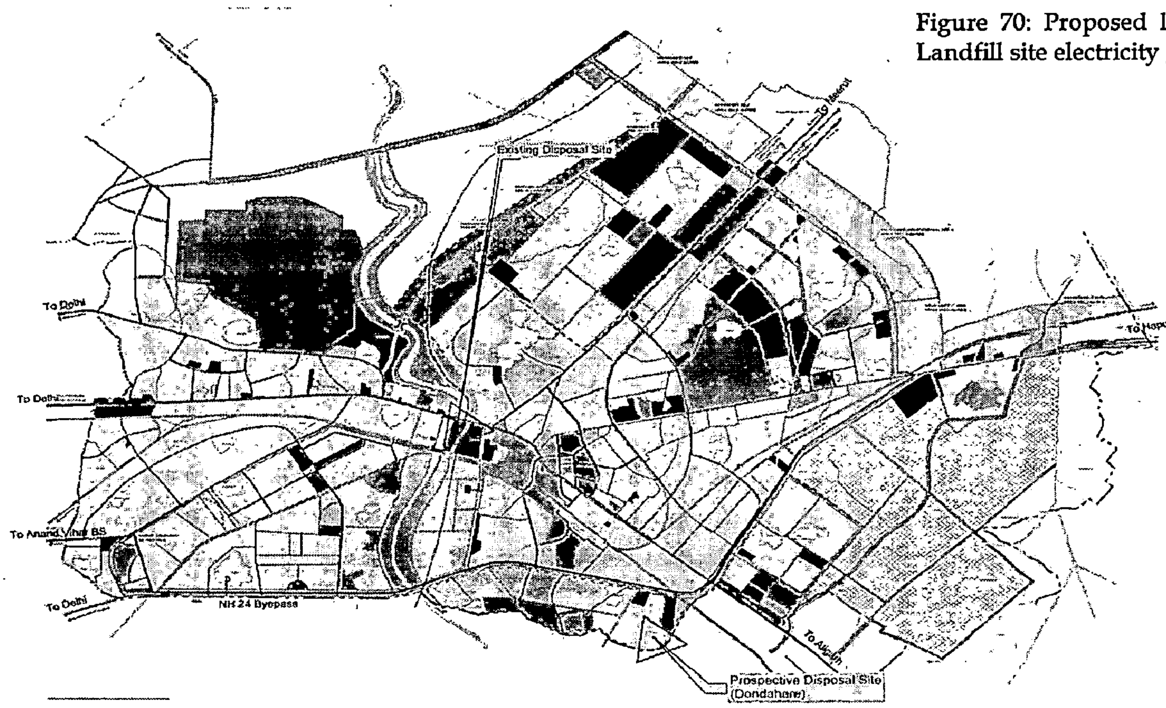
If we assume around 30% of solid waste (refused from composting plants, recycling plants and other wastes) can be utilized for generating energy,

Total amount available per day = 1482 MT

30 per cent of waste available per day= 444 MT

Net Power generation potential (kW) =0.012x796.26x444=2368.8288kW= 2.369MW per day, I.e. around 71 MW of power can be generated per month and 852 MW per year.

Figure 70: Proposed location for Landfill site electricity generation



7.5. Proposal for improving energy access at community level.

Based on the above recommended strategies, there can be an assessment of energy saving at community or sector level in the study area. We take the example of the same surveyed residential sector Kavi Nagar, where there is daily average power cut of 5 to 7 hours occurs. The sector deemed to be a posh colony in the heart of the city where ranges of plot are between x-y m^2.

The savings are estimated on the basis of following 4 considerations.

1. About 30% of Existing and future household adopt energy efficiency measures and consumes 40% less electricity than the conventional mode.
2. About 50% of the Shops adopt efficiency measures and consumes 40 % less energy.

