Concept and Review of Literature
CHAPTER II
CONCEPTS AND REVIEW OF LITERATURE

2.1 Concepts

2.1.1 Household: A household is taken to mean a group of persons related by blood, marriage or adoption living under the same roof and sharing common kitchen continuously for not less than one year at the time of interview (NSSO, 54th round 1998).

2.1.2 LPG: Liquefied Petroleum Gas (LPG), popularly known as cooking gas, is a mixture of hydrocarbons which are gaseous at normal temperature, but can be liquefied at moderate pressure, and can be stored in cylinders as a liquid under pressure, and is drawn out and used as gas.

2.1.3 Air pollution: Air pollution is caused by gas or liquid or solid dispersed through ordinary air released in a big quantity enough to harm the health of people or other animals, kill plants or stop them growing properly, damage or disrupt some other aspect of the environment (such as making buildings crumble), or cause some other kind of nuisance (reduced visibility, perhaps, or an unpleasant odour).

2.1.4 Carbon monoxide: Carbon monoxide (CO) - CO is a colourless, odourless, toxic yet non-irritating gas. It is a product of incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide.

2.1.5 Particulates: Alternatively referred to as particulate matter (PM), atmospheric particulate matter, or fine particles, are tiny particles of solid or liquid suspended in a gas. In contrast, aerosol refers to combined particles and gas. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols. Averaged worldwide, anthropogenic aerosols-those made by human activities-currently account for approximately 10 percent of our atmosphere. Increased levels of fine particles in the air are linked to health hazards such as heart disease, altered lung function and lung cancer.

2.1.6 Volatile organic compounds: VOCs are well-known outdoor air pollutants. They are categorized as either methane (CH₄) or non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhance global warming.
Other hydrocarbon VOCs are also significant greenhouse gases because of their role in creating ozone and prolonging the life of methane in the atmosphere. This effect varies depending on local air quality. The aromatic NMVOCs such as benzene, toluene and xylene are suspected carcinogens and may lead to leukemia with prolonged exposure. 1,3-butadiene is another dangerous compound often associated with industrial use.

2.1.7 Carbon Monoxide: Carbon monoxide poisoning and fatalities are often caused by faulty vents and chimneys, or by the burning of charcoal either indoor or in a confined space, such as a tent. Chronic carbon monoxide poisoning can result even from poorly-adjusted pilot lights. Traps are built into all domestic plumbing to keep sewer gas and hydrogen sulphide, out of interiors. Clothing emits tetrachloroethylene, or other dry cleaning chemicals even days after dry cleaning.

2.1.8 MDGs: A set of plans that were made by the United Nations in 2000 to try to reduce hunger and improve the environment and other conditions in poor countries around the world.

2.1.9 WHO: The World Health Organization is a specialized agency of the United Nations that is concerned with international public health. It was established on 7th April 1948, headquartered in Geneva, Switzerland.

2.1.10 Biomass: Here, biomass is synonymous of vegetable matter used as fuel (bio fuel), either grown for that purpose, or recovered from other related industrial wastes (forestry, farming, food industry…); urban and animal waste might be included too.

2.1.11 Firewood: Firewood is any wooden material that is gathered and used for fuel. Generally, firewood is not highly processed and is in some sort of recognizable log or branch form, compared to other forms of wood fuel like pellets or chips. Firewood can be seasoned (dry) or unseasoned (fresh/wet). It can be classed as hardwood or softwood.

2.2 Review of Literature

There is a dearth of research studies which explore the socio-economic, environmental and institutional aspects of indoor air pollution and its impact on rural poor. Very few empirical investigations have been carried out in different parts of county and at a global level by various authors. These can be summarized as follows.

Many people believe that air pollution is associated principally with Industrial, Urban, Outdoor air pollution, where fossil fuels are burned. However, studies have
shown that many simple, daily used bio fuels (wood, dung, crop residues) in households is also a major source of air pollution and this indoor air pollution has a profound impact on the health of the people. Rennert W.P et al. (2016), have discussed, half of the world population particularly developing country still rely on bio fuel used their cooking purposes. Exposure of indoor air pollution and high PM$_{10}$ and PM$_{2.5}$ have been associated with birth and low weight still of newborns. They have selected 30 households of the community of Buenas Noches in the mountain region, total137 eligible women and children age 6-14 age group were chosen for this research. They were introduced new Justa stoves have been reduced to exposure indoor smoke. Most of the women and children were engaged their meal preparation. After introduction of Justa stoves has given good improvement of their health of peak expiratory flow rate. After introduction of smokeless cook stove technology improved Peak Expiratory Flow Rate (PEFR) in both children and adult.

Sutapa Bandyopadhyay Neogi (2015) has found that household indoor air pollution was major cause of air born disease. The Annual Health Survey was conducted in 284 districts of nine large states covering 1404337 live births. It is revealed 7.6 percent deaths in the category children aged below five years in our country owing to indoor air pollution. This household Indoor Air pollution was second biggest environmental contributor to the burden of diseases in India. Finally conclude that rural area was most affected due to NMR (Neonatal Mortality Rate). There is need for new intervention policy to reduce household air pollution. There should be need fuel efficiency, safety and environmental protection along with affordable price.

