A STUDY ON HOUSEHOLD ENERGY CONSUMPTION OF URBAN NAGALAND

by

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DEDICATED TO,

To my loving parents, who taught me to persevere in life.

To my siblings, thank you for being there always.

Nagaland University

(A Central University Estd. by the Act of Parliament No. 35 of 1989)

Lumami - 798627, Nagaland, India

CERTIFICATE

This is to certify that the thesis entitled **"A Study on Household Energy Consumption of Urban Nagaland"** submitted by Miss Niriezono Punyu, bearing Registration No.723/2016 dated 21/08/2015 embodies the results of investigations carried out by her under my supervision and guidance. Further, certified that this work has not been submitted for any degree elsewhere and that the candidate has fulfilled all conditions laid down by the University. The thesis is therefore, forwarded for adjudication and consideration for the award of degree of Doctor of Philosophy in Economics under Nagaland University.

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DECLARATION

I, Niriezono Punyu, hereby declare that the subject matter of my Ph.D. thesis entitled **"A Study on Household Energy Consumption of Urban Nagaland"** is the record of original work done by me, and that the contents of this thesis did not form the basis for award of any degree to me or to anybody else to the best of my knowledge. This thesis has not been submitted by me for any Research Degree in any University/ Institute.

This thesis is being submitted in compliance with the University Grants Commission Regulations 2016 dated May 05, 2016 (Minimum Standard and Procedure for Award of M. Phil. / Ph.D. Degree). It is certified that the content of the thesis is checked for 'Plagiarism' with licensed software 'URKUND' and satisfies with the norms of 'University Grants Commission, Govt. of India'. This thesis is being submitted to the Nagaland University for the degree of 'Doctor of Philosophy in Economics'.

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(Niriezono Punyu)

CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

ACRONYMS

BEE:	Bureau of Energy Efficiency
CAGR:	Compound Annual Growth Rate
CFLs:	Compact Fluorescent Lamps
GJ:	Giga Joules
GWh:	Giga Watt Hour
IEA:	International Energy Agency
ILBs:	Incandescent Light Bulbs
IRES:	Indian Residential Energy Survey
kgoe:	Kilograms of Oil Equivalent
kWh:	Kilo Watt Hour
LED:	Light-Emitting Diode
LPG:	Liquefied Petroleum Gas
MJ:	Mega Joules
MNRE:	Ministry of New and Renewable Energy
MoSPI:	Ministry of Statistics and Programme Implementation
Mtoe:	Million Tonnes of Oil Equivalent
MU:	Million Units
MW:	Mega Watts
NSAPCC:	Nagaland State Action Plan on Climate Change
NSDP:	Net State Domestic Product
NSHDR:	Nagaland State Human Development Report
NSSO:	National Sample Survey Office
NSVA:	Net State Value Added
OLS:	Ordinary Least Squares
PNG:	Piped Natural Gas
TFLs:	Tubular Fluorescent Lamps

CHAPTER 1

INTRODUCTION

The great challenge of the twenty-first century is to raise people everywhere to a decent standard of living while preserving as much of the rest of life as possible.

~ Edward O. Wilson

1.1 BACKGROUND

Energy is an integral part of human lives and is one of the most fundamental aspects of life on earth. Human survival relies on energy production and use (UNDP, 2000). People rely on energy in various forms to enjoy unprecedented comfort and productivity. Energy has long been recognized as an essential component in meeting basic human needs, stimulating and supporting economic growth, and enhancing the quality of life in human settlements (Musa, 2011). It is also an essential factor of production that plays a vital role in a region's economic and social development. It forms an integral input to the primary development challenge of providing sufficient food, shelter, clothing, sanitation, water, medical care, education, and access to information in a nation. Energy is used widely in all sectors of an economy, including agricultural and allied fields such as manufacturing fertilizers, farm machinery, and more; commerce; in homes for cooking, lighting, heating; and many more uses.

The energy consumption of a country is related to its per capita GDP. India has experienced rapid economic growth over the past decades, which has been accompanied by increasing urbanization, industrialization, and modernization. The growth in India's economy has also meant rapidly changing lifestyles and energy use patterns for its population. Although global energy use has been dominated by industrialized countries, the energy consumption of developing nations is also rapidly rising. Global energy consumption is expected to increase by more than 50% by 2050, primarily due to the rapid growth of urbanization in Asian countries (IEA, 2021a). Energy, therefore, emerges universally as critical for sustained human development and economic growth.

1.1.1 Household Sector and Urban Energy Scenario

The household sector[1] is an important composition for energy use in both developed and developing countries. According to International Energy Agency (IEA), household sector is the major consumer of total energy globally, accounting for 25-30% of total energy in developed countries and 30-95% in developing countries. In 2020, the total final energy consumption in the residential sector corresponded to 6096.76 billion kWh (22.38%) out of the total worldwide energy consumption of 27,238.90 billion kWh (IEA, 2021a). In India, the household sector accounts for 11.35% of final energy consumption (TERI, 2021) and 24.32% of electricity consumption (MoSPI, 2020). The demand for energy in the household sector is ever-increasing due to the sheer size of the population, rapid urbanization, increasing purchasing power, and climate variability (TERI, 2021). Overall household energy consumption refers to both the direct and indirect demand for energy that determines household metabolism (Moll et al., 2005). Direct energy consumption includes the energy consumed directly in or by households, such as fuels and electricity. In contrast, indirect energy use comprises the energy embodied in all goods and services consumed or the energy that is used in the production and distribution of everything that households consume (Pachauri, 2004). Household energy consumption in the current study refers to direct energy consumption.

Urban households have a wide variety of energy commodities from which they can choose. IEA has disaggregated residential energy consumption into five end-uses: space heating, water heating, cooking, lighting, and appliances. Accordingly, the most common energy sources used at the household level include electricity, LPG, solid biomass, including firewood and charcoal, and kerosene, among others. The energy demand by households in urban areas is also increasing due to increasing incomes and improved living standards. They have greater accessibility to modern fuels such as Liquefied Petroleum Gas (LPG), electricity, energy end-use equipment, and appliances (IEA, 2015). Hence their energy requirements are higher than that of rural residents.

[1] Throughout this study, the words ‘household’ and ‘residential’ will be used interchangeably and are taken to mean the same thing. However, precedence will be given to using ‘household’ as this better reflects the focus of this study which is micro, whereas the word ‘residential’ is more associated with a macro focus, i.e., the residential sector.

1.1.2 Energy Problem in the Urban Sector

The rapidly increasing population growth in urban areas poses a considerable challenge to the world's future energy demand. Together with economic development, the proportion of the urban population in the world increased from 30% in 1950 to 55% in 2018 (UNDESA, 2019). Urbanization in developing countries has experienced a high growth rate rising from 17.7% of the population in 1950 to 50.6% in 2018. In developed countries, 78.7% of the population lives in urban areas. Moreover, according to the United Nations projections, the world's urban population is expected to increase by 72% by 2050, from 3.6 billion in 2011 to 6.3 billion in 2050, of which 5.12 billion of this urban population will be in developing countries. The importance of this increasing urban population phenomenon has led various empirical studies to model urbanization as one of the driving factors of energy consumption (Liddle & Lung, 2014).

Urbanization significantly affects energy consumption through various channels. It increases energy consumption levels (Reddy, 2004) by raising the demand for food, housing, land use, electrical equipment, etc. According to IEA (2021a), urban dwellers account for over 60% of world energy use, indicating that the continuous increase in urbanization will significantly impact energy consumption. Urban energy use also significantly contributes to climate change. The Intergovernmental Panel on Climate Change (IPCC) report shows that urban areas generate about three-quarters of global carbon emissions (Seto et al., 2014). This share of global greenhouse gas (GHG) emissions is likely to increase as global urban populations continue to increase in the century. Urbanization also drives higher household energy consumption by facilitating higher average household incomes, as urban dwellers spend a share of extra income on purchasing more energy services (IEA, 2021b). Therefore, with increasing urbanization and population over time, energy efficiency policies and energy conservation behavior among urban households have become important issues in a developing country like India.

According to UNDESA (2007), urban households in developing countries often consume far more fossil fuel and electricity and more energy indirectly than directly as compared to rural households. The rapid growth of urban centers in developing countries has been accompanied by a massive increase in the demand for household fuels and electricity. Moreover, the expansion of urban areas can increase the scale of aggregate demand for biomass fuel. Reddy (2004) contends that urban households use logs which has a more significant adverse environmental impact than rural areas where households depend more on twigs and branches. The urban biomass fuel use pattern would exacerbate environmental and health problems unless supplemented by modern fuels and energy-efficient technologies. There are also externalities associated with urban energy markets (Barnes et al., 2004). Harvesting and utilizing biomass fuels can accelerate deforestation and its associated environmental side effects. Moreover, the demand pressures on surrounding forest land will continue. Therefore, the transition from traditional to modern fuels is vital for the urban population because of the potential to lower indoor air pollution and reduce deforestation in peri-urban environments.

1.1.3 Energy and Sustainability

Attaining energy security in terms of availability, accessibility, and affordability is crucial for sustaining a country's economic growth and human development. At the same time, judicious use of available energy is the key to meeting environmental demands that call for the optimization of resources and preventing environmental degradation. IEA (2015) reports that fossil fuels supply around three-quarters of India's primary energy demand. Without a substantial policy push in favor of alternative fuels, this share will increase over time as households move away from the traditional use of biomass. The decision of households for non-clean energy results in damaged health and increased pollution, which, in turn, negatively affects general societal welfare (Danlami, Islam & Applanaidu, 2015). Consumption of fossil fuels also contributes to air pollution and global greenhouse gas (GHG) emissions (IEA, 2015). Therefore, reducing dependence on fossil fuels for energy generation and improving energy efficiency at the generation and consumption stages are desirable objectives for minimizing the impacts of economic development on climate and ensuring long-term sustainability.

Household energy consumption is one of the significant sustainability challenges in the housing sector. In the World Energy Assessment (UNDP, 2000), sustainable energy is defined as energy produced and used in ways that support human development in the long term with all its economic, ecological, and social dimensions. It mentions the use of renewable energy sources, next-generation technologies, and greater energy efficiency as options to address unsustainable aspects of energy. Forests can absorb excess carbon from energy-related activities, replenishing the atmosphere with the oxygen needed for humans. However, when forests are burnt and cleared for fuel, this function is lost, and the environment is made worse off. Excessive use of biomass fuels also causes health problems, especially in women and children (Pachauri, 2007). Solid fuels are also associated with respiratory diseases like asthma, tuberculosis, and respiratory system cancer (Faizan and Thakur (2019).

As people move from rural to urban areas in search of a better quality of life that provides employment, essential services, health facilities, adequate shelter, and access to the global community, the result will likely increase pressure on the future energy demand of the country. Household energy consumption is also inextricably linked with individual or household behavior and lifestyles. OECD (2006) proposes that promoting sustainable consumption requires an improved understanding of consumer behavior and attitudes. Energy-saving behavior can be considered an integral part of sustainable consumption behavior. Sustainable energy consumption supposes to reduce energy consumption to a sustainable level. On the demand side, this goal can be achieved by improving energy efficiency by investing in better technologies or by energy conservation which means changing behavioral habits when it comes to energy consumption. Energy conservation and energy efficiency are effective means of ensuring that future populations are not negatively impacted by our current generation's consumption of natural resources.

Access to affordable and modern energy is a prerequisite for sustainable development. Realizing that energy is critical for people who are being deprived of the opportunity of access to sustainable energy, the United Nations adopted Goal 7 as one of the 17 Sustainable Development Goals in their General Assembly in 2015, intending to ensure access to affordable, reliable, sustainable and modern energy to all. The goal also stresses more focused attention to improving access to clean and safe cooking fuels and technologies, improving energy efficiency, increasing the use of renewable sources, and promoting sustainable and modern energy for all.

The targets adopted as a part of Goal 7 of the SDGs 2030 Agenda are as follows (adapted from MoSPI 2021):

I. By 2030, ensure universal access to affordable, reliable, and modern energy services.

II. By 2030, substantially increase the share of renewable energy in the global energy mix.

III. By 2030, double the global rate of improvement in energy efficiency.

IV. By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency, advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology.

V. By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular, least developed countries, small island developing states, and land-locked developing countries, under their respective support programmes.

1.2 STATEMENT OF THE PROBLEM

Household energy use is not visible, so people are often unaware of their domestic energy use. They tend to be concerned about the impact of energy use on the environment but fail to link their everyday behavior, such as the impact of domestic energy use on increased emissions and climate change. People are not mindful of leaving the lights on when not needed and leave televisions and other entertainment devices on standby without thinking about how these actions are executed, where the energy to power these modern-day conveniences come from, or what the environmental consequences are. This can lead to limited knowledge about how much energy people actually use in their homes.

The demand for energy in Nagaland is increasing as a result of urbanization. However, the State has a shortfall of power supply, especially during lean seasons, and households experience frequent power shutdowns. Furthermore, households in urban areas use modern energy appliances, which results in the overuse of valuable energy resources. They also rely on fuels like firewood and kerosene for cooking and heating purposes. The use of these fuels impacts human health and the environment due to emissions of pollutants and natural resource depletion. With climate change, intense winters and extreme summers are likely to increase domestic energy consumption in the State for cooling devices during summers and room and water heaters during winters. The supply of electrical power is the most erratic among all the primary energy sources. Power cuts are frequent, and supply is limited to a few hours a day during peak hours. The problem is more likely to intensify further due to increasing dependence on electricity from hydroelectric sources due to climate change affecting water resources. These highlight the issue of energy problems in the household sector and form a significant obstacle to an effective energy policy implementation.

Furthermore, there is no study on urban household energy consumption in the State. The Nagaland government has produced an action plan on climate change and various proposals on energy consumption regulation. However, without the rigors of understanding the factors that drive energy consumption and efficiency amongst domestic consumers, the document may remain conjectural. Hence it is imperative to examine the energy consumption pattern to assist in the formulation of effective future urban energy policies for the household sector in the State.

1.3 RESEARCH OBJECTIVES

Each household has different energy needs depending on many variables (e.g., location, family income, and the number of persons). The current study focuses on the households' direct energy requirements, namely electricity, liquefied petroleum gas (LPG), firewood, kerosene and charcoal, including behaviors such as lighting, using electric appliances, heating, cooking and cooling. Therefore, the study aims to understand the household energy consumption pattern and behavior, which is expected to fulfill the following research objectives:-

1. To examine the energy consumption pattern at the household level in urban Nagaland.
2. To examine the relationship between the types of energy and the various socio-economic determining variables.
3. To identify the factors influencing the adoption of energy-saving behavior at the household level and its impact on energy consumption in urban areas.
4. To assess the attitudes of urban households towards energy sources and uses.

1.4 RESEARCH QUESTIONS

The objectives of the study are answered in the following research questions:

1. What is the consumption pattern of energy in urban households?
2. How is energy consumption related to the various determining variables in the study area?
3. What influences the energy-saving behavior of households?
4. What is the behavioral impact on the households' energy consumption?
5. How are the attitudes of urban households towards energy sources and uses?

1.5 HYPOTHESES

1. Higher income is associated with the use of cleaner fuels but do not lead households to abandon traditional fuels altogether.
2. Socio-economic variables affect household energy consumption.
3. Energy-saving behavior of individuals is influenced by personal characteristics and capabilities, knowledge, psychological trait, and habit.
4. The energy-saving behavior and households' electricity consumption are negatively related.
5. Urban households make efforts to adopt practices and efficient technologies to save energy.

1.6 AREA OF THE STUDY

Nagaland covers an area of 16,597 sq. Km with a population of 19,78,502, out of which 71.03% live in rural area, and 28.97% live in urban area. According to 2011 census, the State has eleven districts, inhabited mainly by tribals with their own distinct traditional, lingual and cultural characteristics. Five new districts have been created from the existing ones during the subsequent years, resulting in a total of sixteen districts. The present study covers the urban area of the State of Nagaland, taking Kohima and Dimapur as sample districts. All the newly created districts are carved out from the previously existing ones, thus, separate data are not available for the new districts. There are three Municipal Councils in Nagaland viz., Dimapur, Kohima, and Mokokchung, out of which, for the present study, has selected Kohima Municipal Council (KMC) and Dimapur Municipal Council (DMC) to represent the urban area of the State. The rationale for selecting the two urban areas is that majority of the urban population in Nagaland is concentrated there (38.86%), these two being the largest urban centers in the State. Furthermore, the differences in geo-climatic conditions of the two areas are assumed to contribute to different energy needs and to give a better representation of the urban households' energy consumption pattern in the State.

1.7 METHODOLOGICAL APPROACH

1.7.1 Sources of Data

The study is based on both primary and secondary data. The primary data were collected by conducting a stratified random sample survey using self-administered survey questionnaires during 2016-17. The secondary data were collected from various sources such as statistical handbooks, census reports and official records available in published and unpublished forms.

1.7.2 Questionnaire

The questionnaire is designed in a manner to bring out maximum information about households' energy consumption patterns. It seeks information on household socio-economic data, type and quantity of energy consumed in the households, awareness and behavior towards energy saving practices. The questionnaires were administered directly to respondents and responses were collected immediately, with an extended period in some cases on request of respondents.

1.7.3 Reliability of Instrument

The questionnaire employed for the primary data collection was pilot-tested and restructured accordingly before conducting the main study, which made it possible to capture the relevant and required information.

The present study has used the recall method supplemented by the physical measurement method and bill records. In the recall method, the respondents are asked to recollect from memory the quantity of fuel consumed over the past few months. On the other hand, in the physical measurement method, energy commodities are measured using weighing scales. The households expressed the quantities in units familiar to them. For instance, in most households, firewood was measured in *'thuk'* in most of the households which was then converted into kilograms (kgs) on the basis of average weight arrived at by actual physical measurement. In the case of electricity, consumption data is collected through the monthly consumption levels (in kWh) as per the electricity bills where the previous month's consumption and expenditure are noted and the bill 6-7 months prior to collecting data for the previous season. However, the monthly electricity bill is not wholly reliable as the actual bill differs from the amount of usage in many cases. Moreover, meter sharing is the norm in many homes, especially in rented accommodations where a household shares their bill with other tenant households in the same building. Therefore, to arrive at reliable consumption data, the households' stock of appliances owned by the households with their units and consumption based on the number of hours used per day and their weekly usage levels are calculated at first and then consumption per month is calculated for analysis. LPG and charcoal were measured in kilograms (kgs), while kerosene was measured in liter (L).

After the data collection, the quantities of fuel were converted into a common denominator. Energy is measured in different units like 'tons of oil equivalent', 'joules', 'kilo calories', etc. The present study has selected 'joules' as the measurement unit because of the conversion convenience. The quantities of fuel used were converted to mega joules using the conversion measures given in Table 1.1.

Table 1.1: Energy Parameters in Mega Joules (MJ)

Fuel item	Unit	Quantity	MJ
Electricity	kWh	1	3.6
LPG	kg	1	45
Firewood	kg	1	16
Kerosene	ltr	1	35
Charcoal	kg	1	30

Source: Barnes et al. (2004).

1.7.4 Sample Design and Sample Size

Stratified random sampling design was used to collect primary data in the study. Firstly, each municipal town/city was stratified into well defined wards. Five wards from each municipality, five wards (26% of the total wards from Kohima Municipal Council and 22% from Dimapur Municipal Council) have been randomly selected.

Then, the sample size was determined using the following formula as recommended by Boyd, Westfall and Stasch (1981):

$$C = \frac{n}{N} \times 100$$

Where C represents a figure greater or equal to 5% of the total household in each ward, N is the total households in the selected ten wards (12,422 households) and n is the number of sampled households.[2] Hence, 621 households (294 from Kohima and 327 from Dimapur) were randomly selected for the study. The sample size for the study area is presented in Table 1.2.

Table 1.2: Sampled Households of the Study Area

Name of urban center	No. of wards in each urban center	Selected wards[3]	No. of households in each ward	No. of sampled households	Total no. of households sampled per urban center
Kohima	19	Ward no. 2	1127	56	294
		Ward no. 3	1262	63	
		Ward no. 4	860	43	
		Ward no. 12	918	46	
		Ward no. 15	1718	86	
Dimapur	23	Ward no. 10	971	49	327
		Ward no. 12	1660	83	
		Ward no. 14	1390	69	
		Ward no. 20	1360	68	
		Ward no. 21	1156	58	
Total	42	10	12,422	621	621

1.7.5 Analytical Technique

Descriptive statistical techniques such as frequency distribution, averages, percentages and cross-tabulations were used to achieve the first and fourth objectives of the study. For the second and third objectives, regression analysis has been used to

[2] The 5% was a sufficient sample size and each sampled ward met the criteria stated by Boyd et al. (1981) that the 5% would be sufficient, provided that the sample size will not be less than 30 units.