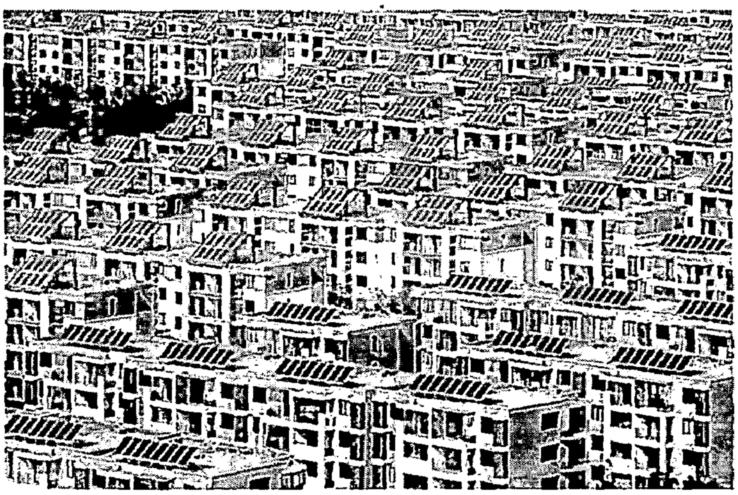


Figure 71: Solar panels on the rooftop. of household

3. Both of the above adopt energy generation through solar energy for their own use. Each unit houses 1 kWp solar power setup.
4. The roof top of community center facilitates solar power of 25kWp capacity connected to grid.

Existing electrical consumption in survey area [X]

Existing Electrical consumption in surveyed residential sector (Annual consumption in kWh)		
Category	**No. of units**	**Total electricity consumption**
Residences	**1000**	**4591700**
Shops	**40**	**292000**
Streets lights (including the lights in parks and other green areas)	**367**	**401865**
Community Center	**1**	**6185**
Total		**5291750**

Efficiency measures in residences [A]

Annual consumption of residences(kWh)	Consumption after taking efficiency measures[@30% of residences,@40% reduction](kWh)	Savings(kWh)
4591700	4040696	**551004**

Induction of renewable energy [B]

Annual savings after using renewable energy[@30% of residences]		
Solar water heater [1.2x240x300]	Solar PV Panel(1 kw) Installation [@5units/dayx300x365]	total
86400	547500	633900

Efficiency measures in shops[C]

Annual savings after taking efficiency measures[@50% of shops, @20units per shops/day]			
Overall Annual consumption of all the shops [20x40x365]	Saving after taking efficiency measures[@40% of consumption] [8x365x20]	Solar PV Panel(1 kw) Installation [@5units/dayx20x365]	total
292000	58400	36500	**94900**

Efficiency measures in community center [D]

The community center however ambiguous in use of electricity has been assumed to use peak power demand on a celebration evening of which most of the portion is covered by diesel gensets. By setting up a grid interactive solar energy plant on rooftop will not only give good proposition to user who lend gensets and burn fuel but also to cover its cost partially. Rest of the cost will cover in terms of saving from grid energy uses charges. It has been assumed that 60 days of a year use peak power demand of 50 units/day, 120 days to use 25 unit/day and inactive days will use 1unit /day.

Overall annual electricity consumption [60x50+120x25+185x1]	Annual energy generation after Solar PV Panel(25 kwp) Installation(grid connected)	Total saving
6185	42000	**35815**

Efficiency measures in street light [E]

All the street light, if replaced by solar powered light then it will sum to great extent in overall energy saving scheme.

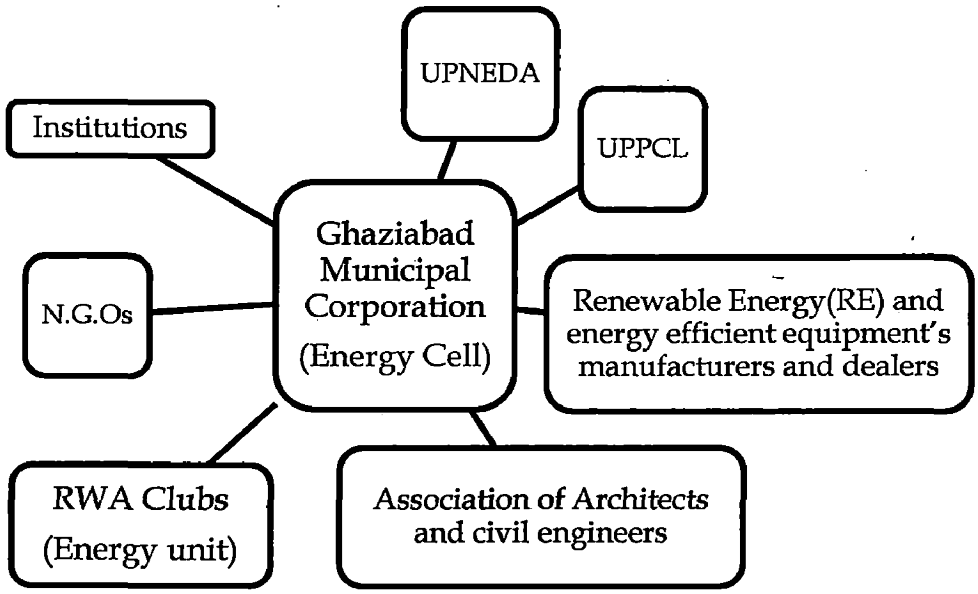
Overall annual electricity consumption [3x367x365]	Annual energy consumption after Solar light Installation	Total saving
401865	0	**401865**