Krishnendu Mukhopadhyay et al. (2014), has focused on the impact of ventilation status on indoor air pollution exposure in households’ kitchens or living rooms. In indoor environment, emission factor of the cooking fuel plays a vital role in determining indoor air pollution disease. Ventilation is a critical component of green homes and it plays a vital role in the assessment of human exposure to air pollutants in indoor environment. It is reported that indoor air has a higher concentration of gases and particles compared to outdoor air typically due to inadequate ventilation combined with high temperature and humidity levels. The use of biomass fuel sources at home are associated with significant adverse health effects on the fetus and young infants including poor intra-uterine growth (IUG), excess respiratory morbidity, poor post-partum growth and increased early infant mortality, although the strength of evidence for the mortality association was only modest.
Indumathi.S (2014), has explained the household air pollution from an environmental health perspective. Around 3 billion people in the world are exposed to household air pollution. Though most of them live in poor countries, the problem is not limited to poor countries. The study estimated that 500,000 to 600,000 people with low incomes in the US are exposed to indoor pollution because their primary source of heating is solid fuel. She has argued that when compared, outdoor air pollution creates less percentage of deaths than indoor air pollution. She has referred the records of World Health Organization that has estimated that around 4.3 million people across the world die every year due to illnesses attributed to household air pollution. In comparison, outdoor air pollution kills 3.7 million a year. Most people are vulnerable to indoor air pollution which is a major cause of all respiratory related illnesses.

Manupriya (2014), explained that according to Indian National Census 2011, around 780 million people have used wood as cooking fuel. She has found from the Global Burden of Disease assessment (2010) done by the World Health Organization (WHO), that around 1.04 million premature deaths and 31.4 million people’s disability-adjusted life years were attributed to household air pollution resulting from combustion of solid fuels used for cooking in India, accounting for about 6 per cent of the National Disease Burden. This situation was found in majority of the rural areas. We should reduce household air pollution through modernized kitchen as well as affordable price of fuels for people.

Krishnapriya P.P. (2013), households in rural regions of Uttar Pradesh and Kerala were surveyed. Within the states the chosen places were Bijnor and Thiruvananthapuram respectively. 723 households were randomly surveyed for this study. She has found that firewood along with dry coconut palm leaves were easily available abundantly free of cost. Since this district is specialized in sugarcane cultivation, agricultural residue such as dried sugarcane leaves was used as fuel during harvesting in winters. Mustard crop residual was also frequently used. Apart from these, people were using cow and cattle dung during the winter months. There is a positive relationship between availability of fuel (free of cost) and cooking materials usage. This type of fuel woods are the main cause of breathing disorders, eye ailments like redness of eyes and watery eyes while cooking, heart diseases and so on. She has recognized this as a major source of health risks to the exposed populations.
The economic component of development is positively associated with power consumption; there is a trade-off between power consumption and natural resource availability. Economic activities have necessarily generated waste residuals during the production or consumption process. There are two kinds of arguments. Whether the vulnerable groups in the society are victims or causes of environmental degradation? Kalpana Sharma has reported in Hindu (2013) that the shocking truth of 'electricity for all' still seems a distant dream. She has discussed that the energy consumption for cooking and its impact on vulnerable groups like women, elderly and children. Unprocessed materials such as agricultural waste, cow dung cake and firewood remained as the source of cooking energy in rural India. 83 percent of rural households rely on firewood, wood chips and cow dung which have more risk on health of women, elderly and children. Gathering of fuel wood is a difficult task for women. Conventionally, fuel wood collection is made by women and children through head-load. In addition women’s workload also is increased along with the other household activities.

Energy is one of the fundamental factors in the functioning of any civilized society needed to improve better life style and socio-economic development of the country. Availability of energy is an important determinant of the quality of life in human settlements. Muhammad Abul Foysal et al. (2012), conducted a systematic survey on household level to understand the energy consumption pattern and consumer’s preference of fuels with its environmental impacts interrelating to socio-demographic and geographic factors in the villages of Kabirhat Upazila under Noakhali District, Bangladesh. Researcher has selected the samples of rural households that use fire wood, cow-dung, leaves & twigs, branches, straw and rice husk as biomass energy mainly for cooking (98.3percent). It was found that rural households collect 42.6percent of biomass from their own homestead and agricultural lands. They said those who have ownership of agriculture lands, use more and more of bio fuel energy. Mass awareness programmes should be done about the use of modern energy systems and these systems should also be made available for the rural households, their income pattern should be increased so that the people use non-polluted energy for their survival purposes.

Murugan M. (2011) has studied about the rural household energy consumption in Kanyakumari District of Tamil Nadu. He has adopted a random sampling method for about 200 households. He has classified two types of energy sources like commercial and non-commercial energy sources. The one which is non-renewable energy
resources comes under the commercial resources like Coal, petroleum and electric power and so on, whereas non-commercial resources consists of renewable energy sources like firewood, dried dung and waste residual crops etc. He strongly mentioned that people do not have access to Commercial energy resources due to the high cost of the installation of the biogas plant at individual level. Whereas, non-commercial resources can be easily available as well as they are free of cost, so majority of people were using firewood and other crop residuals. It will generate environmental problem of air pollution. The researcher found from his study area that though it is possible for the establishment of Biogas plant in this study area, no one has erected the Biogas plant. This is due to the huge amount of investment on it. If cost is minimised and if the government provides the people with subsidized long term loan, then people may come forward for erecting Biogas plants. When people start to use commercial energy the pollution can be minimised.