[3] Some wards consist of multiple colonies, each bearing a different name therefore; it was decided to use the Ward No. instead of their names for convenience.

analyze the relationship between the dependent and independent variables in the study. The following regression methods have been used:-

(i) Multiple Regression

Multiple regression measures the relationship between two or more variables in terms of the original units of the data. It is expressed as:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon \qquad (1.1)$$

Where Y is the dependent variable, the Xs are the independent variables, α is the intercept, βs are the coefficients of Xs and ε is the error term.

(ii) Poisson Regression

Poisson regression predicts count outcomes, with those counts occurring within a given space or time. A Poisson distribution has the following function:

$$P(Y = y) = \frac{\exp\{-x\beta\} x\beta^{y}}{y!} \qquad (1.2)$$

The Poisson regression is given as:

$$\text{Log}\ (y) = \alpha + \beta_n X_n + \varepsilon$$

$$\text{Or, } y = e^{\alpha + \beta n X n + \varepsilon} \qquad (1.3)$$

(iii) Binary Logistic Regression

Binary logistic regression models the relationship between a set of predictors and a binary response dependent variable.

The binary logistic regression model is given as:

$$Logit\ (Y) = \ln\left[\frac{p}{(1-p)}\right] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon \qquad (1.4)$$

Where Y is the binary response variable, p is the probability of an event occurring,

$\frac{p}{(1-p)}$ = odds ratio,

α is the Y intercept, βs are regression coefficients for predictors X_1, X_2,..., X_n and ε is the error term.

1.8 PERIOD OF STUDY

The study relates to the year 2016-17 for primary data collection, whereas the secondary data relating to energy consumption in households both in India and in the State pertains to the year 2011-12 from 68th NSSO Report 2014-15[4].

1.9 SCOPE OF STUDY

The study brings out the energy consumption pattern for various household activities in urban areas in Nagaland. The types of energy use covered in the study include electricity, firewood, LPG, kerosene and charcoal. The study highlighted the various determining factors of individual energy commodities and examined the energy-saving behavior of households. Furthermore, the impact of energy saving on energy consumption has been explored. Based on the findings of the analysis, the study provides suggestions for efficient utilization of energy and conservation and for further future research. Hence, this study will provide a reliable source to assist policymakers in formulating effective policies for promoting energy conservation in the household sector to achieve a sustainable future.

1.10 DEFINITIONS

The key terms used in the present study are as follows:

(i) Energy: The Cambridge Dictionary has defined energy as the power from electricity or oil that can work, such as providing light and heat.

(ii) End use: End use is the purpose for which energy is used, including, but not limited to, heating, cooling, cooking, or lighting.

(iii) Urban area: It includes all places with a municipality, corporation, cantonment, or a notified town area, and all other places having a minimum population of 5000 with at least 75% of the male workforce in non-agriculture pursuits and a density of population of at least 400 per square km (Govt. of India, 2001).

(iv) Household: A group of people normally living together and taking food from a common kitchen constitutes a household (NSSO, 2014).

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[4] The study referred to the 68th NSSO report, as this was the latest and only data available on individual energy consumption in Indian households. Further data are not available from the same source.

(v) Energy consumption: Energy consumption refers to all energy used to perform an action, manufacture something or inhabit a building (Teba, 2018).

(vi) Traditional fuel: This includes all solid fuels, such as firewood and charcoal, which are used for cooking and heating, etc.

(vii) Modern fuels**:** Modern fuels are non-solid fuels, including electricity, LPG and kerosene.

(viii) Firewood: Firewood is wood in the rough form obtained from the trunk and branches of trees used for fuel purposes such as cooking and heating.

(ix) Useful energy: It refers to the energy available to end-users to satisfy their needs (IEA, 2021b).

(x) Energy efficiency: Energy efficiency uses less energy to provide the same performance, comfort, and convenience (energy service).

(xi) Energy conservation: Energy conservation is the act of reducing or going without a service to save energy.

(xii) Energy stacking: Energy stacking refers to simultaneously using traditional and modern energy (Masera et al., 2000).

1.11 LIMITATIONS OF THE STUDY

The present study has several limitations. Firstly, the study was primarily based on the recall method, as no record of consumption was maintained by the households. Secondly, energy consumption being subject to seasonal variations, the study has taken into consideration only two seasons, namely, winter and summer, for one month where information was collected for the current season during the period of the household survey while information for the other season was based on the memory recollection of the informants. Hence the reference period may not wholly capture the seasonal variation. Thirdly, though household energy consumption is primarily meant for domestic purposes, it is also used for other purposes like commercial purposes and livestock rearing. Hence, though data were collected for domestic energy consumption, overlapping with non-domestic purposes may have occurred. The study also did not consider the consumption of alternative energy sources. Fourthly, energy studies often associate energy consumption with the types of houses and the price of energy. However, the present study has not considered these parameters. In the study area, energy is used for different purposes; but it was difficult to divide the energy usage for each activity. Therefore, only the end use of 'cooking' and 'others' and the total consumption of the individual fuel item was recorded. Finally, only energy-consuming activities performed at home are within the scope of the present study and did not consider the fuel for transportation.

1.12 ORGANIZATION OF THE THESIS

This thesis is organized into eight chapters:

Chapter 1: Introduction

This chapter provides a synoptic view of the urban energy problems and its implications to the household sector. The chapter also gives the statement of the problem, the research objectives and questions, hypotheses, methodology and limitations of the study.

Chapter 2: Review of Literature

This chapter presents a detailed review of the existing literature on the subject and their relevance with the current study on household energy consumption in urban areas. This includes the theoretical framework for the study, factors influencing household energy consumption, determinants of household fuel choice, and appliances and energy-saving behavior in the context of energy use in homes.

Chapter 3: Socio Economic Profile

This chapter brings out the profile of the State as well as the study areas. Physical feature of the State, its demographic characteristics, and sectoral performance and employment in the economy are highlighted in this chapter.

Chapter 4: An Overview of Energy Consumption in India and Nagaland

This chapter examines the energy situation in India which includes trends of aggregate energy consumption and household energy consumption. The chapter also highlights the electricity scenario and the household energy consumption in Nagaland.

Chapter 5: Household Energy Consumption Pattern in Urban Nagaland

This chapter focuses the energy consumption pattern in the sample households. Analyses of the energy use pattern and income, per capita energy consumption, end uses and stock of electrical appliances are also provided in this chapter.

Chapter 6: Determining Factors of Household Energy Consumption in Urban Nagaland

This chapter analyzes the relationship between household energy consumption with socio economic and dwelling characteristics. Analyses of possession of electrical appliances, household choice of fuels for cooking, and energy-saving behavior and its impact on energy consumption are also attempted in this chapter.

Chapter 7: Attitudes of the Urban Households towards Energy Consumption and Saving

This chapter provides an assessment of the urban householders' attitudes towards energy sources, uses, conservation practices and energy-efficient technologies, and. The chapter also highlights the energy expense in households and its association with income.

Chapter 8: Summary and Conclusions

In this chapter, important findings of the study are discussed, the answers to the research questions are summarized and suggestions provided for a sustainable energy future in the household sector.

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CHAPTER 2

REVIEW OF LITERATURE

2.1 INTRODUCTION

This chapter presents an overview of the theory and evidence that comprise the literature on energy consumption, concentrating on the literature that specifically focuses on the factors that affect energy consumption at the household level. Section 2.2 presents the theoretical framework surrounding household energy consumption as given by earlier studies. Section 2.3 surveys the literature on household energy consumption and its influencing factors. Section 2.4 reviews literature that specifically focuses on the determinants of household fuel choice. Section 2.5 reviews works done on household appliance ownership, followed by energy use-related behavior at the household level in Section 2.6. Section 2.7 provides a conclusion of the chapter.

2.2 THEORETICAL FRAMEWORK

2.2.1 The Energy Ladder Model

The energy transition theory has dominated the theoretical literature on household energy consumption, according to which households switch to more convenient energy forms and abandon traditional fuels as their disposable income increase (Leach, 1992; Sathaye & Tyler, 1991; Reddy & Reddy, 1994; Barnes & Floor, 1996; Holdren & Smith, 2000; Macht et al., 2012). This "energy ladder" model suggests that income is the critical factor influencing household fuel choice. The theoretical assumption underlying the energy ladder hypothesis is that low living standards induce greater dependence on firewood and other biomass fuels owing to a combination of income and substitution effects (Baland et al., 2007). Furthermore, the hypothesis assumes that cleaner fuels are normal economic goods (Eakins, 2013) while traditional fuels are inferior goods (Rajmohan & Weerahewa, 2007). According to this model, income correlates positively with adopting and transitioning to more efficient and cleaner energy sources. Therefore, when household income improves, households decide to go up the energy ladder which implies a total shift from the utilization of traditional cooking fuels such as firewood towards electricity or LPG. The ladder implies that moving to a new fuel is simultaneously a move away from fuels used hitherto, hence describing a fuel switch or a choice between traditional solid fuels, transitional liquid fuels, and modern gaseous and renewable fuels (Bhattacharyya, 2011).

It can be seen from the schematic representation of the energy ladder hypothesis in Figure 1.1 that the energy ladder model is composed of a three-stage household fuel transition process. The first stage is demonstrated by reliance on solid biomass fuels such as animal dung, agricultural wastes, and firewood, whereas the second stage represents a condition where households switch to charcoal and kerosene when their socio economic status improves. In the third stage, households decide to use LPG and electricity.

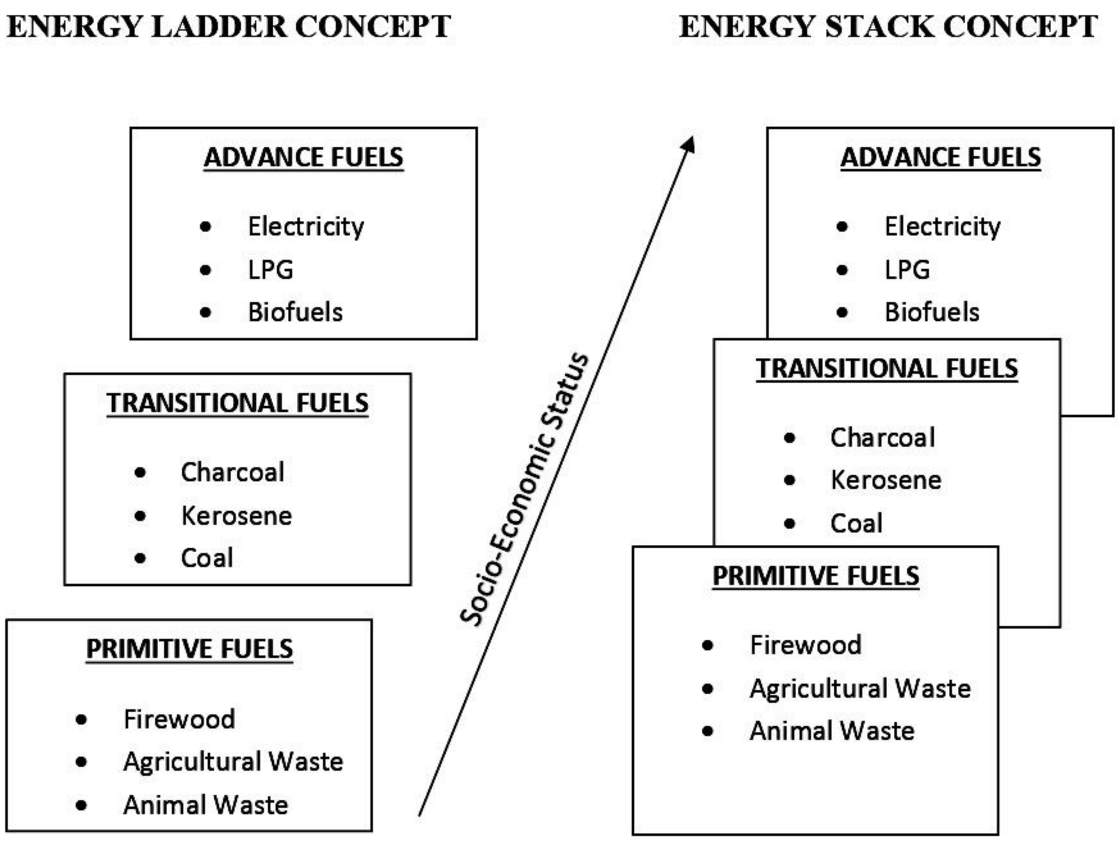

Figure 2.1: The Traditional Energy Ladder Model (Left) and Energy Stacking Model (Right)

However, research findings from different places and times have criticized the energy ladder hypothesis, labeling it idealistic and ambitious in explaining the complex household energy decision-making because household fuel use decisions are influenced by several exogenous and endogenous factors in the household (Heltberg, 2004; Abebaw, 2007; Mekonnen & Kohlin, 2009; Kowsari & Zerriffi, 2011; Takama, et al., 2011; Van der Kroon et al., 2013).

2.2.2 The Energy Stacking Model

The energy ladder model has been criticized because fuel shifts seldom follow an adoption strategy in which households completely abandon traditional fuels with rising income but rather follow a stacked behavior in which traditional fuels are used in conjunction with modern fuels (Masera et al., 2000). Recent empirical studies claim that fuel switching is not a linear process where households directly switch the energy ladder as their socio economic status improves. These studies reveal that households also use traditional fuels even after they have started using modern cooking fuels (Masera et al., 2000; Abebaw, 2007; Kowsari & Zerriffi, 2011; Takama et al., 2011). One of the reasons stated by Kowsari & Zerriffi (2011) is that household energy sources are imperfect substitutes for each other because, most of the time, specific fuels are preferred for specific cooking tasks. Therefore, as can be seen from Figure 2.1, instead of simply switching between different cooking fuels, most of the time, households choose to use one or more combinations of fuels depending on different circumstances even though their socio economic status improves. Masera et al. (2000) assert that the change in energy use can be characterized as an “accumulation of energy options” rather than as a direct shift along the ‘energy ladder’ which is termed as “fuel stacking behavior.” Their study emphasized that households do not switch fuels, but more generally follow a multiple fuel or 'fuel stacking' strategy by which new cooking technologies and fuels are added, but even the most traditional systems are rarely abandoned. Thus, the extent and permanence of multiple fuel use patterns in households are the results of complex interactions between economic factors (such as fuel prices and supply), social factors (such as household incomes), and cultural factors (such as habits and specific cooking practices).

2.3 FACTORS INFLUENCING HOUSEHOLD ENERGY CONSUMPTION

At the household level, income is well-known to have a significant and positive effect on household energy consumption (Cohen et al., 2005; Moll et al., 2005; Lenzen et al., 2006; Cayla et al., 2011; Sovacool, 2011; Sirichotpundit et al., 2013; Tewathia, 2014; Dash, 2015; and Nazer, 2016). Household size is another important factor in household energy use (Van der Horst & Hovorka, 2008). Living together as a group and sharing activities such as heating, cooling and entertainment create an economy of scale in the house involving these basic household activities. As a result, larger households tend to demand less energy than smaller households. Studies also found evidence to suggest economies of scale in household size (Ironmonger et al., 1995; Filippini & Pachauri, 2004; Moll et al., 2005; Brounen et al., 2012; Eakins, 2013; Schröder et al., 2015; Walia, 2019; Kotsila & Polychronidou, 2021; and Wu et al. 2021).

Pachauri and Spreng (2002) studied the total energy requirements of households, both direct and indirect, in India for the years 1983-84, 1989-90, and 1993-94 using input-output transaction tables prepared by CSO (Central Statistical Organization) by applying input-output energy analysis. The findings revealed that total household energy consumption is about evenly divided between direct and indirect energy, which comprises 75% of the total energy consumption of India. Most household energies consumed directly are still non-commercial, and food consumption is responsible for about half the indirect energy consumption. Household energy requirements have increased significantly in total and per capita terms over the period. The main drivers of this increase have been (i) the growing expenditures per capita, (ii) population, and (iii) increasing energy intensity in the food and agricultural sectors.

Fillipini and Pachauri (2004) analyzed the electricity demand in urban Indian households and found that income, size of house, regions and degrees of urbanization significantly influence electricity consumption. Price is inelastic in electricity demand, so the price is not an inhibiting factor in residential electricity consumption. In addition, dwellings with more residents and younger household heads tend to consume less electricity than those with fewer residents and older people.

Moll et al. (2005) used the hybrid energy analysis of household consumption as a methodological approach based on household metabolism. The study suggests that household energy consumption is strongly related to socio-demographic variables, such as income and household size. They suggest that households with higher incomes or larger sizes consume more energy than otherwise.

Hubacek, Guan, and Barua (2007) studied the changing lifestyles and consumption patterns in developing countries like China and India. The study found that people directly consume energy for daily use and aspire to a ‘high-quality life' by purchasing fashionable goods and services. More spacious living space allows consumers to buy and store more household appliances and other durable goods, which helped increase the sales of these appliances. The result of a case study on energy shows that more and more people move up the consumption ladder due to increasing income levels, infrastructure and availability of products and services, even in remote rural locations. It predicted further increases in consumption and pollution levels as compensating gains in efficiency levels. The study suggests that sustainable consumption programmes can promote coherence and synergies across various consumer, education, economic, social, environmental policies, etc.

Joon, Chandra, and Bhattacharya (2009) studied household energy consumption patterns in a village in the Jhajjhar district of Haryana, India. The households surveyed covered heterogeneous populations belonging to different income, educational and social groups. There was more availability and utilization of solid biomass fuels as energy resources in the domestic sector than commercial fuels. Income is an important factor in determining the choice of fuel for cooking at the household level. Dung cakes, crop residues, and firewood were the three primary cooking fuels, though LPG was used along with biomass fuels. However, a complete conversion to cleaner fuels has not occurred even in households using LPG for many years.

Sovacool (2011) proposed that the use of energy services is conditioned strongly by income and wealth within societies: therefore, low-income families rely on a greater number of fuels, ranging from dung and firewood to LPG and charcoal, but a fewer number of services on energy to survive; the middle class relies on electricity and natural gas, followed by coal, LPG and kerosene where a much broader range of services are produced. The upper class has the same energy fuels and technologies as middle-income families but consumes more luxury items and energy.

Golley and Meng (2012) investigated the variations in carbon dioxide emissions across households with different income levels in Chinese urban households. They found that affluent households generate more emissions per capita than poor households via direct energy consumption and higher expenditure on goods and services that use energy as an intermediate input.

A study of household energy consumption in Bangkok showed that three factors significantly affecting consumption are; physical and structural, social and cultural as well as economic factors (Sirichotpundit et al., 2013). Increasing household incomes and education levels cause a need for more comfortable living. Higher household incomes result in higher home energy use, mainly due to purchasing more electrical appliances. Thus it requires more energy production and causes more CO_2 emissions. Smaller household sizes and more compact house spaces with lesser household appliances with more efficient ones are suggested for a reduction in household energy consumption.

Tewathia (2014) studied the determinants of electricity consumption in Delhi using household survey data and found that household income, the number and usage of electrical appliances, the size of the house, family size, time spent out of the house and higher educational level have a significant influence on electricity consumption. Educational level negatively affects energy consumption as higher educated families consume less electricity.

Lin et al. (2014) analyzed residential energy consumption at the provincial level in China to study the differences in the amount and the structure of energy consumption. The study found that population, economic development level, energy resource endowment, and climatic conditions are the main influencing factors of residential energy consumption. In contrast, the main factors that lead to regional differences in residential energy consumption are economic development, climatic conditions, and energy resource endowment. Energy resource endowment and climatic conditions indirectly affect both the proportion of electricity consumption and gasoline consumption.

Examining the impact of income on household energy consumption in urban Odisha, Dash (2015) found that the overall energy consumption in the household sector is the highest among high-income groups than middle and low-income groups. Households of the high-income group were the highest consumer of electrical energy for various household purposes because they use more modernized electrical appliances as their income is higher than the others. It also found that families having high incomes consume more energy. Furthermore, oil consumption for running vehicles was also highest among the households of the high-income group.

Nazer (2016) analyzed the pattern and change in household energy consumption and the determining factors in Indonesia during 2008-2011 from national household survey data using regression analysis. The result showed an increase in traditional and modern energy consumption during the period, and that household income is the main determining factor of energy consumption. There was a positive relationship between energy consumption and income growth. The study also found a positive and significant correlation between the age of the household head, household size, floor area, and house ownership status, i.e., owning house results in higher energy consumption.

Bardazzi and Pazienza (2017) analyzed the influence of population aging on energy expenditure using repeated cross-section data from Italy. They employed pseudo-panel regression and found that aging causes an increase in energy expenditure. Older people stay home for a more significant time of the day and usually require more heating and cooling comfort. Besides, the results also confirmed that recent generations have higher residential energy expenditure. The energy culture of post-war Italian generations seemed to be more linked to thermal comfort (heating and air conditioning) than environmental attitudes.