Overall annual savings after applying all measures [A+B+C+D+E]

1716984 kWh= 1717 MWh=32% of saving as compared to existing consumption**[X]**.
In the areas where the power cut are about 5-8 hours a day, the need for bridging energy deficit comes through inverter and diesel gensets. As we see the saving in energy comes about one third of the overall sector demand, the cost of installing solar PV plant can be trade in lieu of the value of savings. Being an HIG sector, even if 30 percent of the household and 50% of the commercial shops adopt above measures, their payback period comes under 5-7 years (it largely depend upon the power cut and in comparison to diesel genset). However for areas such as community center, a PPP model(as discussed earlier in case studies and analysis) can be adopted, considering its high potential in terms of energy saving value can be used to lure private investors.

7.6. Proposed institutional framework

To achieve the above stated targets of energy efficiency through Alternative means it is essential to establish an Energy Cell. This cell should be established in Ghaziabad Municipal Corporation under the joint patronage of Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) and Uttar Pradesh Power Corporation limited (UPPCL). It is also necessary to involve people and families at household level to work for energy efficiency. A formation of energy unit at RWA level would ensure the awareness among people for energy efficiency and knowledge dissemination for the same.



1. The ENERGY cell should consist of members from Uttar Pradesh Power Corporation, Association of Architects and civil engineers. NGO's can play an active role in demonstrating innovative ways of adopting solar energy.

2. The major responsibilities of the ENERGY cell will be:

3. Generate awareness among the people about environmental benefits through energy efficiency.

4. The cell should be responsible for the energy efficiency programs at household level. It would set target for annual emission reduction and energy

saving against base case scenario. It can even further be developed as Independent Corporation.

5. The cell should focus its line of work at residential household as there is a lack of implementing agency at this segment.
6. The cell should interact with commercial establishments and institutions to adopt energy efficiency and renewable energy for their energy requirements.
7. The cell should interact with designated banks for granting subsidies and loans for energy efficiency programs and renewable technologies promoting SPV and Solar thermal technology.
8. The energy cell should get engage in activities like workshops for Architects and Civil engineers and contractors on energy efficient buildings.
9. To identify CDM(clean development mechanism) opportunities for initiatives like solar street lighting, commercial and institutions adopting BIPV (Building Integrated photovoltaic) systems etc.

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Annexure: 1

House Hold Survey

Part A

1. Name of family member ____________________________
2. Gender- ____
3. Address- ____
4. Family details:

Sr no.	Name	Relation with head	Age	Married	Education	Occupation	
1							
2							
3							
4							
5							
6							
7							

Employment: Full time, part time or casual, retired, Home duties, self-employed, Full time student, part time student, Unemployed.

Occupation: Manager, Sales worker, Professional, Machinery operator, technician, administrative worker, other..

5. Household type _____Nuclear___(Group household , Single person household , couple with no children , couple with children , Other family e.g. extended family household .
6. Monthly Expenditure
7. Type of House: Detached/ semi-detached/ apartment/ row housing
8. Ownership:-Rented/ Owned/ Other
9. No of rooms_________, no of floors ______________
10. Power
    a. Electricity: Yes / No charges :_________ Duration - _________

Part B

11. Household appliances(No of Appliances):
Refrigerator ____Mixer/Grinder _____ TV_____ Cooler___ AC___ Computer ____ Mobile _____Washing Machine ____Geyser_____ Microwave____ Stereo_____ Toaster _____ Coffee maker______ Hair dryer _____Electric Press ___Any Other____

12. Kitchen Electrical Appliance Survey:

Type/ Electrical Appliance	Brand	Hr. use	Power Rating	Notes

13. Bathroom Electrical Appliance Survey:

Type/ Electrical Appliance	Brand	Hr. use	Power Rating	Notes

14. Living Room Electrical Appliance Survey:

Type/ Electrical Appliance	Brand	Hr. use	Power Rating	Notes

15. Office Electrical Appliance Survey:

Type/ Electrical Appliance	Brand	Hr. use	Power Rating	Notes

16. House light bulb Survey:

Type/ Electrical Appliance	No.	Hr. use	Power Rating	Notes
CFL				
Bulb				
Tube Light				

17. Other Electrical Appliance Survey:

Type/ Electrical Appliance	No	Hr. use	Power Rating	Notes
Fan				
exhaust				

Part C

This survey designed to gain understanding of people's attitude and opinion about household energy issues.