Kavi Kumar K.S. and Brinda Viswanathan (2011) Solid fuels are still a major source for cooking in many households in India causing significant diseases and global warming burden. This study analysed that solid fuels burned in traditional stoves often result in inefficient combustion, with less than 80-90 percent conversion of fuel carbon into carbon dioxide (CO). It generates harmful pollutants such as carbon monoxide, formaldehyde, benzene and many other pollutants that have the potential to cause health hazards get emitted through small particles in many houses using the solid fuels. Given that most houses have inadequate ventilation for kitchens and living rooms are not separated from kitchen areas, the emissions from the use of solid fuels are inhaled routinely by the members of the household. Particularly the women, children and elderly in the house get maximum exposure from these emissions. They have concluded that clean cooking stoves programs launched earlier in India have not been very successful, but the recent new program launched by the Government of India aims to renew the efforts in this context and proposes to provide clean energy through next-generation of household cook stoves.

Kim K.H. et al. (2011), has studied about respiratory diseases associated with cooking materials. The energy requirement for cooking depends on many factors such as the type of food cooked, the number of meals cooked, household size, the specific combination of energy source, and cooking equipment employed. Biomass fuel is one of the major sources of domestic energy especially in the developing countries. About
2.4 billion people rely on traditional biomass, mainly for cooking and heating as they have limited access to better alternative energy sources like natural gas or electricity. The major sources of Indoor Air Pollution (IAP), are the combustion by-products released from heating and cooking that can increase potential health risks. There is evidence linking an increased risk of cooking emissions with diverse diseases which include respiratory tract infections, exacerbations of inflammatory lung conditions, cardiac diseases, stroke, eye diseases, tuberculosis (TB), and even cancer. Women exposed to indoor smoke are three times more likely to suffer from COPD, such as chronic bronchitis, than women who cook with electricity, gas, and other cleaner fuels. Exposure to smoke from coal fires doubles the risk of lung cancer. Every year, more than one million people die from lung cancer globally and exposure to biomass fuel smoke is responsible for approximately 1.5 percent of such deaths. There is consistently strong evidence that exposure to indoor air pollution increases the risk of pneumonia among children under the age of five years and chronic respiratory disease and lung cancer (in relation to coal use) among adults over 30 years of age old respectively.

Jyoti Parikh (2011), has explored the inter-linkages of gender, energy use, health and hardships in the Himalayan State of Himachal Pradesh in India. The study brings out a gender-differentiated and age-differentiated picture of hardships and health impact on the use of traditional bio-fuels. She has collected samples from 4296 individuals, 729 households, 84 villages and 9 districts where biomass fuels meet 70 percent of household fuel needs. She says that women are facing many health problems due to the use of fuel wood collection and consumption. On an average, a woman walks 30 km every month taking 2.7 hours per trip for fuel wood collection over hilly terrain, often at high altitudes and undergoes stress like stiff-neck, backache, headache and loss of work days, respiratory diseases, eye diseases, infant mortality, adverse pregnancy and so on. Girls below 5 years of age and females in the 30–60 age-groups have higher proportion of respiratory symptoms than males of similar age-groups. Government should ensure the economic empowerment of women. Access to energy should be linked as a promotional incentive for running small-scale energy business units so that security or livelihood is ensured and employment opportunities for women are generated. The options such as improved stoves, solar cookers, biogas and more LPG and kerosene also need to be considered.
Household use of solid fuels is the most widespread source of indoor air pollution worldwide; solid fuels are extensively used for cooking at home and heating purposes in developing countries, especially in rural areas. Perez-Padilla R. et al. (2010), they have discussed that domestic pollution is relevant to health because people spend most of their time indoors. One half of the world's population is exposed to high concentrations of solid fuel smoke (biomass and coal) that are produced by inefficient open fires, mainly in the rural areas of developing countries. Concentrations of particulate matter in kitchens increase to the range of milligrams per cubic meter during cooking. Solid fuel smoke possesses the majority of the toxins found in tobacco smoke and has also been associated with a variety of diseases, such as chronic obstructive pulmonary disease in women, acute respiratory infection in children and lung cancer in women. As the desirable change to clean fuels is unlikely, efforts have been made to use efficient, vented wood or coal stoves, with varied success due to inconsistent acceptance by the community.

Arunachal Pradesh is a part of Eastern Himalayan biodiversity hotspot. The state has 81.25 percent of area under forest cover, more than 90 percent of the population use biomass as the primary source of energy. Rawat J.S. (2010) has highlighted that the people of this state do not have access to clean fuel. The fuel consumption pattern in rural Arunachal Pradesh reveals that the people spend more than 79.23 percent on firewood only. When people depend on firewood, we cannot prevent the loss of biodiversity. The indiscriminate use of forest products for livelihood is threatening the area and also triggering the climate change. Bio-fuel usage and respiratory diseases are closely related. Author has suggested that new and energy efficient chulha can be popularized in the rural parts of the country. The National Program on Improved chulha (NPIC) being operated in several parts of the country has been popularizing improved chulhas better than the traditional ones. The government can adopt this improved model for propagation in rural areas in subsidized rates. Finally, ensuring adequate supplies of clean fuel is important in relation to both environment and health issues.