Ravindra et al. (2019) assessed the household fuel use pattern and trend in rural India, taking a case study from Punjab. The decadal trend in household energy consumption patterns from the analysis showed that 77.5% of rural households in India rely on solid biomass fuel for cooking. Furthermore, during the last 30 years (up to 2011), only 2% of rural households shifted from solid biomass fuel to cleaner fuels. However, after 2011 data shows significant uptake of cleaner fuels for household cooking. Results of the case study showed that rural households depend on numerous approaches rather than a particular source of household energy, which contradicts the energy ladder hypothesis of improvement in energy sources with an increase in income. Furthermore, cooking fuel preferences were determined by socio economic and cultural factors. The study highlights the need for effective user-behavior-focused interventions to enhance the transition toward cleaner fuel for household energy.

In a study of firewood consumption in Nepal, Ram and Bahadur (2020) aimed to assess the influence of hourly firewood consumption patterns on CO2 emissions in rural areas using data collected from a field survey conducted in 16 households during winter. The results show that most households use more firewood during the morning and evening hours. Family size and the number of animals reared by the households and firewood consumption are positively correlated, whereas family size was negatively correlated with per-capita firewood consumption. The larger households spent more time cooking, while their consumption rate was similar to that of smaller households. High indoor CO2 emissions in the morning and evening hours due to high firewood consumption may pose severe health risks to the inhabitants. Therefore, intensive awareness programmes and pollution control programs are suggested to improve indoor air quality and health conditions, especially in rural areas.

Matsumoto (2020) compared winter energy usage between generations in Japanese households and reported that elderly households consume more energy than younger households, even after controlling the usage time of heating equipment, household income, and housing sizes. The study strongly suggests that as people get older, they seek comfort at home and thus use more energy.

Sena et al. (2021) examined the factors affecting electricity consumption in Malaysian households that focused on the technology perspective (building and appliance characteristics) and socio-economic perspective (socio-demographics and occupant behavior) using surveys among 214 university students. The multiple linear regression analyses showed that appliance characteristic factors were the main variables influencing electricity consumption and house characteristics were the least significant. Monthly income, number of air conditioning appliances and ownership of miscellaneous appliances emerged as factors that significantly affected electricity consumption. These results indicated that higher-income households would have more appliances and use more electricity. It further confirms that occupant behavior factors had a more significant influence than socio-demographic factors.

Kotsila and Polydhronidou (2021) investigated the socio-economic parameters, dwellings' characteristics and climatic conditions that determine the electricity consumption in Greek households. Two statistical models – the OLS model and the log-linear regression model were built. The results showed that the number of occupants, dwelling size, cooling hours, and weather conditions are all significant determinants of electricity consumption.

Wu et al. (2021) analyzed the panel data of Chinese households from 2010 to 2016 and confirmed substantial household-scale economies in electricity consumption. The study observed that specifically reducing the household size by one incurs a 17.0 – 23.6% increase in consumption. They also assessed the ecological/environmental implications and found that household emissions increase with smaller household sizes. They suggested that it is crucial to incorporate the scale effect into energy demand projections and sustainability assessments. The results also highlighted the urgency in transitioning to cleaner energy since household size shrinkage is occurring globally.

Yawale, Hanaoka, and Kapshe (2021) analyzed the energy transition and consumption patterns in rural and urban households in India during 2004, 2009, and 2011 through a bottom-up approach using National Sample Survey data. The study found cooking to be the prime energy-consuming service. Service-wise analysis showed that energy consumption for cooking has decreased with the rise in per capita household income. The study also observed faster energy transition in higher-income households. Urbanization was essential for the transition to clean and energy-efficient fuels for cooking and lighting services. Besides, availability and cost of labour, household expenditure class, access and availability of electricity, availability of local energy resources, technology diffusion, climate and socio-cultural practices were also found to play important roles in energy service demand for urban and rural households in India.

Inoue, Matsumoto and Mayume (2022) examined the effects of population aging on household energy consumption based on an analysis of micro-level energy consumption data of Japanese households from 1989 to 2014, measuring the pure aging effect, the cohort effect, and the family structure effect. Their results confirmed that energy consumption increases by about 12% due to the pure aging effect, or in other words, household energy consumption increased significantly with population aging. Younger generations consume less energy than older generations. Furthermore, population aging changes households' composition and reduces the size of households. Due to this downsizing, household energy consumption increased by about 16.6%. The changes identified in the study led the authors to suggest that more intensive use of electricity per capita is necessary to accommodate lifestyle changes and a desperate need for new and disruptive energy technology.

2.4 DETERMINANTS OF HOUSEHOLD FUEL CHOICE

Economic growth, improvement in living standards and consumer attitude changes are important factors that lead to the diversification of household energy consumption. Studies on household fuel choice and use determinants in developing countries have been carried out by Masera et al. (2000), Heltberg (2004), Heltberg

(2005), Mekonnen and Kohlin, (2009), Nansaior et al. (2011), Swarup and Rao (2015), Rahut, Behera, and Ali (2016), Mottaleb and Rahut (2021), etc.

Studies have indicated a number of factors as determinants of the choice of household fuel. The proponents of the energy stacking model observe that although consumer's income is a significant factor in determining fuel choice, other aspects such as the convenience of use, the uncertainty of supply, cooking habits and consumer preferences are significant (Heltberg, 2003; Mekonnen & Kohlin, 2009). In addition, proxy factors, including household expenditure, size of household, and characteristics of the head of the household—level of education, age and whether male or female—are significant in determining fuel choice. Heltberg (2003) found that the income of the household and education level of the household head had a very significant negative impact on wood consumption while at the same time encouraging demand for LPG. Heltberg (2004) also proposes that since households with higher education are aware of the health impacts inherent in using traditional fuels like firewood and charcoal, such households tend to switch to other efficient and clean modern fuels. Similar findings are also given by Mokennen and Kohlin (2009), which state that when the housewife in the household is educated and has good paying job outside the household chores, the household becomes more motivated to adopt those efficient and modern cooking fuels that are found in the higher energy ladder.

Ouedraogo (2006) shows that significant relationships exist between firewood, charcoal and liquefied petroleum gas (LPG) use and household size. According to Farsi et al. (2007), the choice of household cooking fuel and the amount consumed are related to income and household size. Higher-income households also choose cleaner and more convenient fuels such as electricity or LPG (Reddy, 2004; Farsi et al., 2007; Adam, Brew-Hammond & Essandoh, 2013; Bisu et al., 2016).

Through an in-depth study of energy use in rural villages in Mexico, Masera, et al. (2000) evaluate the energy ladder model using longitudinal data collected from a large-scale survey of four states over four years. Their study shows that a multiple fuel stacking model and not a simple progression as depicted in the traditional energy ladder scenario more accurately describes the pattern of fuel choice and use in rural areas.

Alam, Sathaye, and Barnes (1998), in their study on urban household energy use in India, examine issues related to fuel choices, household income, urban scale and energy decision-making process in the city of Hyderabad. It focused mainly on energy use in low-income households and found the share of fuel wood in total energy consumption to be much lower than before despite the city’s poverty and weak economic base. As energy supplies such as LPG, kerosene, and electricity are subsidized highly, the rich generally benefit from the subsidies, and the poor, who do not have ration cards purchase kerosene at market prices. The low-income groups also want to shift to LPG, which is distinctly preferred over other fuels for cooking. The study suggests policies ranging from higher charges, privatization of distribution and the use of more efficient appliances and lighting to ensure adequate supplies in the future, and also policies that help remove the barriers of the high first cost of obtaining LPG to speed fuel transition.

While observing the history of energy services, Fouquet (2008) noted that energy choices have long been intimately tied up with intangible elements like status or comfort. For instance, modern-day environmentalists place solar panels on their roofs to make an ethical statement. They not only prefer to utilize less polluting sources but also to display a higher socio economic status. Thus, one can assume that households' preferences may lead to opting for energy stacking rather than total fuel switching to modern energy sources, and households may continue to use low-efficiency and polluting fuels accordingly to local traditional practices, despite the availability of modern energy sources.

Mekonnen and Kohlin (2009), in their study on the determinants of household fuel choice in major cities in Ethiopia, suggest that as households’ total expenditures rise, they increase the number of fuels used and spend more on fuel consumption. This study criticized the energy ladder model and reiterated other findings from Latin America and Asia that showed that fuel stacking, as opposed to fuel switching, better describes the fuel choice behavior of households in developing countries. This observation opposed the notion of the complete switch from traditional to cleaner and more costly fuels as income rises. The study concluded that other than income, other factors such as cooking and consumption habits, consumer preference and taste, dependability of supply, cost, and availability of technology also determine the choice of household fuel.

Age is also an important determining factor in household energy choice. Households with older heads are more likely to consume wood than non-wood fuels. Mekonnen and Kohlin (2009) found that households with older heads in major Ethiopian cities were much more likely to use wood and kerosene than electricity and charcoal, while the demand for wood increased with age. This finding was attributed to certain habits of older people that favour traditional energy sources and resist change so that if they grew up with wood as their primary fuel, they would wish to persist with the 'wood tradition' as their energy source.

Nansaior et al. (2011) reported that urbanizing Thai communities preferred to keep using firewood or charcoal for cooking glutinous rice, although having access to modern fuels, i.e., electricity and LPG. Cultural factors such as cooking practices and traditional customs in food preparation play a central role in households' continuous use of traditional cooking energy sources. For example, empirical findings by Taylor et al. (2011) in Guatemala households revealed that households usually use traditional cooking fuels even though LPG is available and affordable. This is evident in some households that foods retain their flavor when cooked with firewood or charcoal than with electricity or Liquefied Petroleum Gas.

Kowsari and Zerriffi (2011) stated that the availability, affordability, accessibility, and reliability of different cooking fuels also greatly influence in household cooking energy choices. Households prefer to use clean and convenient forms of energy, provided it is available. The consumption of modern energy (electricity, LPG, kerosene, gas, renewable fuels) is preferable to traditional energy (firewood, charcoal, coal and other biomass) because these are more convenient and readily available (Alam et al., 1998). LPG consumption is positively related to affordability (Bisu et al., 2016). Similarly, the availability of firewood significantly influences its consumption. The population near the forest resources has higher per capita consumption than those further away (Pandey, 2002). Charcoal is widely used in urban areas with plentiful wood resources, and the per capita consumption of charcoal increases in regions with adequate resources and stays constant as resources become scarce (Barnes et al., 2004).

Urbanization is also associated with a switch from the consumption of firewood to the more resource-consuming charcoal (Mwampamba et al., 2013). For instance, charcoal is preferred in urban areas due to positive characteristics such as higher energy content, increased transportability and storability (avoidance of insect problems), the fact that it can be relit, and smoke-efficient combustion (Kanmen & Lew, 2005). Furthermore, increased availability and accessibility of energy technology and infrastructure with rising urbanization may help explain why urban households shift from lower-quality and more polluting fuels to cleaner and more efficient energy sources (Hiemstra-van der Horst & Hovorka, 2008; Van der Kroon et al., 2013). Nonetheless, Hiemstra-van der Horst and Hovorka (2008) study reported that transition barriers might appear throughout the urbanization process.

Swarup and Rao (2015) studied the trends in the use of fuel types in households using data from three rounds of NSS. Using econometric analysis, the authors examined the trends in fuel choices in Indian households. The analysis showed that the households do not conform to the energy ladder model. In other words, with increased income, households shift to modern or superior fuels but do not abandon the inferior ones altogether. The findings suggested that income, price, education, access to forests and rural and urban differences are important determinants of the household choice of fuels. Furthermore, analyzing the regional differences in fuel choice, the study found that households in the northeastern and eastern parts of the country are more likely to stack fuels than households in other regions. This implies that everything else being equal, a household in the eastern and northeastern parts of the country will continue to use traditional fuels. Therefore, the need for policy makers is to account for these differences to shift households to cleaner fuels successfully.

Rahut et al. (2014) studied the factors likely to influence household decisions when choosing a particular energy source for various uses, such as lighting, cooking, and heating, using the Bhutan Living Standard Survey (BLSS) data for the year 2007. The multinomial logit selection model results showed that a household's choice of cleaner fuels for lighting, cooking, and heating is driven by income level, age, education, gender of the household head, access to electricity, and location. Households with a better-educated or female head, those with a higher level of income, and urban households, have a higher probability of switching to clean energy. In contrast, poor households, rural households and those with a low level of education are constrained by these factors, so they continue using dirty energy. The study shows that female-headed households are more likely to choose cleaner fuels and that, above all, the availability of a clean and cost-effective source of energy within the proximity is an important factor in adopting clean energy. The study also combined BLSS 2003 and 2007, conducted similar analyses and confirmed the robustness of the result.

Rahut, Behera, and Ali (2016) used data from the World Bank's comprehensive living standard survey measurement on Ethiopia, Malawi, and Tanzania to analyze cooking fuel use patterns and their determinants. The descriptive analysis shows that a significant number of households use solid fuels for cooking and only a tiny fraction of households use clean fuels such as electricity and liquid petroleum gas. Rural households and those far from markets depend more on dirty fuels. Multinomial logit and ordered probit model estimation results show that female-headed households, household heads with a higher level of education, and urban and wealthy households are more likely to use modern energy sources such as electricity and liquid petroleum gas (LPG), and are less likely to use solid fuels.

Rahut, Behera, and Ali (2017) examined the factors influencing household use of determinants of renewable and clean energy sources used for lighting purposes in Africa using the Living Standard Measurement Study (LSMS) data from three African countries: Ethiopia, Tanzania, and Malawi. The descriptive analysis reveals that rural households depend primarily on kerosene and batteries for lighting their houses, while electricity and batteries form a major energy source for lighting urban households. A small fraction of households uses solid fuels and solar as their source of energy for lighting. Econometric results showed that female-headed households are more likely to adopt clean and renewable energy sources than male-headed households. Wealthier and more educated households use electricity and solar energy for lighting, while poorer households use kerosene, batteries, and solid fuels. Empirical results indicated that Ethiopian households, followed by Malawian households, are more likely to use clean sources of Energy than Tanzanian households.

An econometrics study made by Mottaleb, Ali and Rahut (2017) on 29,000 households in Bangladesh, demonstrated that the incidence and reliance on clean energy are high among households headed by relatively highly-educated and wealthy heads and spouses. Particularly, households use clean energy progressively with an increase in income. Based on the findings, the study suggested policies to encourage using clean energy for household chores.

Rahut, Ali, and Mottaleb (2017) used multivariate probit, Poisson regression, censored least absolute deviation, and a propensity score matching (PSM) approach to understanding the determinants of alternative sources of cooking energy for far-flung households in the highlands of Pakistan. The empirical results indicate that young and educated farmers with large land holdings use more than one energy source for cooking purposes. Severe weather and remoteness force small farmers in the Himalayas to rely on one or two energy sources only. They recommended that the policy should focus on improving infrastructure and guidance regarding severe weather management which can provide better energy to remote villages during the severe winters.

Rahut et al. (2019) investigated the cooking-fuel use patterns and factors influencing rural household choices in Pakistan. The results show that a significant number of rural households use fuelwood, dung and crop residue for cooking and a tiny fraction of households use natural gas. Low-income families with a lower level of schooling of household heads are likely to depend on fuelwood, dung cake and crop residues. Multinomial logit results show that household heads with higher human capital and physical and financial assets are more likely to use modern fuel such as natural gas and are less likely to use fuelwood, dung cake and crop residues. Empirical findings also indicate that education is the main driver of clean fuel adoption for cooking in rural Pakistan. Hence, the study suggested that energy policy focus on the investment in human capital to enhance the adoption of clean fuel for cooking.

Using National Survey data from three NSSO rounds - 1991-92; 2006-07; and 2011-12, Mottaleb and Rahut (2021) examined the factors influencing fuel choice and the fuel consumption behavior of urban Indian households. The study found that relatively older household heads and spouses choose clean fuels. Female-headed households favoured LPG and electricity for cooking over kerosene and coal. Education level and wealth status are positively associated with clean energy use.

2.5 APPLIANCES AND ENERGY CONSUMPTION

Energy is used to cool, heat, light homes and to run household appliances. Electrical appliances create life a lot easier and more convenient with their use. These appliances have become essential products in every household in modern society. Electrical appliances are found to make a very significant contribution to a household's electricity consumption. Studies have proven that a high percentage of household electricity consumption is associated with the use of household appliances.

Genjo et al. (2005) studied the relationship between the possession of household appliances and electricity consumption in Japanese households and found that the increase in the consumption of residential electricity was due to the use of a great number of household appliances. Similarly, Tewathia (2014) studied the determinants of household electricity consumption in Delhi, and the results suggest that the stock of appliances contributes the most to the variation in the dependent variable.

O'Doherty, Lyons and Tol (2008) investigated the determinants of appliance ownership and energy-saving features in Ireland. Using the National Survey of Housing Quality data carried out in 2001 and 2002, the authors examined the characteristics of households with a large number of energy-using appliances and employed a Poisson count model to analyze those factors affecting the total number of energy-saving features present in a household. The study found that respondents living in newer, detached homes, higher income and home owners are more likely to have a higher number of energy-saving features in their home, but they are also more likely to have a higher number of energy-using appliances. The results indicated that as income increases by £100, the weighted number of appliances would likely increase by 0.6%. Furthermore, households with children have a weighted number of appliances that are about 10% higher than other households. With regard to tenure type, the weighted number of appliances is highest in households that the occupant owns.

Leahy and Lyons (2010) examined household appliance ownership in Ireland using logit models to analyze the determinants of appliance ownership and relate ownership of a particular appliance to household income and a number of household and dwelling characteristics. They found that households living in urban areas, those with a large number of persons or a large number of rooms, and those with higher levels of education are more likely to possess most of the appliances under consideration. The presence of children and occupant-owned households also increases the probability of higher possession of appliances. On the effect of income on individual appliances, it was found that dishwasher ownership has the greatest impact on an increase in income.

Verma, Jaiswal, and Wani (2011) assessed the energy consumption of the residential sector of Gwalior city in Madhya Pradesh and found that the majority of the households are using modern high-energy appliances leading to the overuse of valuable energy resources. The investigation demonstrated that most buildings were not climate-responsive and were consuming high levels of energy to achieve thermal comfort for residents. Therefore, it suggested the dire need for proper energy planning and public participation that can significantly reduce energy consumption and ultimately reduce the burden on fossil fuels.

Rathi, Chunekar, and Kadav (2012) analyzed ownership patterns and distribution in Indian households relating to three major appliances – fans, televisions and refrigerators using two rounds of all India National Sample Survey Organisation (NSSO) expenditure surveys. The report showed evidence of high ownership of appliances by the states with high levels of income. There is also a strong correlation between access to electricity and appliance ownership. Also, climatic conditions influence the ownership of appliances. For instance, ownership of fans is lower in states with colder climates.

Using a household budget survey, Eakins (2013) applied a Poisson model to the possession of electrical appliances. The results showed that households with greater numbers of persons occupying, larger number of rooms and who live in newer homes have higher levels of possession. In addition, households with older or unemployed heads and those renting the accommodation have lower levels of possession.

Dhanaraj, Mahambare and Munjal (2017) studied the determinants of household refrigerator ownership in India and found that income is a necessity for the purchase of an appliance but not a sufficient condition and that the duration of a complementary good, i.e., electricity is critical for the ownership. The study also found that households with a female having a higher level of education have a higher probability of refrigerator ownership.

Singh, Mantha and Phalle (2018) aimed to forecast electricity consumption for Energy efficient management in Indian urban households by evaluating current practices in the home. The work was carried out through a household survey conducted in three different climate zones of India. They found that ownership of major home appliances like air conditioners, refrigerators and electric water heaters contributes to high electricity consumption in households. The price elasticity of electricity consumption was found as -0.72, indicating that electricity consumption decreases when the price increases. Electricity consumption was observed to be more responsive to ownership of air conditioners rather than demographic variables and other appliances. Considering factors such as tonnage, energy star rating, usage duration, year of purchase and numbers, the results suggest that electricity consumption in air conditioning could be reduced by 15% to 30% if existing household air conditioners which are older than 7 years were replaced by new energy efficient ones, with other parameters remaining constant.

Analyzing energy consumption and appliance ownership in Indian households, Walia (2019) found that energy consumption increases with an increase in family size and socio-economic strata. Also, space and water heating devices are major contributors to winter peak demand, whereas summer peak is attributed to space cooling devices. AC households consume at least 50% more energy than non-AC households during summer.

Poblete-Cazenava and Pachauri (2021) developed a simulation-based estimation to estimate the responsiveness of appliance and electricity demand to income in four countries, namely Ghana, Guatemala, India and South Africa, using micro data. The study found that the level of adoption of electrical appliances varied by country, appliance type, climate and income, with a high and stable share of electricity used for entertainment in all four countries and socio-economic futures. However, the share of electricity used for food preservation and preparation and clothes maintenance was found to rise significantly with income as people are able to afford appliances that provide greater convenience and comfort. The study provided an important policy implication in that the demand for electric services in developing and emerging countries will rise with income but making access to these electric services more equitable requires improving the availability and affordability of efficient appliances, in addition to improving the reliability, affordability and extent of electricity access.