Ques1. CLIMATE CHANGE AND ENERGY SOURCES

How strongly do you agree or disagree with the following?

- I am well informed about climate change
- I am well informed about the Fossil Fuels (Coal , Oil , Natural Gas)
- I am well informed about the renewable energy Sources (Solar , Wind , Hydro-electric)
- India should continue using Coal-power to generate electricity.
- India should consider using renewable energy sources to generate electricity.

Ques2. BEHAVIOUR

Mark yes or no for each Statement below

- I can pay extra for green Electricity.
- I use public transport when possible, instead of driving.
- I Carpool.
- I consider energy efficient rating when purchasing appliances.
- I use plastic bags while shopping.

Ques3. BELIEFS ABOUT THE ENVIRONMENT

How strongly do you agree or disagree with the following?

- We are approaching the limit of the number of people the earth can support.
- Humans have the right to modify the natural environment to suit their needs.
- When humans interfere with nature it often produces disastrous consequences.
- Human are severely abusing the environment.
- The earth has plenty of natural resources if we just learn how to develop them.
- The balance of nature is strong enough to cope with the impacts of modern Industrial development.
- The balance of nature is very delicate and easily upset.

Ques4. KNOWLEDGE OF ENERGY AND ENVIRONMENT

Mark yes or no for each Statement below

- Most of the air pollution in Cities is caused by Motor vehicles.
- Most of the CO_2 emissions comes from electricity generation.
- Generating electricity from renewable sources costs about the same as generating electricity from coal.

Ques5. ATTITUDE TO ENERGY CONSUMPTION

How strongly do you agree or disagree with the following?

- I know of at least three things I could do to reduce my household's energy consumption.
- Reducing my household's energy consumption would help in protecting the environment.
- It would save my money to reduce my household's energy consumption.
- It would make me feel good to reduce my household's energy consumption.
- Reducing my household's consumption would be inconvenient.

Ques6. BUILDING AND ENERGY CONSUMPTION

Mark yes or no for each Statement below

- I am aware that some modification in my building can reduce my energy use.
- I am aware that material used in my building effect my energy usage.
- I am aware that size of windows and its orientation affect my energy use.
- I am aware that my building design affects my energy usage.

Annexure: 2

Category wise waste generation per capita per day	
Category of average per capita waste	**Per day (gms)**
Households	325.29
Commercial	97.59
Road sweeping	65.06
Industrial and institutional	58.55
Total	546.49

Waste Composition Details at Source and Trenching Ground			
S. No.	**Category wise fraction**	**At Source**	**At Trenching Ground**
		Percentage (%)	
A. Biodegradable			
1	Green waste and kitchen waste	55.94	58.09
B. Non-Biodegradable			
1	Wooden pieces	3.28	1.44
2	Textiles	2.94	0.55
3	Rubber/leather	0.98	0.48
4	Inert	15.9	29.38
Total		23.1	31.85
C. Recyclable			
1	Paper and cardboard	9.71	2.72
2	Glass	1.39	0.2
3	Metal	0.64	0.1
4	Polythene and plastics	9.12	6.93
5	Others	0.1	0.11
Total		20.96	10.06
Grand Total		100	100
Moisture		**38.1**	**41.63**
Calorific value (Kcal/Kg)		**1097.39**	**796.26**

Source: Quantification an characterization survey repoı Ghaziabad SWM Master plan.

Annexure-3

Solar Energy Application energy saving and cost:

1. **Solar Water Heater (SWH):**

    - A 100 liters capacity SWH can replace an electric geyser for residential use and saves 1500 units of electricity annually.
    - The use of 1000 SWHs of 100 liters capacity can contribute to a peak load saving of 1MW.
    - An average household with an electric water heater spends about 25% of its home energy costs on heating water. It is found that solar water heaters offered the largest potential savings compared to electric heating, with solar water-heater owners saving as much as 50% to 85% annually on their utility bills over the cost of electric water heating.