Considering the fact that the women and young children are vulnerable to indoor air pollution, for instance Fullerton D.G et al. (2010) has highlighted the problem faced by the women and young children affected by indoor air pollution associated with very high levels of indoor Particulate matter. The incidence of Acute Respiratory Infections, Tuberculosis, and Chronic Obstructive Pulmonary Disease, among those who spend much of their time cooking indoors and preparing food is caused by using unprocessed
polluted materials. It affects particularly women and young children. He has said that, the WHO listed Indoor Air pollution from burning solid fuels as one of the top ten global health risks. Moreover, all existing studies have been performed in the context of developing countries. The purpose of the current paper is to partially fill this important gap to be addressed, i.e. need for better estimates for policy making, there is commendable new major effort to improve and update such steps being initiated.

Fuel is one of the domestic energy need for everyday. Income is an important factor to determine choice of fuel. Gender has also been well recognized as a social dimension among the population sorting out who are exposed to indoor air pollution. Vinod Joon et al. (2009), the researchers have collected 250 samples from household survey in the selected rural village of Nuna Majra of district Jhajjar, Haryana. They observed that the women aged between 16–60 years spent maximum time in kitchen as they are involved in cooking, indicating that women were more affected by indoor air pollution, whereas, elderly people and children below five years of age who remain indoors, though not necessarily in kitchen, were also exposed to the harmful effects of indoor air pollution. Young male members were least exposed to the kitchen smoke as most of the time they were outside the home. Women are the main beneficiaries of a transition to cleaner fuels not only because of better health, but also because of eliminating the drudgery associated with fuel collection. Author has suggested that if people were using improved cooking technology with cleaner-burning fuels it will reduce the morbidity and mortality rate associated with indoor air pollution.

Brendon Barnes et al. (2009) made an attempt to study that indoor air pollution due to the burning of polluting fuels indoors has been associated with Acute Lower Respiratory Infections (ALRI) among children less than five years of age. He has found that indoor air pollution is responsible for about 1400 deaths among child population annually. Most of the children depend on their parents. He has argued that there should be some positive associations between indoor air pollution and child Acute Lower Respiratory Infections (ALRI). And also indoor air quality is a major cause of indoor air pollution related diseases. Due to polluting fuels many health issues were generated among people who were involved in cooking and other who depend on them. Finally he has concluded that there is evidence of the progression up the energy ladder towards the exclusive use of electricity. There are possibilities, however, for a considerable delay in the uptake of
electricity as a main source of energy by people. Practitioners need to identify effective yet appropriate interventions to fill the gap until electricity is accessible and affordable.

**Priscilla Johnson et al. (2008)** assessed the economic cost of Indoor Air Pollution among the rural communities in terms of human health. The cost estimates are based on the detailed primary (household level) data collected from an intensive study conducted in Tiruvallur District, in the state of Tamil Nadu in South India. The cost estimates revealed that the impact of Indoor Air Pollution on rural communities is quite substantial in monetary terms. This paper argues that the biomass has remained as the principal cooking fuel for a large majority of rural households for many years. Hence, the author suggests that, an effective mitigation strategy should employ a variety of options, starting from improving the usage of clean fuels and cooking technology to housing and kitchen improvement in order to avoid health risk in future and also to reduce the morbidity, mortality rates thereby decreasing the economic burden.

Most of the developing countries still rely on firewood for their basic energy needs. This energy usage is associated with high levels of indoor air pollution and an increase in the occurrence of respiratory infections including pneumonia, tuberculosis and chronic obstructive pulmonary disease, low birth weight, chronic obstructive lung disease in women and adults. **John H. Y. Edwards and Christian Langpap (2008)** have found out that those women who have been carrying children during the cooking time were indirectly exposing their children to respiratory diseases. More than 14 percent of children were affected by the respiratory infection. They suggested that policies that improve access to credit or subsidize the price of stoves or LPG are likely to be effective in increasing stove ownership and decreasing the wood consumption.

**Esther Duflo et al. (2008)** made a study on indoor air pollution and respiratory health in rural regions of Orissa state. The study covered 2357 households of 40 villages in the two districts of Ganjam and Gajabathi. The study revealed that indoor air pollution is indeed a significant health threat in rural areas where households rely on traditional chulhas for their cooking needs. Author found a high incidence of respiratory illnesses, however, the choice of stove usage is correlated with other factors that affect health (such as income levels and empowerment of women). They have discussed that cooking and heating with solid fuels on open fires or on traditional stoves generates high levels of health-damaging pollutants, such as particulates and carbon monoxide. Women are primarily responsible for cooking, and as children often spend time with their mothers
health-damaging pollutants, such as particulates and carbon monoxide. Women are primarily responsible for cooking, and as children often spend time with their mothers while they are engaged in cooking activities, women and young children are disproportionately affected.

Indoor air pollution affects human health and wellbeing in several ways. M. Khalequzzaman et al. (2007) they disputed that Indoor air had concentrations of volatile organic compounds (VOCs), carbon monoxide (CO), carbon dioxide (CO), nitrogen dioxide (NO), and dust particles which were measured amongst 49 biomass and 46 fossil fuel users in urban slums of Dhaka, Bangladesh. The health impact of these pollutants was assessed on 65 and 51 children under the age of five years from families who use biomass and fossil fuels as the main source of energy, respectively. They assessed the symptoms such as redness of eyes, itching of skin, nasal discharge, cough, shortness of breath, chest tightness, wheezing, or whistling chest were found to be associated with the choice of biomass fuel. Health effects include acute respiratory infection in children, chronic obstructive lung disease, and adverse pregnancy outcomes and lung cancer in women.