2.6 ENERGY-SAVING BEHAVIOUR

A number of factors influence energy consumption and saving behaviors in households. Hitchcock (1993) contends that household energy consumption is driven by the needs or behavior of occupants and/or by the physical characteristics of the dwelling. Therefore, the household environment plays a crucial role in the relationship. It is a universal fact that domestic dwellings basically provide a comfortable environment for human activities by providing space heating, lighting, hot water, and a host of others. Hence the amount of energy consumed in dwellings depends on the level of service required and the efficiency with which the dwelling can provide such a service.

A report on a study by Norden (2007) states that patterns and trends around energy use in the households are the result of changing life styles and practices, tendency towards increased ownership of labour-saving devices, an increasing number of people and households, and a trend towards ignorance, misunderstanding or misuse of energy-saving features of modern appliances, thereby curtailing much of the potential for efficiency gains.

Sardianou (2007) investigated the main determinants of household energy conservation patterns in Greek households using cross-section data. Results of the study showed that socio economic variables such as consumers' income and family size are suitable to explain the difference in energy conservation preferences. In addition, the results suggest that electricity expenditures and the respondent's age are negatively associated with the number of energy-conserving actions a consumer is willing to adopt. People with higher incomes who own their houses and have large families are more willing to conserve energy. The number of rooms, dwelling size, gender, educational level and marital status have no significant influence on energy conservation. Larger electricity expenditures have a negative impact on energy conservation behavior, and older people are more energy-conserving than younger ones.

Chatterjee and Singh (2012) studied the status of consumers' awareness and their perception on Energy efficient products in India. Product brand was found to be the most important factor determining the purchase decisions, followed by product price. Consumers' preference for energy-efficient products appears to be a lowly placed determinant factor in all the product segments. By energy efficiency, most consumers refer to low power consumption, leading to lower electricity bills. The most significant of all sources of information is 'Star Mark' label on the product. Awareness level is directly influenced by income level. Television is the most important source of information on energy-efficient products. The results implied that consumer awareness of energy efficiency is increasing and also willingness to buy energy products is relatively high and the market of these products is emerging fast.

Reddy and Nathan (2012), in their study on energy in the development strategy of Indian households, found considerable changes in the use of energy-consuming devices and the behavior of energy users in the household sector. The study found that during 1950-2005, the population tripled, whereas household energy use doubled during the same period. The findings suggest that the shift from low to high efficiency fuels/technologies from the perspective of the households increased the standards of comfort, cleanliness, and convenience. The study also suggests having access to sufficient amounts of good quality energy to help the household climb the 'Comfort ladder' and, thereby, the 'Development ladder.'

Han et al. (2013) investigated intervention strategy in stimulating energy-saving behavior and identified that residents for less than two years had a higher level of energy curtailment behavior than those residing for more than ten years. Both groups had low-income levels and occupied rental houses. The lowest energy curtailment group was medium-income residents who owned their houses and lived for 2 to 5 years or more than ten years. However, if the owners had lived for more than ten years and had the highest income, they also had a high level of curtailment behavior. The overall picture suggests that recent movers, particularly renters, are more susceptible to adopting curtailment behavior than those who have lived for more than two years.

Hori et al. (2013) surveyed five major Asian cities to identify the factors influencing household energy-saving behavior. Their results showed that global warming consciousness, environmental behavior and social interaction significantly affect energy-saving behavior. Furthermore, income and age were also found to have weak positive effects on energy-saving behaviors. The strong linkage of social interaction to energy-saving behaviors indicates that community-based activities impact energy-saving behaviors.

Using an online self-selection survey, Karlin et al. (2014) systematically reviewed studies on the behavioral dimension of energy conservation in high-income countries. The authors found a significant effect of environmental concern on curtailment behavior relating to energy use but found no effect of environmental concern on efficiency behaviors and suggest that these behaviors are rather driven by demographics, structural, technical and financial factors.

Fithri, Susanti and Bestarina (2015) assessed household energy savings and consumer behavior to investigate the behavior related to energy savings, factors that encourage energy-saving behavior and the possible potential savings in the household sector in Padang city in China. The study results show that household size, income, payment methods and house size affect energy-saving behavior. Household expenses on electricity are strongly influenced by gender, type of job, level of education, size of house, income, payment method and level of installed power. However, households are not concerned about energy-saving behavior because of cheap energy prices and affordability of the household to pay, especially for middle to high-income households. Moreover, households are not so well-informed about energy-efficient equipment, so their effort to control power consumption is not a priority. Therefore, the study suggests the need for households to be more educational through sufficient information to help them take action in behavioral change toward energy saving.

Liu, Wu and Zhang (2015) investigated the residential energy consumption behavior in Beijing and found that the direct energy consumption behavior of older respondents and those with higher education backgrounds and income levels are more energy conservative than younger respondents and other education and income level groups. The findings from the study suggest that the promotion of energy-saving appliances is effective in driving energy conservation and emission reductions.

Poruschi and Ambrey (2016) studied the connection between households' energy-saving behavior and direct residential energy consumption in Australia using Household Energy Consumption Survey data. Results from a seemingly unrelated regression (SUR) system of equations revealed that characteristics unique to living in a city are linked to higher levels of direct residential energy consumption. On a number of measures, e.g., household income, tenure type and dwelling type, the results point to a lower likelihood of engaging in energy-saving behaviors in cities. Furthermore, renters are significantly disadvantaged, suffering from a much lower adaptive capacity. Specifically, householders who rent their homes are 77% less likely to have solar electricity. In addition, householders who rent are less likely to engage in energy-saving actions. This reflects difference in ontological security and the greater psychological burden associated with undertaking energy-saving behaviour borne by renters not shared with home owners.

Yang, Zhang and Zhao (2016), in their study on the energy-saving behavior in Chinese urban residents, provided evidence that the curtailment behaviors are significantly related to environmental responsibility and energy curtailment attitude. The study also found socio-demographic factors such as female gender and being older to be correlated with curtailment behavior.

Enzler, Diekmann and Liebe (2019) studied the relationship between two psychological factors: future orientation, environmental concern, and energy consumption in Swiss households. They found a significant and negative correlation between the variables, which translates to less energy use by more environmentally concerned and future-oriented persons. The study also found a large gender difference, with women using less electricity than men.

Spandagos et al. (2020) studied energy use patterns and attitudes in an urban setting among Hong Kong households. The authors examined energy-saving behavior relating to efficiency and conservation on three objectives - environment, personal comfort and economic/monetary, and found that consumer perceptions are affected by choice of behavior. The study suggested that the importance the consumers assign to environmental and economic objectives for efficiency behavior are higher than those for conservation behavior, and comfort is the most important objective for conservation. On the other hand, the environmental and economic objectives for conservation do not correlate strongly with the efficiency objective. Furthermore, the perceptions are more affected by the consumers' psycho-cognitive characters, and less by socio-demographics. The authors suggested a "satisfy" policy target, where changes in both energy behaviors need to be targeted at the same time, by satisfying the most important objectives for each one of them.

Using a household survey in Hanoi City, Nguyen, Duong and Do (2021) studied household energy-saving behavior in households. Results from the structural analysis showed that the quality of energy-efficient appliances and social norms affect energy-saving behavior positively. The study also revealed that gender, income and educational level act as stimulant factors in promoting energy-saving behavior and that women tend to practice energy-saving behavior more than men.

Maqbool and Haider (2021) examined the impact of the energy-saving behavior of individuals on energy consumption in urban and rural Pakistani households using primary data. The study found a positive and significant relationship between income and energy consumption and a negative and significant relationship between job status, marital status, energy consumption awareness and saving behavior in electronic appliances with energy consumption.

Slupik, Kos-Labedowicz and Trzesiok (2021) attempted to identify individual attitudes and beliefs of energy consumers in Poland and confirmed psychological factors to be the most important factors in shaping energy-saving behaviors. The results also indicated that other factors such as income, number of people in a household, level of environmental knowledge and awareness, house equipment level or the place of residence or building type shaped energy-saving behaviors of the consumers but to a lesser extent than the psychological factors.

Never et al. (2022) studied the individual motivation to behavior and its impact on households' energy expenditure in the capital cities of Ghana, Peru and Philippines. Using household surveys on middle-class households, the authors examined the energy-saving behavior relating to energy efficiency investments and curtailment behaviors of the households by emphasizing the environmental concern and environmental knowledge of the individuals. The results suggest that consumers who have environmental concerns are more likely to adopt curtailment behaviors, but that concern does not influence energy efficiency investments. On the other hand, consumers with higher levels of environmental knowledge are more likely to make energy efficiency investments, but that knowledge does not influence curtailment. Further examination of the impact of environmental concern, knowledge, curtailment and energy-efficient appliance purchase behavior on household electricity expenditure showed that socio-demographics have a stronger effect on electricity expenditures compared to concern, knowledge and energy-saving behavior.

Though studies have shown varying significance and the influence of individual factors on energy-saving behaviors, the impact of income is usually similar in different countries. This is supported by the proposition that the higher the income, the higher the likelihood of purchasing energy-efficient appliances, but also the lower the probability of engaging in energy-curtailing behaviors as confirmed by Umit et al. (2019). As proposed by Solanki, Mallela and Zhou (2013), reduction in energy use may be achieved through changing attitudes, suitable consumption measures, replacement of less efficient appliances with more efficient ones and increased efficiency in its use. These measures are indispensable for saving energy.

2.7 CONCLUSION

This chapter presents a review of the literature that focuses on the factors that affect energy consumption at the household level. It can be concluded from the above review of literature that various studies surrounding household energy consumption have been done in India and different countries around the world. However, to the knowledge of the researcher, little or no intensive study in this area has been done in the northeastern part of the country, including Nagaland, which is a major lacuna. Moreover, the studies on household energy in India have mainly focused on fuel choice but not much has been done on the consumption patterns. Research undertaken in this study is therefore expected to fill the gap and should deepen the foundation for understanding the urban energy consumption in the household sector.

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CHAPTER 3

SOCIO ECONOMIC PROFILE

3.1 INTRODUCTION

The socio-economic profile of an area is a crucial element of assessment that has considerable influence on the level of living of the people. This chapter presents an overview of the socio-economic profile of Nagaland in general and of the sample areas in particular.

3.2 PHYSICAL FEATURES OF NAGALAND

Nagaland is a landlocked state in the northeast region of India. It is bounded by Assam in the west and in the north, Myanmar and Arunachal Pradesh in the east and Manipur in the south. The State lies between $25^0$60' N and $27^0$40' N latitude and between the longitudinal lines $93^0$20' E and $95^0$15' E. It has an area of 16,579 square kilometers comprising 0.5% of India's geographical area and constituting about 6.32% of the whole northeast region of India. The capital of the State is Kohima, which is located at an elevated altitude of 1444.12 meters above sea level. Dimapur is the largest city, with an elevation of 260 meters above sea level. Nagaland is largely a mountainous state with a wide variety of forest and natural resource cover due to its unique geographical location and climatic conditions (Govt. of Nagaland, 2016, pp. 10).

3.3 CLIMATE OF THE STATE

Nagaland has a typical monsoon climate with high humidity levels. The plain areas are slightly warmer than the hills. Annual rainfall in the State averages around 1,800–2,500 millimeters (70–100 inches), concentrated in the months of May to September, with May, June and July being the wettest months. Nagaland has an average year-round temperature of 19.6 degree Celsius with atmospheric temperature varying from 15 degree Celsius to 30 degree Celsius in summers and from less than 5 degree Celsius to 25 degree Celsius in winters. In winter, the temperature does not generally drop below 4 degree Celsius, but frost is common at high elevations. Summer is the shortest season in the State that lasts for only a few months.

In Nagaland, altitude variation is among the prime factors affecting climate and weather conditions. Relief features such as high mountains act as barriers to the movement of the monsoon winds. Low temperature, high rainfall on windward slopes, comparatively dry on the leeward side, and heavy precipitation in the form of snow at the mountain tops are the main features of the climate.

3.4 ADMINISTRATIVE SETUP OF THE STATE

The State of Nagaland was formally inaugurated on 1 December 1963 as the 16th State of the Indian Union, and Kohima was declared as the state capital. The entire administrative area was then divided into three districts, namely, Kohima, Mokokchung and Tuensang. During the subsequent years, more districts were carved out from the existing ones. Thus currently, Nagaland has 16 districts, namely, Kohima, Dimapur, Kiphre, Longleng, Mokokchung, Mon, Peren, Phek, Tuensang, Wokha, Zunheboto, Noklak, Tsemenyu, Chumukedima, Niuland and Shamator. The State has 19 statutory towns, 7 census towns, 1355 villages, 3 Municipal Councils and 20 Town Councils. The State is almost entirely inhabited by tribals with their own distinct traditional, lingual and cultural characteristics. As such, 17 tribes are recognized in the State, viz; Angami, Ao, Chakhesang, Chang, Kachari, Khiamniungan, Konyak, Kuki, Lotha, Phom, Pochury, Rengma, Sangtam, Sema, Tikhir, Yimkhiung and Zeliang (Government of Nagaland, 2022).

3.5 CATEGORY-WISE URBAN CENTERS IN NAGALAND

As per the 2011 census, Nagaland has a total of 26 urban centers, comprising of 3 municipal councils, 16 town councils and 7 census towns. These urban centers are categorized into different classes – Class I to Class VI, depending on the size of the population. According to the 2011 census, Dimapur has emerged as the only Class I city (population 100,000 and above) with a population of 122,834. Accordingly, Dimapur city accounts for 21.51% of the State’s total urban population. The State capital Kohima is the only Class II town (population 50,000 – 99,999) with a population of 99,039, accounting for 17.35% of the State's total urban population. Besides, the State has 6 urban centers under Class III (population 20,000 – 49,999), 6 under Class IV (population 10,000 – 19,999), 10 under Class V (population 5,000 – 9,999) and 2 under Class VI (population below 5,000). Accordingly, Class III, Class IV, Class V, and Class

VI respectively account for 32%, 14.57%, 13%, and 1.64% of the State's total urban population.

Table 3.1: District-Wise Urban Centres under Different Size Categories in Nagaland in 2011

District	Towns	Class	Population	% of urban population
Dimapur	Dimapur (MC)	I	1,22,834	21.51
	Kuda (CT)	IV	16,108	2.82
	Rangapahar (CT)	V	6,673	1.17
	Chumukedima (TC)	III	25,885	4.53
	Puranabazar 'A' (CT)	V	7,385	1.29
	Diphupar 'A' (CT)	IV	10,246	1.79
	Medziphema (TC)	V	8,738	1.53
Kohima	Tsemenyu (TC)	V	6,315	1.11
	Kohima (MC)	II	99,039	17.35
	Kohima Village (CT)	IV	15,734	2.76
Phek	Phek (TC)	IV	14,204	2.49
	Pfutsero (TC)	IV	10,371	1.82
Peren	Jalukie (TC)	V	8,706	1.52
	Peren (TC)	V	5,084	0.89
Mokokchung	Tuli (TC)	V	7,864	1.38
	Tsudikong (CT)	VI	4,416	0.77
	Changtongya (TC)	V	7,532	1.32
	Mokokchung (MC)	III	35,913	6.29
Zunheboto	Zunheboto (TC)	III	22,633	3.96
	Satakha Hq. (CT)	VI	4,964	0.87
Wokha	Wokha (TC)	III	35,004	6.13
Tuensang	Tuensang (TC)	III	36,774	6.44
Kiphire	Kiphire (TC)	IV	16,487	2.89
Longleng	Longleng (TC)	V	7,613	1.33
Mon	Naginimora (TC)	V	8,116	1.42
	Mon (TC)	III	26,328	4.61

Source: Census of India, 2011 and Nagaland Primary Census Abstract.

Note: MC = Municipal Council, CT = Census Town and TC = Town Council.

3.6 DEMOGRAPHIC CHARACTERISTICS OF THE STATE

3.6.1 Population and Density of Population

Nagaland has a total population of 1,978,502 (0.16% of India's population) as per the 2011 census. Dimapur district constitutes the highest population with 378,811, while the lowest is Longleng with 50,484. The density of population in Nagaland is 119 per sq. km against the country's average of 362 per sq. km. Among the districts, Dimapur has the highest population density with 409 persons per square kilometer, whereas Peren was the lowest with 58 persons per square kilometre.

During the 2011 Census, Dimapur had the highest share of population, comprising 19.15%, followed by Kohima with 13.54%, Mon with 12.65% and Mokokchung and Tuensang with an almost equal share of 9.84% and 9.94%, respectively. Meanwhile, Longleng has the smallest share of population with only 2.55%, followed by Kiphire with 3.74%.

The decadal growth rate during 2001-2011 in Nagaland was -0.47%, while that of India was 17.64%. There was no uniformity among the districts in population growth, whereby some districts have exhibited positive growth while others have witnessed negative growth. Among the districts, Dimapur had the highest decadal growth rate with 23.23%, followed by Kohima, Phek, Peren, Tuensang and Wokha with 22.66%, 10.19%, 4.61%, 5.81% and 3.11% respectively. On the other end, districts such as Longleng, Kiphire, Mokokchung, Zunheboto and Mon have witnessed negative growth rates with -58.39%, -30.54%, -16.77%, -8.79% and -3.83%, respectively. Dimapur (51.95%) and Kohima (45.60%) are the most urbanized districts in the State.

3.6.2 Sex Ratio

The average sex ratio is the number of females per 1000 males. As per the 2011 Census, the average sex ratio of Nagaland is 931 compared to the national average of 940 females per 1000 males. Among the districts, Zunheboto has the highest sex ratio, while Mon has the lowest with 981 and 898, respectively. The average sex ratio in urban regions of Nagaland was 905 against 926 in India. Similarly, the average sex ratio in rural areas of the State was 940 against 947 in India. In the rural area, the highest was Zunheboto with 998, while the lowest was Mon with 901. Similarly, in the urban area,

Table 3.2: Population Structure of Nagaland in 2011

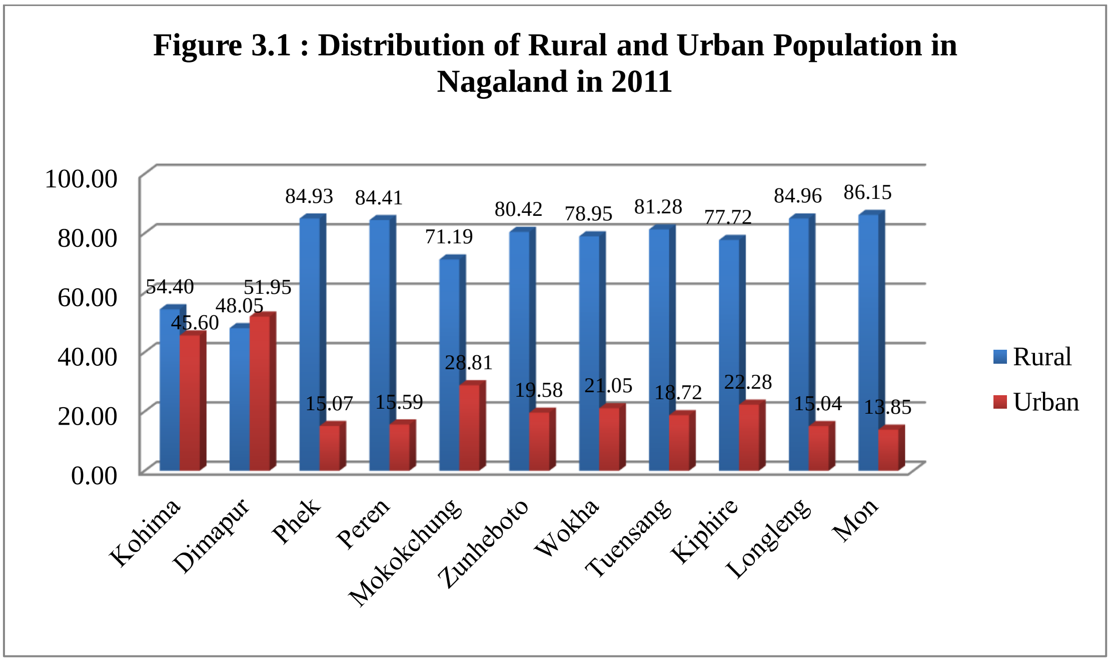
	Population				Density of population (per sq. km)	Decadal growth rate 2001-2011 (%)	Sex Ratio		
	Total	% share of State's total population	Rural (%)	Urban (%)			Total	Rural	Urban
Kohima	267988	13.54	54.40	45.60	183	22.66	927	924	932
Dimapur	378811	19.15	48.05	51.95	409	23.23	916	931	903
Phek	95219	8.26	84.93	15.07	81	10.19	551	969	860
Peren	163418	4.81	84.41	15.59	58	4.61	917	916	921
Mokokchung	194622	9.84	71.19	28.81	121	-16.77	927	950	874
Zunheboto	140757	7.11	80.42	19.58	112	-8.79	981	998	916
Wokha	166343	8.41	78.95	21.05	102	3.11	969	980	930
Tuensang	196596	9.94	81.28	18.72	90	5.81	930	939	890
Kiphire	74004	3.74	77.72	22.28	65	-30.54	961	970	928
Longleng	50484	2.55	84.96	15.04	90	-58.39	903	902	905
Mon	250260	12.65	86.15	13.85	140	-3.83	898	901	878
Nagaland	1978502	100	71.03	28.97	119	-0.47	931	942	905
India	1,210,854,977		68.84	31.16	362	17.64	940	947	926

Source: Census of India, 2011.

the highest was Kohima with 932, while the lowest was Phek with 860.