2. **Solar street lighting System:**

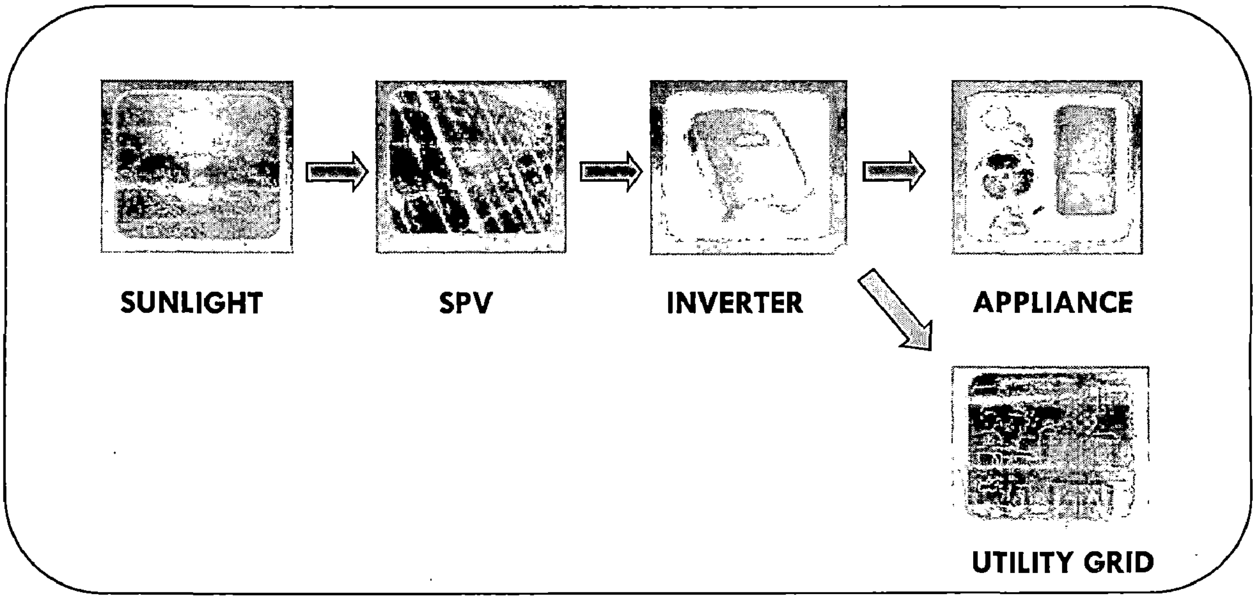
    Parts of system:

    1 - SPV Module
    2 - Battery Box
    3 - Lamp with charge controller
    4 - Lamp Post

The solar module of the system converts sun light into DC power. This DC power is used the Lead Acid battery. During the night time the DC power from the battery is inverte frequency AC by the inverter and is fed to the CFL. A solar photovoltaic street lightin comprises of a 11 W / 18 W compact fluorescent lamp, Low maintenance lead acid l Maintenance free lead acid battery, PV module(s), Control electronics. The system is automatic ON/OFF time switch for dusk to dawn operation and overcharge / deep prevention cut-off with LED indicators.

Cost of the system is Rs.18000 to 21000.

3. **Grid Interactive SPV system:**



- Sun shines on the solar panels generating DC electricity
- The DC electricity is fed into an inverter which converts it to 240V, 50Hz AC electricity.
- The 240V AC electricity is used to power home appliances.
- Surplus electricity is fed back into the main grid.

When the home or structure requires more electricity than the PV system is generating, the need is automatically met by main grid. When that home or business requires less electricity than the PV array is generating, the excess can often be fed (or sold) back to the utility through net metering. Thus the grid acts like a kind of storage device or battery for PV- generated power. At the end of the month, a credit for electricity sold is deducted from charges for electricity purchased.

- In the event of a power outage, safety switches in the inverter automatically disconnect the PV system from the line. This safety disconnect protects utility repair personnel from being shocked by electricity flowing from the PV array.
- At the end of the month, if the customer has generated more electricity than that used, the utility credits the net kilowatt-hours produced at the wholesale power rate. But if the customer uses more electricity than the PV system generates, the customer pays the difference.

Table 17 Solar PV panels costing

Panel size	Cost
10W-12V	2800/-
37W-12V	10200/-
74W-12V	20400/-

Source: R.K Pachauri, 2008, From sunlight to electricity, Second Edition