James H (2007), discussed about those indoor air pollutants associated with combustion of solid fuels in households of developing countries. Researcher chose a study village on Nianjem in Bagamoyo, Tanzania. He randomly selected one hundred homes in Nianjem and found that most of the pollutants associated with indoor pollution are PM10, NO2, and CO whose concentration in kitchen is high due to bio mass fuel burning. Moreover, exposure to the pollutants present in smoke is widely believed to be a risk factor for a number of health damages such as Acute Respiratory Infections (ARI), Chronic Obstructive Pulmonary Disease (COPD), Asthma, Low birth weight, Cataract and Blindness. Strong association has been documented between biomass fuel use and increased incidences of COPD in women and acute respiratory infections in children.

Joshi SK (2006), assessed the indoor air pollution and health effects of solid bio mass fuel, she has explained that around 50 percent of people were using solid bio-fuels that lead to chronic diseases. Exposure from bio-mass smoke is estimated to cause a global death toll of 2.5 million every year equivalent to 4 to 5 percent of total global deaths. The work of households can be categorized as hazardous occupation as they might be exposed to volatile organic compounds and polycyclic aromatic hydrocarbons every day. There are evidences that indoor air pollution may increase the risk of
respiratory tract infections and lung cancer among people. Poor ventilation of housing can lead to many health problems, and is associated with various infectious diseases, stress and depression. She suggested that indoor air pollution for instance can be reduced by changes in energy technology, such as, switching from bio-mass fuels to cleaner fuels like kerosene, liquid petroleum gas, biogas, solar energy; improving the design and construction of locally made traditional stoves by the use of chimney, fume hoods; and changes in the living environment such as, improving the state of kitchen ventilation and raising awareness among the local people about the seriousness of the kitchen air pollution and building up participatory approach in the efforts can reduce indoor air pollution.

Eva Rehfueß et al. (2006) analyzed the socio economic dimensions of assessing household solid fuel use, specially referring to United Nations Millennium Development Goals (MDG). Relevant Socio Economic Variables such as eradication of poverty, achieving universal primary education, promoting gender equality and empowering women, reducing child mortality, improving maternal health, combating HIV/AIDS disease, and ensuring environmental sustainability, developing global partnership development based on 2.4 billion people continue to depend on biomass fuels to meet their basic energy needs for cooking. Globally, 52 percent of the population cook with solid fuels. Young children are often carried on their mother's back during cooking or kept close to them. Consequently, children spend many hours breathing indoor air pollution during their first year of life, when their respiratory systems are not properly developed and their immature immune systems make them particularly vulnerable to hazardous pollutants. Moreover adult education and child care will reduce the risk of health problems and injury for women and children.

Antonio I. Lacayo (2006) has said that the rural areas in developing countries suffer significantly from energy scarcity, forcing people to rely on traditional biomass as their primary energy source. The current approach of the government of India (GOI) to solve this problem focuses on extending the electricity grid, which fails to attend the real needs of poor people and is too expensive. He has discussed the potential use of off-grid energy technologies, like improved cooking stoves, biogas digesters, and micro hydropower, as an alternative for grid extension. This is followed by four policy recommendations to ensure that UN rural energy projects are effective in complementing the GOI's efforts and attending the basic energy needs of the most poor
in rural India. These recommendations are: to provide micro-credit and consulting for the promotion of off-grid renewable energy technologies (RETs) to focus on alleviating women’s energy needs, particularly cooking; to include capacity building in energy projects by creating partnerships with the community and providing technical assistance; and to financially support local entrepreneurs who could either benefit from energy access or supply their communities with energy services.

Madubansi M. and Shackleton C.M. (2005) have explained that in South Africa in the early 1990s the government implemented a widespread electrification programme, as well as introduced a free basic electricity allowance as a means of poverty alleviation. There are limited longitudinal studies on the impacts of the introduction of electricity on the patterns of household energy use, and even more so in the neglected rural sector. This study reports on the patterns of household energy use in five rural settlements in 1991 and again in 2002. He has indicated a changing pattern of energy use for lighting and powering entertainment appliances, more specifically from dry-cell batteries and paraffin to electricity. Yet for thermal needs, most not capably cooking, fuel wood has remained the most widespread fuel, and the amount used per month has not changed, despite increasing scarcity of wood in the local environment. There has been an increase in the proportion of households purchasing fuel wood as opposed to collecting their own indicating that electricity is simply viewed as an additional energy, rather than an alternative. Yet, electricity accounted for approximately 60 percent of expenditure on energy sources in 2002, despite the government’s policy of a free basic allowance of 5–6 kWh per month. This has implications for energy supply costing, as well as the poverty alleviation dimensions of the future.

Howells M.I. et al. (2005) say that the gathering of fuel-wood and other traditional fuels is a strenuous and time consuming task mainly performed by women; Indoor exposure to particulate matter, mainly from cooking and heating with traditional fuels, causes about 2.5 million deaths each year in developing countries. Modern fuels and appliances allow households to reduce their exposure to smoke from biomass cookers and heaters. Yet modern fuels are costly for income-poor households and often carry their own external costs. For example, numerous children are poisoned from ingesting paraffin, and whole villages have burned from fires triggered by paraffin stoves and lamps.

Kalpana Balakrishnan et al. (2004) made a study on indoor air pollution associated with rural households in India among three districts of Andhra Pradesh,
namely Ranga reddy, Warrangal and Nizambad. 1452 sample households were taken up for the purpose. Researcher found that household income has been one of the most important determinants in the choice of fuel. Thus their using of traditional fuels and poverty remains closely interlinked.