3.6.3 Rural and Urban Population Distribution

According to the 2011 Census, the proportion of Nagaland's rural population was 71.03% which was higher than that of India with 68.84%, whereas the urban population was 28.97% against that of India with 31.16%. In Nagaland, the highest proportion of rural population among the districts was Mon with 86.15%, while the lowest was Dimapur with 48.05% in 2011. Correspondingly, Dimapur has the highest and Mon has the lowest urban population with 51.95% and 13.85%, respectively.



Source: From Table 3.2.

3.6.4 Urban Population Structure and Growth in Nagaland

During 2001, the proportion of the urban population in Nagaland was 17.23% against 27.81% of India. The proportion of the urban population increased to 28.97% in 2011, while that of India corresponds to 31.16%. The growth rate of the urban population in Nagaland during 2001-2011 was 67.38%, which was much higher than the national growth rate of 31.80%. Mon had the highest decadal growth rate with 109.27%, followed by Phek, Mokokchung, Dimapur, Kohima, Tuensang and Zunheboto with 91.27%, 78.30%, 72.14%, 50.87%, 23.70% and 19.60%, respectively. In contrast, Wokha has exhibited negative growth rate with -7.04%. It is revealed from Table 3.3

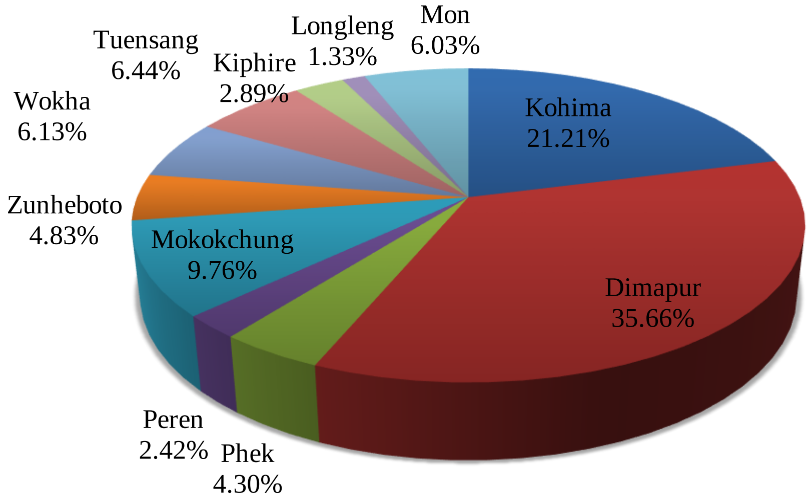
that Dimapur and Kohima are the most urbanized districts, where 51.95% and 45.60% of their respective population resided in urban areas in 2011.

Table 3.3: Urban Population Structure of Nagaland during 2001-2011

	% share of urban population 2001	% share of urban population 2011	Urban decadal growth rate 2001-2011	% of total urban population 2011
Kohima	35	45.60	59.87	21.21
Dimapur	37.19	51.95	72.14	35.66
Phek	8.68	15.07	91.27	4.30
Peren	-	15.59	-	2.42
Mokokchung	13.45	28.81	78.30	9.76
Zunheboto	14.93	19.58	19.60	4.83
Wokha	23.34	21.05	-7.04	6.13
Tuensang	16.01	18.72	23.74	6.44
Kiphire	-	22.28	-	2.89
Longleng	-	15.04	-	1.33
Mon	6.36	13.85	109.27	6.03
Nagaland	17.23	28.97	67.38	100
India	27.81	31.16	31.80	

Source: Census of India, 2011.

Figure 3.2: District-Wise Share of Urban Population in Nagaland in 2011



Source: Census of India, 2011.

During 2011, Dimapur had the highest urban population constituting 35.66% of the total urban population of the State followed by Kohima, Mokokchung, Tuensang, Wokha and Mon with 21.21%, 9.76%, 6.44%, 6.13% and 6.03% respectively. Meanwhile, Longleng recorded the lowest proportion of urban population accounting for 1.33% of the total urban population of the State followed by Peren, Kiphire, Phek and Zunheboto with 2.42%, 2.89%, 4.30% and 4.83%, respectively.

3.7 SECTORAL PERFORMANCE OF THE ECONOMY

Table 3.4 reveals that the NSDP has increased from ₹1,055,428 lakhs in 2011-12 to ₹1,547,210 lakhs in 2019-20. Correspondingly, the per capita NSDP has also increased from ₹53,010 to ₹71,399 during the same period. Among the sectors, the tertiary sector has been the major contributing sector, with 55.45% during 2011-12, 58.41% during 2015-16 and 63.57% during 2019-20. The primary sector follows this with 31.86%, 30.45% and 24.36% during the corresponding periods. The secondary sector has been the lowest contributing sector during the same period with 12.69%, 11.14% and 12.07%, respectively.

Among the sub-sectors, agriculture and allied activities has been the highest contributor to NSDP, with 31.38% during 2011-12, 29.11% during 2015-16, and 22.90% during 2019-20. Other services were the second highest contributing sector during 2011-12 with 13.87%, while in the subsequent periods it was public administration with 16.53% and 18.70% respectively. The lowest contributing sub-sectors were mining and quarrying, manufacturing, electricity, gas, water supply and other utility services, and financial services. Trade, hotels and restaurants, construction, real estate, ownership of dwelling & professional services, and transport, storage & communication are other major sub-sectors in the economy.

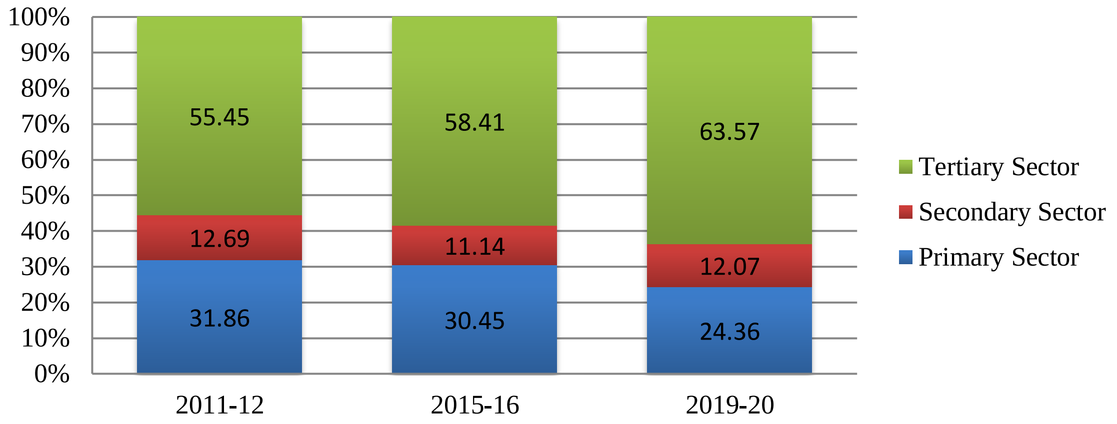
It can be inferred from the above discussions that among the sub-sectors, agriculture remains the major contributing sector to NSDP. Public administration has emerged as an important sector in the State's economy. The tertiary sector has been the leading sector in the last decade in terms of its contribution to NSDP. This is followed by the primary sector, while the secondary sector has been the lowest contributing sector. Hence, the economy of the State is mostly dependent on the secondary sector.

Table 3.4: NSVA at Constant Prices during 2011-20 (₹ in Lakhs at 2011-12 Prices)

	2011-12	2015-16	2019-20
1. Primary Sector	**332,745 (31.86)**	**377180 (30.45)**	**365,580 (24.36)**
1.1. Agriculture and Allied Activities	327,768 (31.38)	360563 (29.11)	343,692 (22.90)
1.2. Mining and Quarrying	4977 (0.48)	16617 (1.34)	21,888 (1.46)
2. Secondary Sector	**132,563 (12.69)**	**137984 (11.14)**	**181,081 (12.07)**
2.1. Manufacturing	11,153 (1.07)	17876 (1.44)	23,303 (1.55)
2.2. Electricity, Gas, Water Supply & Other Utility Services	21,462 (2.05)	21115 (1.70)	33,258 (2.22)
2.3. Construction	99,948 (9.57)	98993 (7.99)	124,520 (8.30)
3. Tertiary Sector	**579,119 (55.45)**	**723546 (58.41)**	**953,905 (63.57)**
3.1. Trade, Repair, Hotels and Restaurants	103,558 (9.92)	123428 (9.96)	196,349 (13.09)
3.2. Transport, Storage & Communication	48,754 (4.67)	61883 (5.00)	84,653 (5.64)
3.3. Financial Services	46,948 (4.50)	49425 (3.99)	52,698 (3.51)
3.4. Real Estate, Ownership of Dwelling & Professional Services	106,716 (10.22)	97455 (7.87)	92,797 (6.18)
3.5. Public Administration	128,283 (12.28)	204788 (16.53)	280,532 (18.70)
3.6. Other Services	144,859 (13.87)	186567 (15.06)	246,876 (16.45)
4. Total NSVA at Basic Prices	**1,044,428**	**1,238,711**	**1,500,565**
5. NSDP	**1,055,428**	**1,259,970**	**1,547,210**
6. Per Capita NSDP (₹)	**53,010**	**60,663**	**71,399**

Source: Directorate of Economics and Statistics, Nagaland, 2022.
Note: Figures in brackets indicate percentages to NSVA.

Figure 3.3: Percentage of Sectoral Contribution to NSDP during 2011-2020



Source: From Table 2.4.

3.8 EMPLOYMENT IN THE ECONOMY

The total number of workers in Nagaland was 974,122 in 2011, constituting 49.24% of the population. The distribution of workers for the State in 2011 is presented in Table 3.5. Main workers constitute 76.09% of the total workforce, out of which 59.77% were engaged in agricultural activity, indicating the agrarian nature of the economy. On the other hand, 23.91% of the total workers were marginal workers. The proportion of cultivators, agricultural labourers, household industries and other workers constitute 56.72%, 3.05%, 1.29% and 38.95%, respectively.

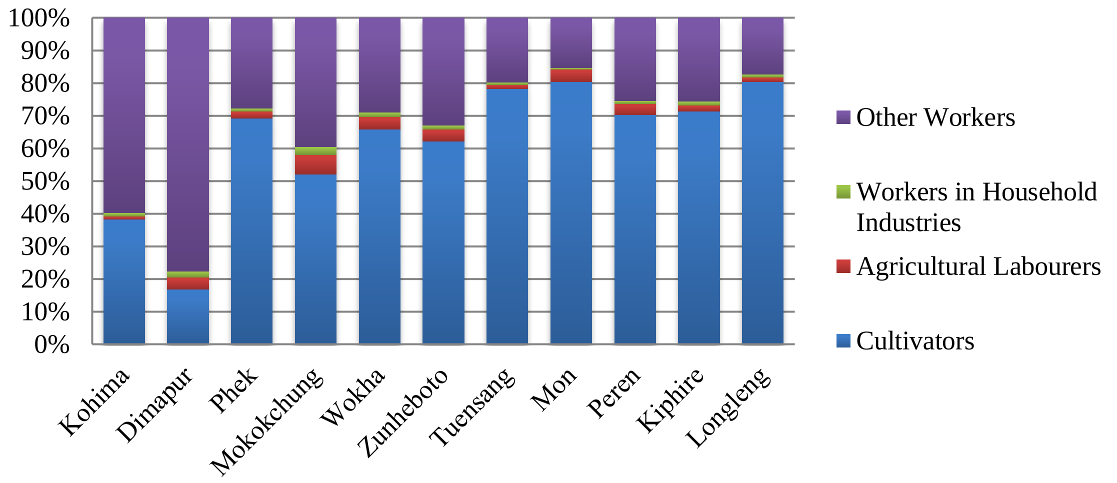
Among the districts, Peren exhibited the highest proportion of total workers with 64.47%, while Dimapur had the lowest with 39.95%. When only the main workers are taken into consideration, Kohima was the highest with 86.57%, while Peren was the lowest with 59.55%. Reversely, Peren exhibited the highest proportion of marginal workers at 40.45%, and Kohima was the lowest at 13.43%. Regarding the distribution of main workers, the proportion of cultivators was highest in Mon with 80.40%, while that of the lowest was Dimapur with 16.83%. However, the trend was reversed in the proportion of other workers, with the highest and lowest in Dimapur and Mon with 77.58% and 15.26%, respectively. For agricultural labourers, it was highest in Mokokchung with 6% and lowest in Kohima with 0.92%. The household industry was highest in Mokokchung and lowest in Mon with 2.39% and 0.58%, respectively.

Table 3.5: Distribution of Main and Marginal Workers in Nagaland in 2011 (%)

Districts	Total Workers	Main Workers	Category-wise Distribution of Main Workers				Marginal Workers
			Cultivators	Agricultural Labourers	Household Industrial Workers	Other Workers	
Kohima	42.85	86.57	38.24	0.92	1.14	59.70	13.43
Dimapur	39.95	80.84	16.83	3.68	1.91	77.58	19.16
Phek	49.12	79.28	69.24	2.06	0.96	27.74	20.72
Mokokchung	51.42	80.99	52.11	6.00	2.39	39.49	19.01
Wokha	47.14	81.00	65.91	3.74	1.38	28.97	19.00
Zunheboto	56.46	62.14	62.25	3.57	1.24	32.94	37.86
Tuensang	49.93	74.90	78.18	1.29	0.74	19.80	25.10
Mon	59.00	71.10	80.40	3.76	0.58	15.26	28.90
Peren	64.47	59.55	70.30	3.37	0.95	25.38	40.45
Kiphire	43.19	80.82	71.43	1.70	1.25	25.62	19.18
Longleng	60.55	68.52	80.39	1.33	0.95	17.33	31.48
Nagaland	49.24	76.09	56.72	3.05	1.29	38.95	23.91

Source: Statistical Handbook of Nagaland, 2021.

Figure 3.4 : Percentage Distribution of Main Workers in Nagaland in 2011



Source: From Table 3.5.

3.9 PROFILE OF THE SAMPLE AREAS

Household energy consumption is a part of an integrated system that varies from region to region depending on the composition of this system. To conceive these variations, the present study selected two urban centers located at geo-climatically different regions in Nagaland, viz. Kohima municipal area in Kohima district and Dimapur municipal area in Dimapur district.

3.9.1 Kohima Municipal Area

Kohima is the capital of Nagaland, and is located between the geographical coordinates of 25.49 degree North latitude and 94.08 degree South longitude. Kohima municipal area is located on the Pulie Badze mountain's hilly high slopes that range with a mean elevation of 1468 m above sea level. Its temperature ranges from 2.9 to 27 degree Celsius. It occupies an area of about 11 square kilometres. The municipal area is divided into 19 wards with a total population of 99,039 and 22,312 households constituting 83.39% of the total urban population in Kohima district, accounting for 17.34% of the total state urban population as per the 2011 census.

3.9.2 Dimapur Municipal Area

Dimapur is the largest city in Nagaland and is located at 25.92 degree North latitude and 93.73 degree East longitude. Dimapur municipal area is situated in the plains with an average elevation of 195 m above sea level. Its temperature ranges from 10.4 to 36 degree Celsius. It occupies an area of about 18.13 square kilometres. The Dimapur municipal area is divided into 23 wards with a total population of 122,834 and 27,165 households, constituting 65% of the total urban population in Dimapur district and accounting for nearly 22% of the total state urban population according to the 2011 Census.

3.10 PROFILE OF THE SAMPLE HOUSEHOLDS

3.10.1 Sample Population: The total population in 621 sample households was 2865, comprising of 49.88% in Kohima and 50.12% in Dimapur. As shown in Table 3.6, the household demographics of the sample populations are quite consistent. In each sample area, males represent the prominent gender comprising 51.66% of the total population.

The sex ratio in sample households was 936, which was higher than that of the 2011 census with 905. Among the sample areas, Kohima has higher sex ratio of 939 than Dimapur, with 933. The average family size is found to be 4.6 persons. Kohima has an average family size of 4.9 and Dimapur has an average of 4.4.

Table 3.6: Distribution of the Sample Population

Sex	Kohima	Dimapur	Total
No. of households	294	327	621
Male	737	743	1480
Female	692	693	1385
Total	1429 (49.88)	1436 (50.12)	2865 (100)
Sex ratio	939	933	936
Average household size	4.9	4.4	4.6

Source: Household Survey, 2016-17.
Note: The figures in brackets represent percentages in the total sample population.

3.10.2 Age-Wise Composition: The sample population has been divided into seven age cohorts, such as 10 years and below, 11-20, 21-30, 31-40, 41-50, 51-60 and above 60 years of age. For the aggregate sample and individual areas, the proportion of people was found to be highest within the age group of 21-30 years, accounting for 28.59%, 29.18% (Kohima) and 27.99% (Dimapur). On the other hand, the least was in the age group of 0-10 years with 4.47%. Kohima constituted 4.06% of 0-10 age group and Dimapur constituted 4.87%.

Table 3.7: Age-Wise Composition of Population in Sample Areas

Age	Kohima	Dimapur	Total
0-10	58 (4.06)	70 (4.87)	128 (4.47)
11-20	351 (24.56)	290 (20.19)	641 (22.37)
21-30	417 (29.18)	402 (27.99)	819 (28.59)
31-40	171 (11.97)	177 (12.33)	318 (12.15)
41-50	174 (12.18)	196 (13.65)	370 (12.91)
51-60	169 (11.83)	174 (12.12)	343 (11.97)
Above 60	89 (6.23)	127 (8.84)	216 (7.54)
Total	1429 (100)	1436 (100)	2865 (100)

Source: Household Survey, 2016-17.
Note: Figures in brackets represent percentages of age groups to respective total population.

3.10.3 Educational Status of Household Members: Table 3.8 shows the distribution of the households according to the members' educational status. It is interesting to note that in the study areas, most people were graduates (31.37%), followed by post-graduate/professional degree, higher secondary, primary, upper primary and secondary with 17.15%, 15.61%, 12.40%, 12.04% and 9.25%, respectively. The proportion of population over three years of age with no schooling was 2.18%.

Table 3.8: Distribution of Population by Educational Status

Educational Status	Kohima	Dimapur	Overall
No Schooling	30 (2.16)	31 (2.20)	61 (2.18)
Primary	145 (10.43)	202 (14.34)	347 (12.40)
Upper Primary	178 (12.81)	159 (11.28)	337 (12.04)
Secondary	153 (11.01)	106 (7.52)	259 (9.25)
Higher Secondary	194 (13.96)	243 (17.25)	437 (15.61)
Graduate	433 (31.15)	445 (31.58)	878 (31.37)
Post Graduate/Professional Degree	257 (18.49)	223 (15.83)	480 (17.15)
Total	1390 (100)	1409 (100)	2799 (100)

Source: Household Survey, 2016-17.
Note: 1) Figures in brackets represent percentages of the respective total.
2) Children under 3 years are excluded.

3.10.4 Gender of Household Head: Of the total households, 81.6% were headed by males, and females headed were 18.4%. Male-headed households in Kohima constituted 79.6%, whereas 20.4% of the households were female-headed. The corresponding male and female-headed households in Dimapur were 83.5% and 16.5%, respectively.

Table 3.9: Gender-Wise Household Heads in Sample Areas

Gender	Kohima	Dimapur	Overall
Male	234 (79.6)	273 (83.5)	507 (81.6)
Female	60 (20.4)	54 (16.5)	114 (18.4)
Total	294 (100)	327 (100)	621 (100)

Source: Household Survey, 2016-17.
Note: Figures in brackets represent percentages of the respective total.

3.10.5 Educational Status of Household Head: The educational status of the household heads in the sample area is given in Table 3.10. The cumulative educational qualification for the study area reveals that 4.2% of household heads had no formal education, 9.8% had primary education, 35.1% had graduate qualifications, and 15.5% had post-graduate and professional degrees. Graduate level constituted the highest share of qualification of household heads in both Kohima and Dimapur, with 36.4% and 33.9%, respectively. Higher secondary education level formed the second highest share in Dimapur with 21.7%, followed by post-graduate and professional degrees with 11.9%. On the other hand, post-graduate and professional degrees formed the second highest share in Kohima with 19.4%, followed by upper primary level with 15.3%. 3.1 % of household heads in Kohima and 5.2% in Dimapur had no formal education.

Table 3.10: Educational Qualification of Household Heads

Educational Qualification	Kohima	Dimapur	Overall
No schooling	9 (3.1)	17 (5.2)	26 (4.2)
Primary	26 (8.8)	35 (10.7)	61 (9.8)
Upper Primary	45 (15.3)	24 (7.3)	69 (11.1)
Secondary	19 (6.5)	30 (9.2)	49 (7.9)
Higher Secondary	31 (10.5)	71 (21.7)	102 (16.4)
Graduate	107 (36.4)	111 (33.9)	219 (35.1)
Post Graduate/Professional Degree	57 (19.4)	39 (11.9)	96 (15.5)
Total	294 (100)	327 (100)	621 (100)

Source: Household Survey, 2016-17.
Note: Figures in brackets represent percentages of the respective total.

3.10.6 Age of Household Head: The age of household heads was categorized into five groups, namely, below 30 years, 31-40 years, 41-50 years, 51-60 years and above 60 years. In the aggregate sample, age 51-60 constituted the highest group with 31.6%, followed by above 60 years, 41-50 and 31-40 years with 23.7%, 21.7% and 17.4%, respectively. The age group below 30 years constituted the lowest with 5.6%. The same trend is exhibited in both sample areas.

Table 3.11: Age Group of Household Heads

Age (in years)	Kohima	Dimapur	Overall
<30	21 (7.1)	14 (4.3)	35 (5.6)
31-40	53 (18)	55 (16.8)	108 (17.4)
41-50	62 (21.1)	73 (22.3)	135 (21.7)
51-60	94 (32)	102 (31.2)	196 (31.6)
>60	64 (21.8)	83 (25.4)	147 (23.7)
Total	294 (100)	327 (100)	621(100)

Source: Household Survey, 2016-17.
Note: Figures in brackets represent percentages of the respective total.

3.10.7 Work Status of Household Head: The work status of household heads was categorized into four groups, namely, retired, salaried, self-employed and unemployed. Households whose income is mainly from pension benefits comprised 17.1% of the total sample households. The same was 15.3% in Kohima and 18.7% in Dimapur.

Table 3.12**:** Occupational Status of Household Heads

Occupation	Kohima	Dimapur	Overall
Retired	45 (15.3)	61 (18.7)	106 (17.1)
Salaried	186 (63.3)	176 (53.8)	362 (58.3)
Self-employed	27 (9.2)	45 (13.8)	72 (11.6)
Unemployed	36 (12.2)	45 (13.8)	81 (13)
Total	294 (100)	327 (100)	621 (100)

Source: Household Survey, 2016-17.
Note: Figures in brackets represent percentages of the respective total.

Self-employed refers to individuals who are employed themselves in various economic activities. It is observed that in the total sample households, 11.6% of the household heads were self-employed. The same was 9.2% in Kohima and 13.8% in Dimapur. The term ‘salaried’ refers to employees of an organized sector, whether governmental or non-governmental. The proportion of household heads salaried was 58.3% for the total sample. The same was 63.3% in Kohima and 53.8% in Dimapur. The unemployed category is comprised of those who do not have any source of income, including the unemployed and full-time stay-at-home parents. This category constituted 13% of the aggregate sample, with 12.2% in Kohima and 13.8% in Dimapur.

3.10.8 Distribution of Sample Households by Monthly Income: The sample households are categorized into five income groups based on their average monthly income. These comprised of households who earn less than ₹20,000; households with income levels between ₹20,000 and ₹50,000; ₹51,000 and ₹80,000; ₹81,000 and ₹100000 and households with income levels above ₹100000. Income group ₹20,000-₹50,000 constituted the highest percentage of aggregate households with 38.8% followed by ₹51,000-₹80,000, ₹81,000-₹100,000, and <₹20,000 with 34%, 15.1%, 7.7% and 4.3% respectively. In Kohima, most of the households (40.1%) were within the income group of ₹20,000-₹50,000, while for Dimapur (40.1%), it was within the income group of ₹51,000-₹80,000.

Table 3.13: Income Group of Households

Income group	Kohima	Dimapur	Overall
<20,000	16 (5.4)	11 (3.4)	27 (4.3)
20,000-50,000	118 (40.1)	123 (37.6)	241 (38.8)
51,000-80,000	80 (27.2)	131 (40.1)	211 (34)
81,000-100000	51 (17.3)	43 (13.1)	94 (15.1)
>100000	29 (9.9)	19 (5.8)	48 (7.7)
Total	294 (100)	327 (100)	621 (100)

Source: Household Survey, 2016-17.

Note: Figures in brackets represent percentages of the respective total.

3.10.9 Number of Rooms: The number of rooms in the sample households is categorized into four groups: 1-3, 4-6, 6-9 and more than 9. Majority of the households in the aggregate sample had 4-6 rooms in their homes (51.9%), 25% had 1-3 rooms, 15.6% had 7-9 rooms and 7.1% had more than 9 rooms.

Table 3.14: Number of Rooms in Sample Households

Number of rooms	Kohima	Dimapur	Overall
1-3	87 (29.6)	71 (21.7)	158 (25.4)
4-6	125 (42.5)	197 (60.2)	322 (51.9)
7-9	52 (17.7)	45 (13.8)	97 (15.6)
More than 9	30 (10.2)	14 (4.2)	44 (7.1)
Total	294 (100)	327 (100)	621 (100)

Source: Household Survey, 2016-17.

Note: Figures in brackets represent percentages of the respective total.

3.10.10 House Ownership: 64.9% of the sample households owned their place of dwelling (64.3% in Kohima and 65.4% in Dimapur), 30.1% were residing in rented accommodations and 5% in government quarters.

Table 3.15: House Ownership of Households

	Kohima	Dimapur	Overall
Rent	87 (29.6)	100 (30.6)	187 (30.1)
Government Quarters	18 (6.1)	13 (4)	31 (5)
Owned	189 (64.3)	214 (65.4)	403 (64.9)
Total	294 (100)	327 (100)	621 (100)

Source: Household Survey, 2016-17.

Note: Figures in brackets represent percentages of the respective total.

3.10.11 Types of House: Of the aggregate households, 69.89% had pucca houses, 27.38% had semi-pucca houses and 2.74% had katcha houses. In Kohima, 69.05% of the households had pucca houses, 27.21% had semi-pucca houses and 3.74% had katcha houses. Likewise, in Dimapur, 70.64% had pucca houses, 27.52% had semi-pucca houses and 1.83% had katcha houses.

Table 3.16: Types of House

	Kohima	Dimapur	Overall
Pucca	203 (69.05)	231 (70.64)	434 (69.89)
Semi-pucca	80 (27.21)	90 (27.52)	170 (27.38)
Katcha	11 (3.74)	6 (1.83)	17 (2.74)
Total	294 (100)	327 (100)	621 (100)

Source: Household Survey, 2016-17.
Note: Figures in brackets represent percentages of the respective total.

3.11 CONCLUSION

This chapter briefly discussed the profile of Nagaland pertaining to its physical features, urban concentrations, demography, sectoral performance and employment. Profile of the sample areas, i.e., Kohima and Dimapur have also been highlighted. It can be deduced from the above revelation that Nagaland is basically an agrarian economy with a rapidly growing urban population, who are mostly dependent on the service sector.

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CHAPTER 4

AN OVERVIEW OF ENERGY CONSUMPTION IN INDIA AND NAGALAND

4.1 INTRODUCTION

India is currently the world's second-most populous country after China, and it has become the fifth-largest economy in nominal terms, behind the United States, China, Japan and Germany. Expressed in terms of purchasing power parity (PPP), India is the third largest economy behind China and the United States (IEA, 2021b). The accelerating economic growth has resulted in increasing per capita income levels. Consequently, rapid growth in income has been accompanied by quick changing lifestyles, increasing availability and access to material goods and services and the ability to afford them, and increasing energy use for the country as a whole. The country exhibits wide variations in climate, topology and geography and has vast economic, social, ethnic, religious and cultural differences among its inhabitants. This heterogeneity accounts for differences in habits, attitudes and lifestyles and manifests itself in varying levels and energy use patterns throughout the country (Pachauri, 2009). The present chapter gives an overview of energy consumption in general, and household energy consumption in India and Nagaland in particular.

4.2 TRENDS IN INDIA'S ENERGY CONSUMPTION

India is the third largest energy consumer in the world after China and the United States (Enerdata, 2021). Table 4.1 shows the share of energy consumption of India, the US, China and some selected Asian countries compared to the world consumption. The total energy consumption in the world was 10105 Mtoe in 2001, which increased to 13828 Mtoe in 2020. Energy consumption has increased by 1.6% per year from 2001 to 2020. The total energy consumption of India corresponds to 448 Mtoe, which increased to 908 Mtoe during the same period. Correspondingly, the share of India's energy consumption to the world's total energy consumption was 4.4% in 2001, which increased to 6.6% in 2020. The total energy consumption of India increased at a rate of 3.6% per year during 2001-2020.

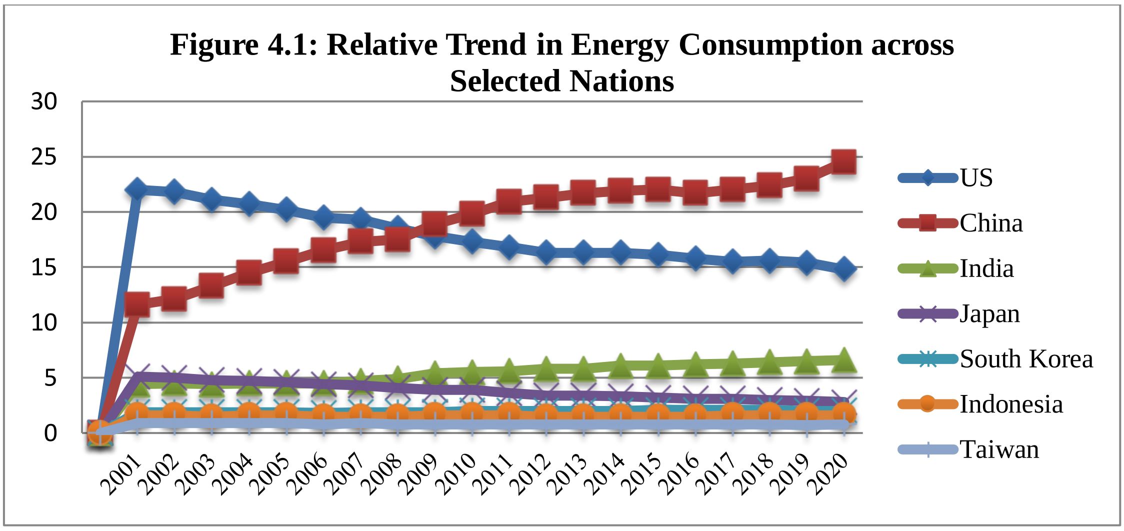
It can be observed from Table 4.1 and Figure 4.1 that during 2001-2020, while the share of the US in the world's total energy consumption shows a declining trend, China's share exhibited an increasing trend at an annual rate of change of -0.4% and 5.5%, respectively during the same period. Similarly, other Asian countries such as South Korea, Indonesia and Taiwan exhibited increasing trends at 1.9%, 1.8% and 1%, respectively, whereas Japan witnessed a declining consumption trend at -1.4% during the period.

Table 4.1: Energy Consumption in India and Some Selected Countries in Comparison with the World (in Mtoe)

Year	World	US	China	India	Japan	South Korea	Indonesia	Taiwan
2001	10105	2226 (22.0)	1168 (11.6)	448 (4.4)	511 (5.1)	193 (1.9)	159 (1.6)	86 (0.9)
2002	10336	2256 (21.8)	1246 (12.1)	462 (4.5)	513 (5.0)	201 (1.9)	165 (1.6)	90 (0.9)
2003	10702	2262 (21.1)	1420 (13.3)	474 (4.4)	509 (4.8)	206 (1.9)	165 (1.5)	94 (0.9)
2004	11174	2308 (20.7)	1615 (14.5)	500 (4.5)	526 (4.7)	212 (1.9)	176 (1.6)	96 (0.9)
2005	11486	2320 (20.2)	1782 (15.5)	515 (4.5)	524 (4.6)	214 (1.9)	179 (1.6)	98 (0.9)
2006	11814	2298 (19.5)	1950 (16.5)	533 (4.5)	524 (4.4)	218 (1.8)	183 (1.5)	100 (0.8)
2007	12142	2338 (19.3)	2099 (17.3)	568 (4.7)	519 (4.3)	227 (1.9)	182 (1.5)	105 (0.9)
2008	12285	2278 (18.5)	2155 (17.5)	604 (4.9)	500 (4.1)	232 (1.9)	185 (1.5)	101 (0.8)
2009	12166	2165 (17.8)	2297 (18.9)	663 (5.4)	477 (3.9)	234 (1.9)	196 (1.6)	100 (0.8)
2010	12837	2217 (17.3)	2536 (19.8)	701 (5.5)	503 (3.9)	256 (2.0)	202 (1.6)	106 (0.8)
2011	13051	2191 (16.8)	2723 (20.9)	734 (5.6)	466 (3.6)	267 (2.0)	205 (1.6)	105 (0.8)
2012	13220	2152 (16.3)	2821 (21.3)	766 (5.8)	456 (3.4)	271 (2.0)	204 (1.5)	105 (0.8)
2013	13410	2190 (16.3)	2912 (21.7)	779 (5.8)	457 (3.4)	272 (2.0)	197 (1.5)	107 (0.8)
2014	13557	2216 (16.3)	2966 (21.9)	822 (6.1)	442 (3.3)	277 (2.0)	206 (1.5)	109 (0.8)
2015	13593	2192 (16.1)	2998 (22.0)	835 (6.1)	434 (3.2)	283 (2.1)	204 (1.5)	107 (0.8)
2016	13704	2168 (15.8)	2977 (21.7)	852 (6.2)	429 (3.1)	293 (2.1)	209 (1.5)	109 (0.8)
2017	13969	2161 (15.5)	3070 (22.0)	883 (6.3)	434 (3.1)	295 (2.1)	222 (1.6)	107 (0.8)
2018	14299	2236 (15.6)	3201 (22.4)	919 (6.4)	428 (3.0)	296 (2.1)	231 (1.6)	110 (0.8)
2019	14407	2214 (15.4)	3309 (23.0)	940 (6.5)	416 (2.9)	293 (2.0)	237 (1.6)	108 (0.7)
2020	13828	2046 (14.8)	3381 (24.5)	908 (6.6)	386 (2.8)	283 (2.0)	225 (1.6)	105 (0.8)
CAGR	1.6	-0.4	5.5	3.6	-1.4	1.9	1.8	1

Source: Enerdata, 2021.

Note: Figures in brackets represent percentages of the world's consumption.



Source: From Table 4.1.

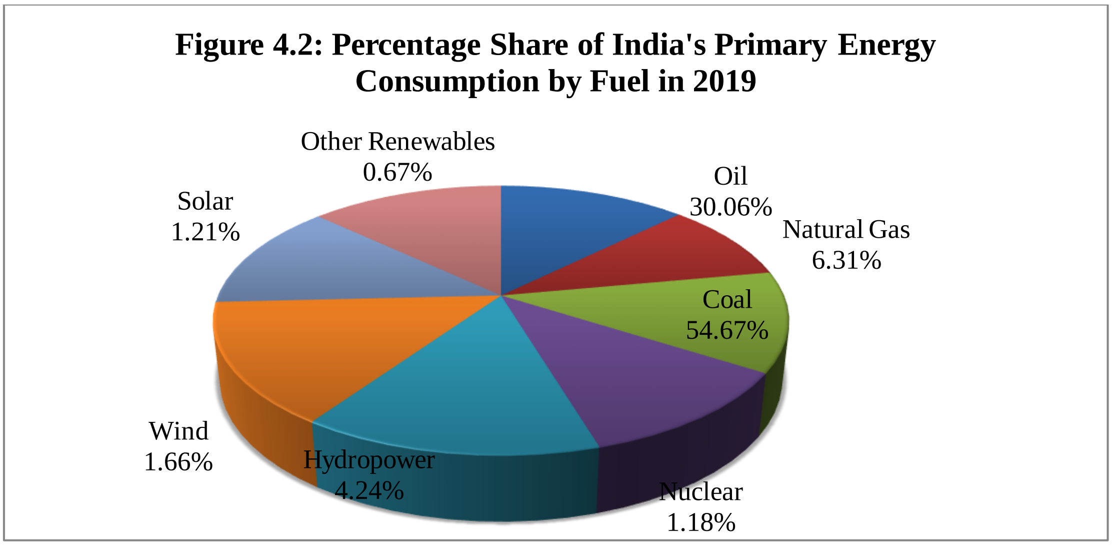
4.2.1 Consumption of Primary Energy by Fuel in India

In 2019, India consumed a total of primary energy of 6,923 kWh from fossil fuels, nuclear and renewables. It can be seen from Table 3.2 that of the various sources, fossil fuel constituted maximum consumption at 91.04%, followed by renewables at 7.78%. Nuclear constituted the lowest contribution among the primary fuels at 1.18%. Among the fossil fuels, coal constituted the highest share with 54.67%, followed by oil and natural gas with 30.06% and 6.31%, respectively. Under renewables, hydropower constituted the highest with 4.24%, followed by wind, solar and other renewables at 1.66%, 1.21% and 0.67%, respectively.

Table 4.2; India's Primary Energy Consumption by Fuel in 2019 (in kWh)

Fuel	Consumption	% share
1. Fossil fuel	**6303**	**91.04**
i) Oil	2081	30.06
ii) Natural gas	437	6.31
iii) Coal	3785	54.67
2. Nuclear	**82**	**1.18**
3. Renewables	**538**	**7.78**
i) Hydropower	293	4.24
ii) Wind	115	1.66
iii) Solar	84	1.21
iv) Other renewable	46	0.67
Total	**6923**	**100**

Source: Ritchie, Roser & Rosado, 2020.



Source: From Table 4.2.

4.2.2 Per Capita Primary Energy Consumption

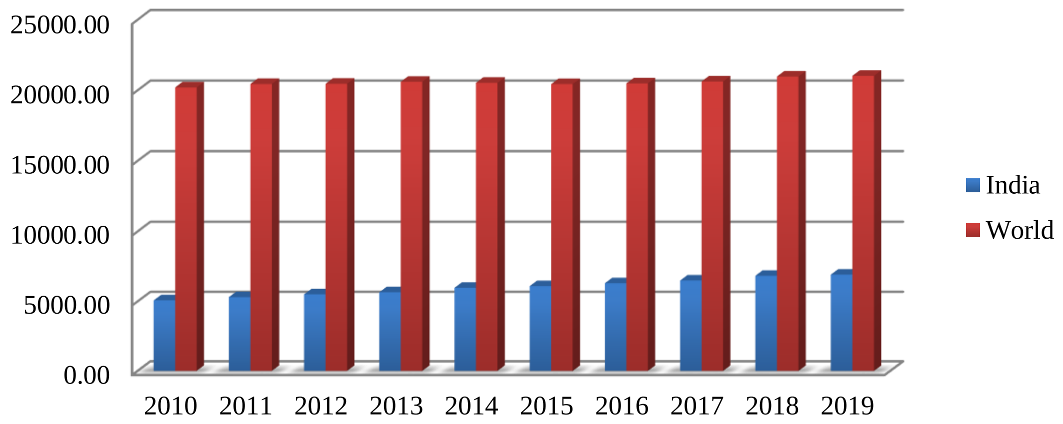
The per capita consumption of primary energy in India and its comparison with that of the world is shown in Table 4.3 and Figure 4.3. The per capita consumption of primary energy in India was 5075.99 kWh in 2010 against 20204.96 kWh of the world, which constituted 25.12% of the world's per capita consumption. It increased to 6923.93 kWh in 2019 but still constituted only 32.93% of the world's per capita. However, India's CAGR of per capita consumption was proportionately much higher at 3.15% during 2010 - 2019 compared to the world average of 0.4%. Nonetheless, the per capita consumption for India has been consistently lower than that of the world.