Vijay Laxmi et al. (2003) have analyzed the socio-economic dimensions of household energy, women’s hardship and health impacts in rural Rajasthan. They argued that indoor air pollution has economic terms as negative externalities. They have collected data through a large and comprehensive survey covering perhaps the largest sample of 58,768 individuals in 10,265 rural households from three states in northern India, viz., Uttar Pradesh, Rajasthan and Himachal Pradesh. They had revealed that women experience a lot of drudgery due to the use of bio-fuels. People are walking approximately 2.5km to collect fuel-wood. About 50 hours per month per household are spent in fuel-wood collection and transportation. The use of kerosene for cooking is negligible in the area, because of unavailability more than non-affordability. The people in the rural areas of Rajasthan are willing to pay for kerosene, the next fuel on the energy ladder above bio-fuels. It is estimated that even at a price of Rs.13 per litre, which is higher than the market price, about 34 percent of households are willing to buy additional quantities of kerosene for cooking. Therefore there is a need to meet this unmet demand by addressing market failures. They explained that higher the respiratory problem, lower the female literacy rate. Wherever the female literacy rates are higher, the incidence of respiratory problems is lower. So, the education of women plays a vital role in determining their household structure like using modernised kitchen, ventilation of house and separating the kitchen from the living area.

Kirk R. Smith, Sumi Mehta, (2003) They have analyzed four different methods and applied them to estimate the burden of disease due to indoor air pollution from household solid fuel use in developing countries (LDCs). The largest number of estimates involves applying exposure-response information from urban ambient air pollution studies to estimate indoor exposure concentrations of particulate air pollution. Another approach is to construct child survival curves using the results of large-scale household surveys, as had been done for India. A third approach involves cross-national analysis of child survival and household fuel use. The fourth method, referred to as the fuel-based approach found that globally 4-5 percent of people suffer in developing countries and totals to both deaths and DALYs (disability adjusted life years) from acute
respiratory infections, chronic obstructive pulmonary disease, tuberculosis, asthma, lung cancer, heart disease, and blindness which could be attributed to solid fuel use in developing countries. 64 percent of children who suffered from acute respiratory infections were under five years of age and are the largest single category of deaths. 81 percent were affected with Disability Adjusted life years (DALYs) from indoor air pollution, before last two decades apparently being responsible globally for about 1.2 million premature deaths annually.

Jyoti Parikh et al. (2003), concentrated the study an women’s health risk especially for those who actively involved in cooking and analyzed the factors for respiratory disease symptoms in rural women on the basis of socio-economic variables such as characteristics of the kitchen, cooking practices, type of fuel used, health symptoms, etc., They have collected a random sample of selected states like Rajasthan, Himachal Pradesh and Uttar Pradesh. They found that there is an inverse relationship between female literacy and indoor air pollution diseases. When there is an increase in the education level of female adult, prevalence of indoor air pollution symptom decreases. In terms of socio-economic status, which may be reflected through income, house quality, nutritional intake, and so on, the occurrence of respiratory symptoms could be found directly or indirectly. Ventilation of kitchen and proper awareness may reduce their health effects.

WHO (2002) has estimated that IAP is responsible for nearly two million deaths annually in developing countries and around 4 percent of the burden of diseases (expressed as DALYs – disability adjusted life years). In addition to these direct effects of IAP on health, are other consequences arising from the use of household energy in conditions of poverty. These include burns to children falling onto open fires, ingestion of kerosene stored in soft-drink containers, restrictions on income generating activity, the opportunity costs for women for spending many hours in collecting fuel as this becomes increasingly scarce, as well as injuries arising from carrying heavy loads and collecting fuel in areas where there is a risk.

The human civilization started with the historic revolutionary invention of fuel energy which today has become a universal concern. Energy is the important component of ecosystem and household is the major consumer of this component for various activities like cooking, water heating and lighting. Suma Hasalkar et al. (2002) assessed the energy consumption in the household ecosystem. They chose the study area
of Dharwad taluk and another base line study of Hubli-Dharwad pre-urban interface in five talks around Hubli-Dharwad city. They selected the rural area, urban area and urban slums. Seventy households from each of the three areas were interviewed. The Researcher has found out that the commercial energy sources were higher in urban areas and the non-commercial energy sources were higher in rural areas. Among the urban people 100 percentage were using LPG and electricity for their cooking and heating purposes. On the other hand, all the rural households used kerosene for lighting purpose because of the frequent power failure in rural areas. The non-commercial energy sources were mainly used in rural areas and the main reason for usage was that it was a traditional fuel and was easy to handle. Maximum percentage of rural respondents says LPG has high initial investment and it was the main problem for their not using LPG. Therefore, they depend mainly on non-commercial energy sources for household energy needs.

Mr. Pandey (2002), author conducted a study on the domestic smoke pollution and respiratory diseases in Nepal Four different sites were selected for this purpose, these sites were Urban Kathmandu and the Sundarijal and Bhadrab as villages of Kathmandu district from the rural hill region, Parasauni of Baradistrict from the plain region, and Chandannath of Jumla district from the mountain region of the country. He strongly argued that domestic Indoor air pollution is the main cause of respiratory diseases such as chronic obstructive pulmonary disease (COPD) in adults and acute respiratory infection (ARI) in children especially in rural locations of developing countries. He estimated that about half of the world’s houses cook daily with biomass fuels. Most of the people cook indoors with unventilated stoves. It'll generate domestic smoke and this pollution may lead to asthma.

Kirk Smith (2002) has indicated that indoor air pollution (IAP) from household cooking and space heating apparently causes substantial ill-health in developing countries where the majority of households rely on solid fuels (coal or biomass as wood, crop residues, and dung), but there are many remaining uncertainties, Acute Respiratory Infections (ARI) a class that includes infections from a range of viruses and bacteria, but with similar symptoms and risk factors. At one-eighth of the total burden, ARI is the largest single disease category for India, as well as for the world at large where it causes about one-twelfth of the total burden of disease. Firewood smoke has been released preferential carbon monoxide. Its absorption by hemoglobin leads to Low birth weight, and it is a risk factor for a range of diseases in childhood and, probably in later life. Much
health impacts from air pollution worldwide seems to occur among the poorest and most vulnerable populations, largely women and young children who are the most exposed to the indoor pollution sources of importance in poor countries.

Kalpana Balakrishnan et al. (2002). Indoor air pollution is a major risk factor contributing to the national burden of disease. Considerable uncertainty exists about the absolute magnitude of the health risks. Indoor air pollution resulting from combustion of biomass fuels in rural households of developing countries is now recognized as a major contributor to the global burden of disease. They have quantified exposures to respirable particulate matter from biomass-fuel combustion in 436 rural homes selected through stratified random sampling from four districts of Tamil Nadu, India. Researchers collected socio-economic and health information from the selected households. Combustion of biomass fuels in poorly ventilated kitchens using poorly functioning stoves leads to high concentrations of respirable particulates. Researchers have identified that the frequency of biomass-fuel use in households with access to clean fuels varied depending upon availability of clean fuels, the economic situation of the household, and occasional social considerations. But for the most part these households used biomass fuels, as there was no direct cost involved in procuring the fuels locally. The morbidity and mortality associated with such smoke exposures. The burden of environmentally associated diseases is just beginning to catch the attention of health policy makers in developing countries.

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Considering the fact that the women and children are more vulnerable to indoor air pollution problem, Majid Ezzati et al. (2002) has highlighted the problems faced by the young children and women. Burden of disease is calculated as the number of years lost because of premature mortality plus the number of years lived with disability due to a disease caused by indoor air pollution, with appropriate disability weights, childhood mortality counts for a large number of years lost because of premature mortality and a large contribution to burden of disease. They suggested that people must use new inventions (for effective combustion of fuels). Infrastructure to support technological innovations, marketing, dissemination and maintenance of new equipment at an affordable cost may reduce indoor air pollution and resulting health hazards.

Nigel Bruce et al. (2000) discussed that indoor air pollution has been strongly influenced by the negative externality. An external cost exists when an activity by one agent causes a loss of welfare to another agent. Various studies in developing countries have reported on the association between exposure to indoor air pollution and acute lower respiratory infections. Poverty is one of the main barriers to the adoption of cleaner fuels. The slow pace of development in many countries suggests that biomass fuels will continue to be used by the poor for many decades. Finally, it is necessary to keep in mind the close interrelationship between poverty and dependence on fuel wood and consequently the importance of socio-economic development, which should be at the core of efforts to achieve healthier household environments.

Kirk R. Smith (2000) He has discussed that developing countries experience total burden of disease mortality and morbidity attributed to use of solid fuels in adult women and young children, who jointly receive the highest exposure because of their household roles. Attributed risks are calculated based on the inference to the demographic conditions and patterns of each disease in India. Indoor air pollution generated for acute respiratory infections, chronic obstructive pulmonary disease, and lung cancer. Smith estimated that diseases like tuberculosis, asthma, blindness occurred in most of the women and children who have maximum exposure to indoor air pollution.
He has also estimated the lowest possibility of occurrence of heart disease due to this air pollution. Insufficient quantitative evidence is currently available to estimate the impact of adverse pregnancy outcomes such as low birth weight and stillbirth. His estimates indicate that some 400–550 thousand premature deaths can be attributed annually to the use of biomass fuels in these population groups. Using a disability-adjusted lost life-year approach, the total is 4–6 percent of the Indian national burden of disease, placing indoor air pollution as a major risk factor in the country.

**Jyoti Parikh and Vijay Laxmi (2000),** assessed the economic costs of rural communities in terms of biofuel pollution and health linkages of rural Tamil Nadu. The cost estimates are based on the detailed primary household level data collected from an intensive study. They chose four districts of Tamil Nadu, namely Chengalpattu MGR, Coimbatore, Tirunelveli and Tiruchirapalli were selected from four socio-cultural regions. They used multistage sampling design covering all the three corners and central region of the state. Biofuels are the main source of cooking for about 96 percent of households. Use of dung cake is not very common in the area. In most of the villages the distance travelled to collect fuel wood is less than 1 km. Average consumption of fuel wood is 2.5 kg per household per day and fuel is generally gathered from the nearby forests. The average distance travelled to collect wood is about 1.5 km and in a month about 12 km is travelled by each household. The paper argues that approximately 50 percent of the population have no other option but to use biofuels due to non-availability of kerosene. Demand of kerosene at market price of Rs. 10 is estimated to be 8 litres per month in the sample households. This latent demand can be tapped to reduce health impacts and drudgery of women. People can take efforts to substitute biofuel with kerosene or LPG to avoid smoke. The results suggested that availability of clean fuels viz., kerosene and LPG is not sufficient in the area. Commercial fuel use lacked mainly due to non-affordability and unavailability. Therefore, people were forced to use non-commercial fuel i.e. Bio-fuels.