Table 4.3: Per Capita Consumption of Energy for India and the World from 2010 to 2019 (in kWh)

	World	India	% of India's PC energy consumption to world PC
2010	20204.96	5075.99	25.12
2011	20447.58	5305.55	25.95
2012	20464.76	5511.19	26.93
2013	20606.61	5655.34	27.44
2014	20532.66	5973.57	29.09
2015	20445.28	6099.98	29.84
2016	20490.96	6305.75	30.77
2017	20624.76	6501.98	31.53
2018	20975.20	6838.84	32.60
2019	21027.42	6923.93	32.93
2010-2019 (CAGR)	0.4	3.15	

Source: Ritchie, Roser & Rosado, 2020.

Figure 4.3: Trend in Per Capita Primary Energy Consumption in India and the World (in kWh)

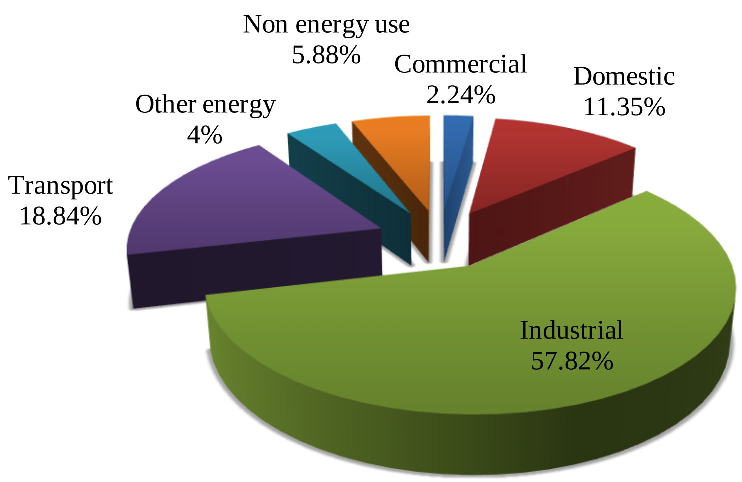


Source: From Table 4.3

4.2.3 Sector-Wise Final Energy Consumption in India

Final energy consumption in an economy covers all energy supplied to the final consumers for all energy uses. It is disaggregated into the final end-use sectors. In India, the industrial sector is the largest consumer of final energy consumption with a share of 57.82%, followed by transport and domestic sectors with 18.84% and 11.35%, respectively. The commercial sector accounts for 2.24%, while 5.88% of the final energy is utilized for non-energy purposes (TERI, 2021).

Figure 4.4: Composition of Final Energy Consumption in India during 2017-18



Source: TERI, 2021.

4.2.4 Electricity Consumption in India

India is the third largest electricity consumer in the world after China and US in 2020 (IEA, 2021b). A significant trend in the country's energy sector is that electricity consumption has increased rapidly, particularly over the past decades. India's share of electricity consumption in total final energy consumption was 16.3% in 2020 (Enerdata, 2021). One of the targets identified by the Sustainable Development Goals focuses on universally making affordable, reliable and modern energy accessible to everyone. Therefore, India has been focusing on making electricity available to all citizens by implementing various schemes to ensure the same. One such scheme is Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) for rural electrification. As a result of the efforts by the Government, all census villages in the country have gained access to electricity (TERI, 2021).

India's per capita electricity consumption is about one-third of the world average and is the lowest among most BRICS nations[1]. In 2020, India accounted for 11% of non-OECD residential electricity consumption (IEA, 2021b). Global per capita electricity consumption was 3,130 kWh in 2014, and that of India was 805 kWh (IEA, 2015).

The state-wise per capita electricity consumption in India during 2019-20 is given in Table 4.4. The table reveals that India's per capita electricity consumption increased to 1,208 kWh during 2019-20. State-wise data shows that Dadra & Nagar Haveli has the highest per capita electricity consumption with 15,517 kWh, followed by Daman & Diu, Goa, Gujarat, Haryana and Punjab with 7,561 kWh, 2,396 kWh, 2,388 kWh, 2,229 kWh and 2,171 kWh, respectively. On the other hand, Bihar has the lowest per capita electricity consumption with 332 kWh, followed by Assam, Nagaland, Manipur and Tripura with 348 kWh, 367 kWh, 385 kWh and 425 kWh, respectively. That is, Nagaland is the third lowest per capita electricity-consuming State in India after Bihar and Assam.

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[1] BRICS is an association of five major emerging economies – Brazil, Russia, India, China and South Africa.

Table 4.4: Per Capita Electricity Consumption in India (State-Wise) during 2019-20 (in kWh)

SI. No.	States/UTs	Per Capita Consumption	Sl. No.	States/UTs	Per Capita Consumption
1	Andaman & Nicobar	585	20	Madhya Pradesh	1086
2	Assam	348	21	Maharashtra	1418
3	Andhra Pradesh	1507	22	Manipur	385
4	Arunachal Pradesh	631	23	Meghalaya	861
5	Bihar	332	24	Mizoram	629
6	Chandigarh	986	25	Nagaland	367
7	Chattisgarh	2044	26	Odisha	1559
8	Delhi	1572	27	Puducherry	1752
9	Daman & Diu	7561	28	Punjab	2171
10	Dadra & Nagar Haveli	15517	29	Rajasthan	1317
11	Goa	2396	30	Sikkhim	929
12	Gujarat	2388	31	Tamil Nadu	1844
13	Haryana	2229	32	Telengana	2071
14	Himachal Pradesh	1527	33	Tripura	425
15	Jammu & Kashmir	1384	34	Uttar Pradesh	629
16	Jharkhand	853	35	Uttarakhand	1528
17	Karnataka	1468	36	West Bengal	757
18	Kerala	826	37	India	1208
19	Lakshadweep	551			

Source: CEA, 2022.

4.2.4a Sector-Wise Electricity Consumption in India

The industrial sector is the largest electricity consumer in India, constituting 43% of the total energy consumption, followed by domestic (24%), agriculture (18%) and commercial (8%) sectors, as shown in Figure 4.5. The share of electricity in total final consumption in India grows in all sectors, particularly in the buildings sector, where there is a continued pivot away from traditional biomass and steady uptake of appliances (IEA, 2021b). On the other hand, it can be seen from Figure 4.6 that at the global level, the industrial sector accounts for 42% of the total electricity consumption, followed by domestic and commercial sectors at 27% and 21%, respectively. The sector-wise trends in electricity consumption in India from 1970-71 to 2020-21 are provided in Table 4.5.

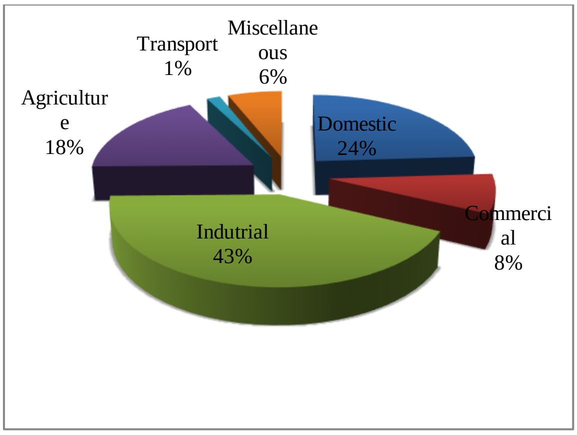


Figure 4.5: Sector-Wise Electricity Consumption in India during 2019-20 (MoSPI, 2021).

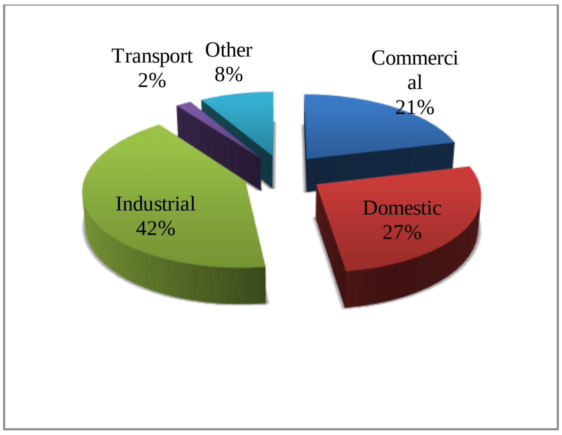


Figure 4.6: Sector-Wise Electricity Consumption in the World in 2019 (IEA, 2021a).

Table 4.5: Trends in Electricity Consumption in India Sector-Wise from 1970-71 to 2020-21 (in GWh)

Year	Industry	Agriculture	Domestic	Commercial	T & R	Others	TEC
1970-71	29,579 (67.65)	4,470 (10.22)	3,840 (8.78)	2573 (5.88)	1,364 (3.12)	1,898 (4.34)	43,724 (100.00)
1975-76	37,568 (62.36)	8,721 (14.48)	5,821 (9.66)	3,507 (5.82)	1,855 (3.08)	2,774 (4.60)	60,246 (100.00)
1980-81	48,069 (58.36)	14,489 (17.59)	9,246 (11.23)	4,682 (5.68)	2,266 (2.75)	3,615 (4.39)	82,367 (100.00)
1985-86	66,980 (54.41)	23,422 (10.03)	17,258 (14.02)	7,290 (5.92)	3,182 (2.58)	4,967 (4.03)	123,099 (100.00)
1990-91	84,209 (44.24)	50,321 (26.44)	31,982 (16.80)	11,181 (5.87)	4,112 (2.16)	8,552 (4.49)	190,357 (100.00)
1995-96	104,693 (37.79)	85,732 (30.95)	51,733 (18.67)	16,996 (6.14)	6,223 (2.25)	11,652 (4.21)	277,029 (100.00)
2000-01	107,622 (33.99)	84,729 (26.76)	75,629 (23.89)	22,545 (7.12)	8,213 (2.59)	17,862 (5.64)	316,600 (100.00)
2005-06	151,557 (36.80)	90,292 (21.92)	100,000 (24.30)	35,965 (8.73)	9,944 (2.41)	24,039 (5.84)	411,887 (100.00)
2010-11	272,589 (39.26)	131,967 (19.00)	169,326 (24.38)	67,289 (9.69)	14,003 (2.02)	39,218 (5.65)	694,392 (100.00)
2015-16	423,523 (42.30)	173,185 (17.30)	238,876 (23.86)	86,037 (8.59)	16,594 (1.66)	62,976 (6.29)	10,01,191 (100.00)
2020-21	504,200 (41.09)	215,000 (17.52)	315,000 (25.67)	102,000 (8.31)	18,500 (1.51)	72,300 (5.89)	12,27,000 (100.00)
CAGR	5.84	8.05	9.21	7.64	5.35	7.55	6.90

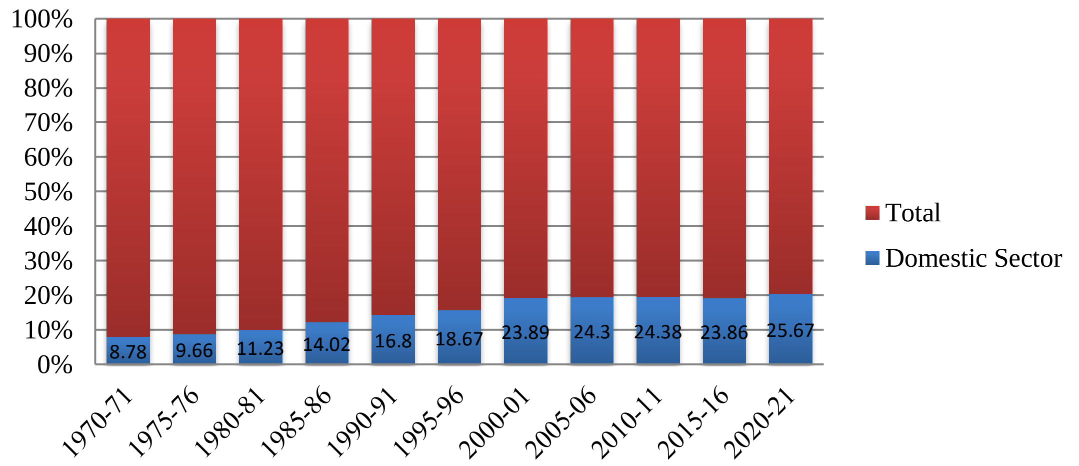
Source: 1. CEA, New Delhi; 2. MoSPI, 2020 and 2022;

Note: 1) Figures in brackets indicate percentages of electricity consumption in different sectors to total consumption.

2) T & R = Traction and Railways, and TEC = Total Electricity Consumed.

From the above Table 4.5, it can be observed that electricity consumption in the industrial sector has increased from 29,579 GWh in 1970-71 to 272,589 GWh in 2010-11 and 504,200 GWh in 2020-21. Likewise, in the domestic sector, it has increased from 3,840 GWh in 1970-71 to 169,326 GWh in 2010-11 and to 315,000 GWh in 2020-21. Similarly, consumption in other sectors such as agriculture, commercial, traction & railways and others also increased enormously during this period. Furthermore, it can be seen from the table that the share of consumption to the total electricity consumption in the industrial and traction & railways sectors has been declining. In contrast, domestic, commercial, agriculture and others show an increasing trend since 1970-71. Electricity consumption in the domestic sector has experienced the fastest growth in the country, with a CAGR of 9.21% from 1970-71 to 2020-21, followed by agriculture, commercial, others, industrial, and traction & railways. Consumption in the domestic sector has increased more than four times since 2000-01. The share of electricity consumption in the domestic sector to total consumption in India from 1970-71 to 2020-21 is illustrated in Figure 4.7.

Figure 4.7: Percentage of Electricity Consumption in Domestic Sector to Total Consumption in India from 1970-71 to 2020-21



Source: From Table 4.5.

4.3 HOUSEHOLD ENERGY CONSUMPTION IN INDIA

The household sector is one of India's major consumers of energy, accounting for 39% of the total energy supplied in the country. A large share (about 77%) of the total energy supplied is through traditional biomass fuels like firewood, charcoal, dung cake, etc. (Ganesan & Vishnu, 2015). Households consume energy, both directly and indirectly. Energy is consumed in households directly in the form of fuels and electricity and indirectly through the purchase of non-energy goods and services. Besides traditional biomass, the household sector in India relies on LPG for cooking, kerosene for cooking and lighting, and electricity for various purposes. Rapid economic development and higher disposable incomes for consumers have contributed to a change in households' lifestyles and behavior, leading to faster growth in energy consumption (Pachauri, 2009).

As per the 2014 NSS report, 96% of urban households in India consume electricity, 71% consume LPG, 23% use firewood and chips and 22.85% use kerosene during 2011-12. Table 4.6 shows the household per capita consumption of various energy commodities in India during 2011-12. The primary energy items such as electricity, firewood, kerosene and LPG accounted for 95% of energy consumption in urban India. Monthly per capita consumption of LPG in urban areas was 1.93 kg with a value of ₹56.74, constituting 32% of fuel expenditure. However, in rural areas, only 21.4% of households used LPG, with a value and quantity of ₹11.31 and 0.38 kg, respectively. LPG made up 10% of fuel expenditure in the average rural household. Electricity comprised about 50% of fuel expenditure in the average urban household and 22% in the average rural household. Electricity was consumed by 96% of households in urban areas and 74.2% in rural areas. The monthly per capita urban electricity consumption was 25.8 kWh and that of rural areas was 8.9 kWh, with a value of ₹87.20 and ₹25.11, respectively.

Moreover, 48.65% of rural and 22.85% of urban households used kerosene, with fuel expenditure share at 9% and 5%, respectively. The percentage of households who used firewood and chips remained as high as 83.5% in rural areas and 23% in urban areas. Monthly per capita rural consumption of firewood and chips was 19.04 kg, and its value at ₹48.20, constituting 42% of fuel expenditure. On the other hand, monthly per capita urban consumption of firewood and chips was 4.29 kg, and its value at ₹13.17, which made up 8% of the fuel expenditure of urban consumption. When converted into a standard unit, the urban monthly per capita energy consumption stood at 4.01 kgoe, and that of rural is 2.41 kgoe (Ganesan & Vishnu, 2015). The state-wise per capita consumption of four major fuels is given in the appendix of this chapter.

Table 4.6: Household Per Capita Consumption of Energy in India during 2011-12

Energy item	Quantity		Value (₹)		% of households	
	Rural	Urban	Rural	Urban	Rural	Urban
Firewood & Chips (kg)	19.04	4.29	48.20 (42)	13.17 (8)	83.5	22.9
Electricity (kWh)	8.9	25.8	25.11 (22)	87.20 (50)	74.2	96
Kerosene (L)	0.27	0.20	9.7 (9)	9.2 (5)	48.65	22.85
LPG (kg)	0.38	1.93	11.31 (10)	56.74 (32)	21.4	70.8
Others*	-	-	19.79 (17)	9.55 (5)	-	-

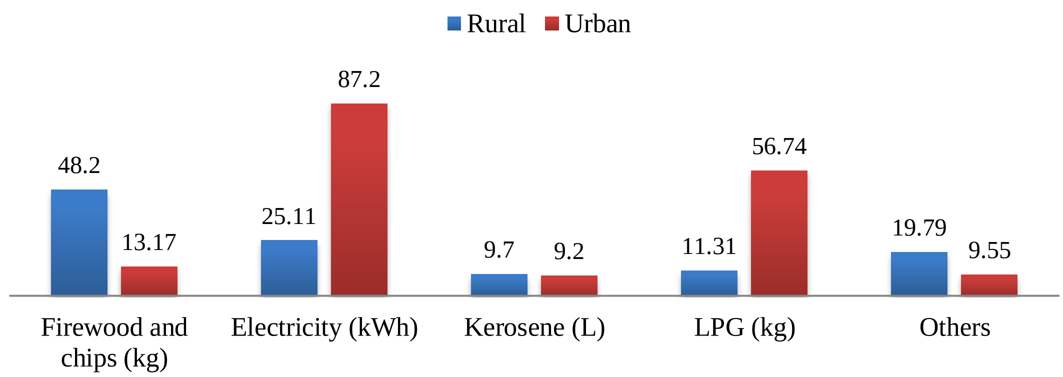
Source: NSSO, 2014.

Note: 1) Figures in brackets represent percentages of individual fuel expenditures to respective total energy expenditures in rural and urban areas.

2) Others include gobar gas, charcoal, dung cake, and candles.

Figure 4.8 depicts the monthly per capita consumption value of household fuels in rural and urban India. It can be seen that monthly per capita expenditures on firewood and chips, kerosene and other fuels were higher in the rural areas. In contrast, expenditures on electricity and LPG were higher in the urban areas.

Figure 4.8: Monthly Per Capita Expenditure on Household Fuels in India during 2011-12 (in ₹)



Source: From Table 4.6.

4.3.1 Cooking Fuels in Indian Households

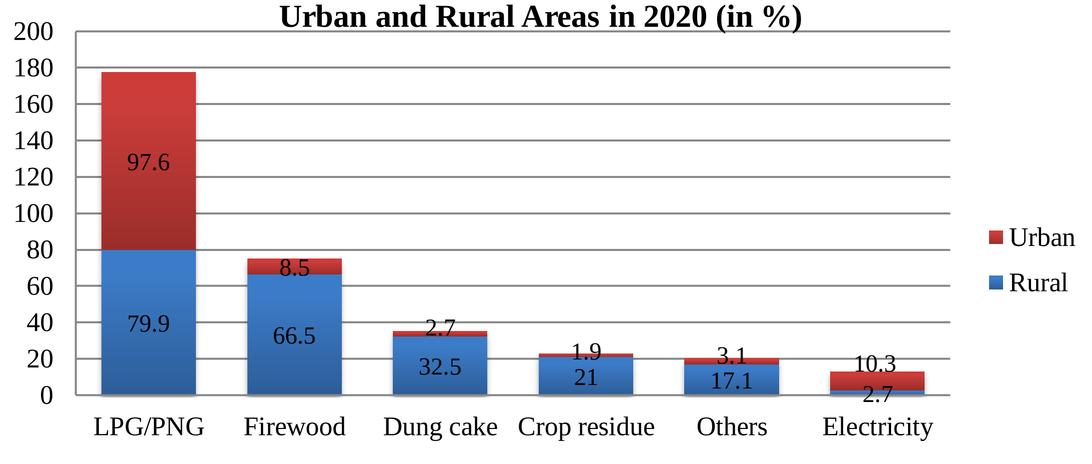
Households in India use various sources of fuel for cooking. Table 4.7 explores the cooking fuels used by households in India. It is evident that LPG/PNG is the most important cooking fuel used by 85.1% of households. Firewood, which is still used by around half of the households (49.4%), is the second most important cooking fuel, followed by dung cake, crop residue, 'Others' and electricity used by 23.7%, 15.4%, 13% and 5% of households respectively. A similar trend is exhibited by households in rural areas. On the other hand, in urban areas, while LPG/PNG is the dominant cooking fuel (97.6%), electricity is the second most important one (10.3%), followed by firewood (8.5%), 'Others' (3.1%), dung cake (2.7%) and crop residue (1.9%). It can be observed from the table that households in rural areas continue to depend on firewood for cooking (66.5%), even though around 80% of rural households have an LPG/PNG connection.