Considering the fact that women and children are vulnerable to any socio-economic and environmental problems, for instance **Jyoti Parikh et al. (1999)** have highlighted the acute respiratory infections (ARI), chronic obstructive lung disease such as chronic bronchitis and lung cancer, and possibly tuberculosis, adverse pregnancy outcomes, blindness, heart disease and asthma problems faced by the women and young children exposed to indoor air pollution. The importance of this in India is
illustrated by the startling statistics revealing that ARI plays a prominent role in the Indian national burden of disease (NBD) in Indian children under the age of 5. It alone is responsible for 2 percent of the entire Global Burden Disease.

Pandey M. R. et al. (1990), chose 20 houses for this study in Dundechaur taluk village panchayat, situated on the south west valley about 22 km from the edge of Kathmandu. The terrain and living conditions of the area are typical of rural communities in the hilly region of Nepal. People were using traditional stoves which burn biomass fuels for cooking and heating in houses with no chimneys. Due to poor ventilation, household smoke levels are high. They have introduced new Tamang smokeless stove. It released less smoke in the indoor environment. In all cases but one, the women found that there was less smoke in the kitchen while cooking with Tamang stove than with the old one. They have established the cause-effect relationship between smokeless stove use and reduction in domestic smoke pollution. It supports efforts to introduce smokeless stoves in the village as soon as possible.

Pandey M.A. et al. (1989) conducted a preliminary study on Domestic Smoke Pollution and Acute Respiratory Infections in a Rural Community that belongs to a Hilly Region in Nepal. The study area is comprised of two contiguous village panchayats, Taluk Dundechaur and Chhaimale, and the adjacent villages of Dakshinkali. They argued that air pollution is a problem of industrially developed countries. But the problem of indoor air pollution in rural locations in developing countries, where biomass fuel is the principal source of energy is considerable. Traditional stoves that burn biomass fuels such as firewood and agricultural residues are used for cooking and heating in ill-ventilated houses. This problem is common in the north Indian belt. Hence they consider that domestic smoke pollution is very common in many parts of the developing world. They pointed out that the infants were affected by acute respiratory infection in those regions. They suggested that smoke-less stoves can reduce this type of pollution.

Holly F. Reid et al. (1986), has chosen two districts, Gorkha and Beni (Myagdhi) districts of middle hills of Nepal. They have collected 60 sample households from both the districts. They have assessed that, rural Nepali women usually cook on indoor open fire, on an average for more than 90 percent of the cooking period, confined within 2 metre both traditional and improved cooking stove. Thus they spend 5 hours a day, nearly 20 percent of the day near the cooking stove. It was found that non-smoking
women had a higher rate of chronic bronchitis than non-smoking men. They found that domestic cooking is an important factor in the promotion of this chronic obstructive lung disease, which affects about one-fifth of rural adults in Nepal. They suggest people need to use improved cooking stove, which may reduce women’s health problems.

2.3 Critical Remarks

The review of literature highlights the important issues pertaining to the Indoor Air Pollution (IAP) of the households particularly in the Indian context and certain studies are reviewed. This chapter deals with identifying the appropriate theoretical variables to be considered for the present study, besides findings lacuna in research. Though several empirical studies related to indoor air pollution problems, such as, those of women, children and dependency health are there, references to certain empirical studies are quoted in the subsequent chapters of the thesis.

Only few studies have been made in Tamil Nadu. For instance, Jyoti Parikh and Vijay Laxmi (2000), Kalpana Balakrishna (2002), M.Murugan (2011) etc., they have discussed the reasons for the usage of bio-fuels by the rural households. Commercial fuel has high cost; hence they could not afford to get clean fuel. Therefore, people were forced to use non-commercial fuel such as firewood, crop residue, dung cake and so on.

Most of the studies have been done in India about Socio-Economic dimensions of Indoor Air Pollution, particularly about its impact on the health of women and children. Other aspects like ventilation of kitchen, availability and affordability of clean fuel have also been studied. Kirk Smith (2000, 2002), Jyoti Parikh (2003, 2011) were the empirical works carried out in India. Women and children who spend time near the domestic hearth are more likely to suffer from the ill-effects of indoor air pollution. It is admitted that the review made in this chapter cannot be claimed to be exhaustive. But earnest efforts have been made to access the available studies in our country, the review of which is included in the foregoing chapter.

From the preceding review, the present study could identify different theoretical and policy variables, in the sphere of indoor air pollution. It includes Health damage cost spent on the treatment of airborne and other diseases particularly those occurring in women and children, distance travelled to collect firewood, collection hours, family size, time spent in cooking process, kitchen ventilation, percapita fuel consumption, percapita cost incurred for fuel, and health respectively.
The methodology adopted in various studies was aimed at penetrating issues more at part of some extent. Hardly any attempt is made so far in India to look at this problem in a holistic approach through the economic aspects towards finding a solution to the problem. The present study is proposed to estimate the demand for clean fuel energy for cooking and heating in the rural areas in particular. Most of the researchers have discussed about health and availability of fuel. This study has identified socio economic character such as households’ income, expenditure, kitchen ventilation, cooking place, primary source of cooking material and health impacts of air borne diseases and its health cost thereof as crucial factors.