Table 4.7: Cooking Fuels Used by Households in India in 2020 (in %)

	India	Rural	Urban
LPG/PNG	85.1	79.9	97.6
Firewood	49.4	66.5	8.5
Dung cake	23.7	32.5	2.7
Crop residue	15.4	21	1.9
Others	13	17.1	3.1
Electricity	5	2.7	10.3

Source: CEEW, 2021a, 2021b and 2021c.

Figure 4.9: Use of Cooking Fuels by Indian Households in Urban and Rural Areas in 2020 (in %)



Source: From Table 4.7.

4.3.2 Fuel Stacking in Indian Households

Data from the Indian Residential Energy Survey (IRES) 2020 reveals that households use different types of fuel for cooking in India. The fuel stacking pattern in Indian households is provided in Table 4.8. It shows that among the households, 47%

used exclusively clean fuel, 24% used primarily clean fuel, 14% used primarily solid fuel, and 15% used solid fuel only.

Table: 4.8: Fuel Stacking in Households in India, 2020 (in %)

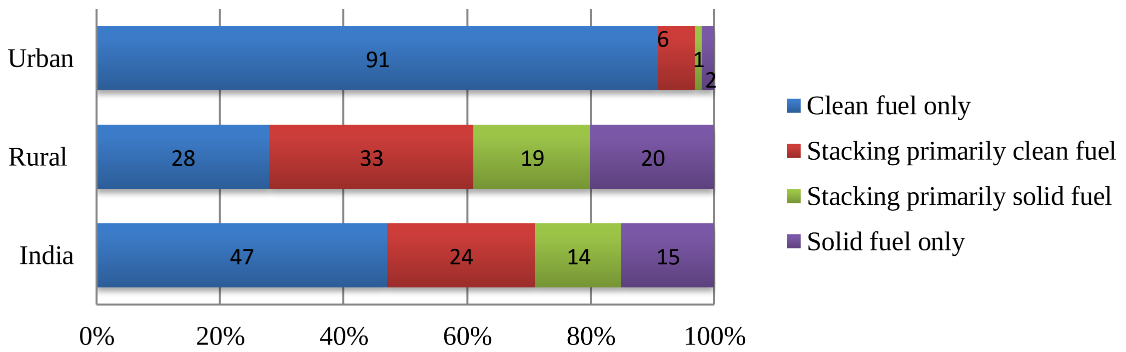
	Clean fuel only	Stacking primarily clean fuel	Stacking primarily solid fuel	Solid fuel only	Total
India	47	24	14	15	100
Rural	28	33	19	20	100
Urban	91	6	1	2	100

Source: CEEW, 2021d.

The table also reveals a considerable difference in fuel usage in rural and urban areas. It can be seen that 91% of households in the urban area exclusively used clean fuel, while in the rural area, it was 28%. Among the households that stack primarily clean fuel, 33% are in rural area and 6% are in urban area. Regarding households stacking primarily solid fuel, the corresponding shares in rural and urban areas are 19% and 1%. Similarly, for households using only solid fuel, the shares of households in rural and urban areas are 20% and 2%, respectively. The main reasons for stacking LPG with solid fuels for cooking in Indian households are high expenditure on LPG refills, cultural preferences for cooking on *chulhas*, easy access to free biomass and the lack of timely LPG refills (Mani et al., 2021).

From the above discussions, it can be inferred that while 85% of Indian households use clean cooking fuels such as LPG/PNG, only 47% use them exclusively. Thus, almost half of LPG/PNG users in India stack them with solid fuels, with most households stacking solid fuels located in rural areas.

Figure 4.10: Fuel Stacking in Indian Households in 2020 (in %)



Source: From Table 4.8.

4.4 ELECTRICITY SCENARIO IN NAGALAND

Electricity is one of the core infrastructures to accelerate the economic development of a region. It has also become a part of modern life and the demand for energy over time has increased immensely. It has, therefore, grown at a rate faster than other forms of energy. The power sector makes a direct and significant contribution to the economy in terms of revenue generation and employment opportunities and enhances the quality of life.

4.4.1 Electricity Demand and Supply Scenario

There have been electricity shortages throughout the last decade in Nagaland, although it has decreased from 13.7% during 2013-14 to 0.05 % during 2020-21. The electricity demand and supply scenario in Nagaland from 2011-12 to 2020-21 is given in Table 4.9. It can be noted from the table that the gap between energy requirement and energy supplied was 0.5% in the State during the year 2020-21 as compared to 0.7% during the year 2019- 20. The peak power demand is of the order of 165 MW and 100 MW during off-peak periods. The peak demand during 2020-21 stands at 160 MW, out of which 155 MW comes from State's own generation and Central Sector allocation.

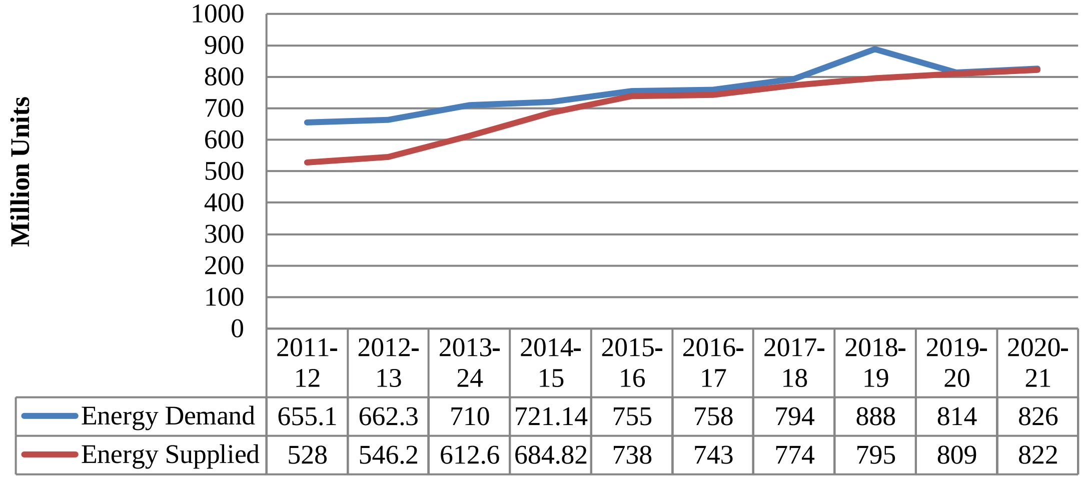
Table 4.9: Electricity Demand and Supply in Nagaland from 2011-12 to 2020-21

	Energy Demand	Energy Supplied	Energy Deficit		Peak Demand	Peak Met	Peak Deficit	
	(MU)	(MU)	(MU)	(%)	(MW)	(MW)	(MW)	(%)
2011-12	655.10	528.00	19.40	19.4	112	87	12.5	22.3
2012-13	662.30	546.20	116.10	17.5	120	102	18	15
2013-14	710.00	612.60	97.40	13.7	132	108	24	18.2
2014-15	721.14	684.82	36.32	5.04	145	120	25	17.24
2015-16	755.00	738.00	16.00	2.1	140	138	2	1.4
2016-17	758.00	743.00	15.00	2	148	147	1	0.7
2017-18	795.00	771.00	23.00	2.9	155	146	9	5.9
2018-19	888.00	795.00	93.00	10.5	156	138	18	11.6
2019-20	814.00	809.00	5.00	0.7	186	169	17	9.3
2020-21	826.00	822.00	4.00	0.5	160	155	5	2.9

Source: CEA Annual Reports.

The State was able to meet its peak demand during 2016-17, while there was a gap of 11.6% between peak demand and peak met during 2018-19, which declined to 2.9% during 2020-21. The deficit has been due to less internal/ own generation and Transmission & Distribution constraints. The energy demand, including all categories of consumers, has posted a CAGR of 2.58% against the supply growing at a CAGR of 4.99% based on data from 2011-12 to 2020-21. The scenario is exhibited in Figure 4.11.

Figure 4.11: Energy Requirement and Supply in Nagaland from 2011-12 to 2020-21



	2011-12	2012-13	2013-24	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Energy Demand	655.1	662.3	710	721.14	755	758	794	888	814	826
Energy Supplied	528	546.2	612.6	684.82	738	743	774	795	809	822

Source: From Table 4.9.

4.4.2 Per Capita Electricity Consumption

Per capita electricity consumption in Nagaland from 2010-11 to 2019-20 is given in Table 4.10. It can be seen from the table that the per capita electricity consumption for Nagaland at 367 kWh during 2019-20 is much lower than that of the country at 1208 kWh. However, it may be noted that the consumption has been steadily increasing in the State since 2010-11 when the per capita consumption was only 265 kWh.

Table 4.10: Per Capita Consumption of Electricity in Nagaland against India (kWh)

	2010-11	1011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Nagaland	265	257	268	259	311	346	345	348	356	367
India	819	884	914	957	1010	1075	1122	1149	1181	1208

Source: CEA, 2022.

4.4.3 Sector-Wise Electricity Consumption

The growth of electricity consumption under different categories of consumers from 2011-12 to 2017-18 is given in Table 4.11.

Table 4.11: Growth of Consumption of Electricity under different Class of Consumers in Nagaland (in GWh)

Year	Domestic	Commercial	Industry	Public Lighting	Agri.	PWW	Misc.	TEC
2011-12	236.48 (67.10)	39.08 (11.09)	16.1 (4.57)	4.89 (1.39)	0.04 (0.01)	2.53 (0.72)	53.33 (15.13)	352.45 (100.00)
2012-13	232.53 (66.42)	39.87 (11.32)	17.82 (5.09)	5.27 (1.51)	0.04 (0.01)	3.07 (0.88)	51.48 (14.71)	350.08 (100.00)
2013-14	269.80 (64.10)	52.99 (12.59)	25.15 (5.98)	4.90 (1.16)	0.04 (0.01)	3.10 (0.74)	64.92 (15.42)	420.90 (100.00)
2014-15	307.79 (58.20)	68.43 (12.94)	53.78 (10.17)	11.26 (2.13)	0.00 (0.00)	5.22 (0.99)	82.34 (15.57)	528.82 (100.00)
2015-16	338.51 (58.11)	75.05 (12.88)	55.72 (9.56)	13.30 (2.28)	0.00 (0.00)	8.95 (1.54)	91.02 (15.62)	582.55 (100.00)
2016-17	362.52 (57.51)	82.58 (13.10)	61.29 (9.72)	14.60 (2.32)	0.00 (0.00)	9.24 (1.47)	100.10 (15.88)	630.33 (100.00)
2017-18	378.21 (57.00)	88.12 (13.28)	65.56 (9.88)	14.80 (2.23)	0.00 (0.00)	9.36 (1.41)	107.63 (16.22)	663.72 (100.00)
CAGR	6.8	12.1	21.7	16.8	-	20.1	10.3	9.3

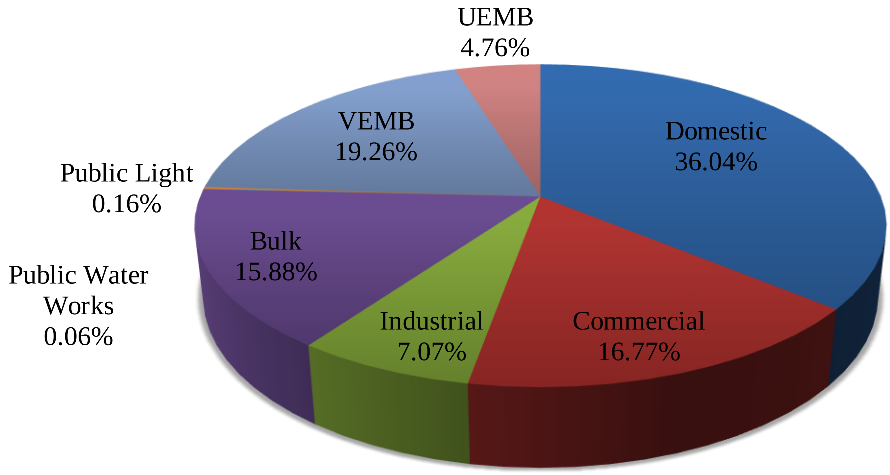
Source: Department of Power, Government of Nagaland (2019).
Note: 1) Figures in brackets indicate percentages of electricity consumption in different sectors to total consumption.
2) PWW = Public Water Works, and TEC = Total Electricity Consumed.

It can be noted from Table 4.11 that electricity consumption in the domestic sector has increased from 236.48 GWh during 2011-12 to 378.21 GWh during 2017-18. The domestic sector is the largest consumer of electricity, constituting 57% of the total electricity consumption during 2017-18. Consumption of electricity by the commercial sector, industrial sector, public lighting, public water works and miscellaneous constituted 13.28%, 9.88%, 2.23%, 1.41% and 16.22%, respectively. It may be noted that the increase in electricity consumption in the domestic sector may be attributed to the growth of urban centers and improved economic conditions of people that bring lifestyle changes, leading to an increase in the demand for electricity. In the domestic sector, lights, fans, television and air conditioning form the major consumption of electricity in the State.

The agriculture sector is not a consumer of electricity in the State as farming practices are of the traditional system, where most irrigation is either rain-fed or through water canals or natural springs. The water supply sector is also a very low consumer of electricity as the main sources of supply are from natural water bodies such as springs and by and large supply is through gravitational force. The State has very little piped water supply and virtually no water treatment facility; therefore, the energy consumption in the water sector is exceptionally minimal. Consumption in the industrial sector was also very low in 2013-14 but witnessed a marginal increase from 2014-15 onwards.

Category-wise electricity consumption in Nagaland during 2020-21 reveals that the domestic sector constituted 36.04%, with commercial, industrial, bulk, public water works and public lighting, constituting 16.77%, 7.07%, 15.88%, 0.06% and 0.16% of the total electricity consumption respectively. Village Electricity Management Board (VEMB) and Urban Electricity Management Board (UEMB) constituted 19.26% and 4.76% of the State's total electricity consumption. The share of both sector-wise and category-wise electricity consumption patterns reflects the poor economic activities and underdevelopment of the State.

Figure 4.12: Share of Category-Wise Electricity Consumption in Nagaland during 2020-21



Source: Nagaland Statistical Handbook, 2021.

4.5 HOUSEHOLD ENERGY CONSUMPTION IN NAGALAND

The overall energy mix of the State can be broadly classified as electricity, biomass (fuelwood), petroleum products (including LPG) addressing the household (lighting, cooking, heating), entertainment, transport, commercial and industrial needs. Traditional biomass is one of the predominant fuels in Nagaland particularly for cooking and heating purposes. The household requirements of energy for cooking are primarily met by firewood, while lighting requirements are met by electricity (Govt. of Nagaland, 2012). As per the NSSO-68 round survey, 46.60% of rural households and 13.50% of urban households depend upon firewood for cooking.

The energy used for various household activities in Nagaland during 2011-12 is given in Table 4.12. In rural areas, 85.6% of households consumed firewood and chips. The estimated value of monthly per capita consumption of firewood and chips was ₹77.80, with a quantity per capita consumption of 25.35 kg. It constituted about 55% of fuel expenditure in the average rural household. On the other hand, 47.9% of households in urban areas consumed firewood and chips, with monthly per capita consumption at 11.59 kg. Firewood and chips constituted 21.83% of fuel expenditure in the average urban household. The monthly per capita electricity consumption in urban areas was 11.95 kWh and 7.72 kWh in rural areas. Electricity comprised 25.56% of fuel expenditure in the average urban household and 17.62% of rural households.

Table 4.12: Household Per Capita Consumption on Energy Items in Nagaland during 2011-12

Energy item	Quantity		Value (₹)		% of households	
	Rural	Urban	Rural	Urban	Rural	Urban
Firewood & Chips (kg)	25.35	11.59	77.80 (54.96)	33.82 (21.83)	85.6	47.9
Electricity (kWh)	7.72	11.95	24.94 (17.62)	39.60 (25.56)	99.2	100
Kerosene (L)	0.08	0.04	1.98 (1.40)	0.98 (0.63)	21.9	7.6
LPG (kg)	0.89	2.33	28.74 (20.30)	73.80 (47.63)	37.1	83.7
Others*	3	2.51	8.12 (5.73)	6.73 (4.31)	85.3	76.7

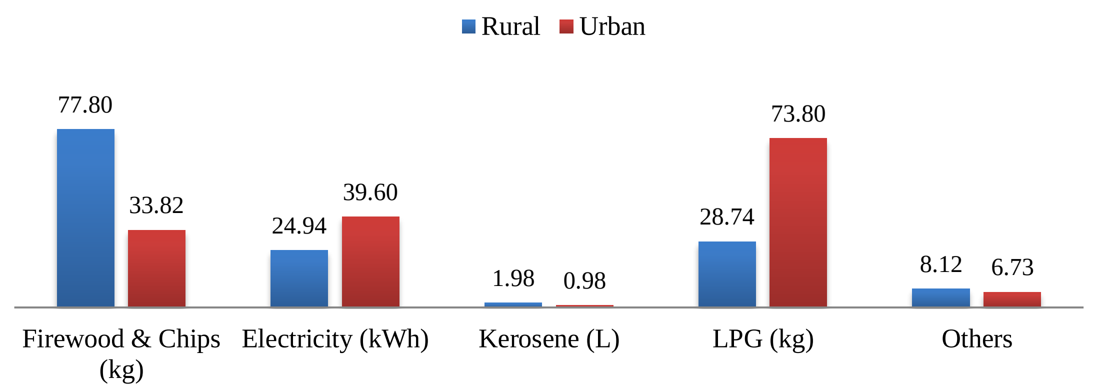
Source: NSSO, 2015.

Note: 1) Others include charcoal and candles.

2) Figures in brackets represent percentages of total fuel expenditure.

The primary source of cooking in urban Nagaland was LPG, used by 83.7% of households. Monthly per capita consumption of LPG in urban areas was 2.33 kg with a value of ₹73.80, constituting 47.63% of fuel expenditure. However, in rural areas, only 37.1% of households used LPG with value and quantity of ₹28.74 and 0.89 kg respectively. LPG made up 20.30% of fuel expenditure in the average rural household.

Figure 4.13: Monthly Per Capita Expenditure on Household Fuels in Nagaland during 2011-12 (in ₹)



Source: From Table 4.12.

Figure 4.13 depicts the monthly per capita consumption of household fuels in rural and urban Nagaland. It can be seen that monthly per capita expenditures on firewood and chips, kerosene and other fuels were higher in rural areas. In comparison, expenditure on electricity and LPG was higher in the urban area.

4.6 CONCLUSION

This chapter presented the status and trends in energy consumption in India and the different types of energy used for carrying out household activities. The household sector is one of the major consumers of energy in India that relies on a variety of traditional and modern energy sources. The major fuel items used by households include firewood, electricity, LPG and kerosene. Among the households that stack cooking fuels, almost half of the clean fuel users in India stack them with solid fuels, with majority of the households that stack located in rural areas. Furthermore, among the individual fuel items, consumption of firewood and LPG remains higher in Nagaland compared to India in both rural and urban areas.

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APPENDIX

Table 4A: Per Capita Consumption (Useful Energy) of Fuels across States in Kgoe/Month

State	Electricity		LPG		Kerosene		Traditional Biomass	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
A & N Islands	1.69	3.01	0.72	1.63	0.39	0.29	1.32	0.14
Andhra Pradesh	1.41	2.26	0.47	1.34	0.13	0.07	0.94	0.15
Arunachal Pradesh	0.43	0.72	0.63	1.77	0.12	0.07	2.31	0.73
Assam	0.38	1.19	0.31	1.60	0.19	0.13	1.35	0.23
Bihar	0.20	0.85	0.11	1.09	0.17	0.13	0.45	0.21
Chandigarh	3.71	2.61	1.74	1.59	0.09	0.16	0.02	0.04
Chattisgarh	0.66	1.88	0.03	0.77	0.14	0.10	1.08	0.36
D & N Haveli	1.25	2.19	0.17	1.21	0.21	0.09	1.37	0.33
Daman & Diu	2.59	2.90	0.94	1.31	0.35	0.15	0.27	0.28
Delhi	2.85	3.88	1.75	1.68	0.00	0.02	0.02	0.01
Goa	3.36	4.15	1.45	1.99	0.21	0.09	0.37	0.08
Gujarat	0.97	2.10	0.25	1.14	0.23	0.13	0.93	0.15
Haryana	1.33	3.25	0.54	1.73	0.06	0.02	0.51	0.05
Himachal Pradesh	2.58	4.70	0.68	1.65	0.05	0.11	1.59	0.25
Jammu & Kashmir	1.39	2.66	0.57	1.49	0.14	0.11	1.38	0.23
Jharkhand	0.48	1.66	0.05	1.08	0.19	0.11	0.99	0.13
Karnataka	0.71	1.92	0.23	1.31	0.18	0.14	1.34	0.31
Kerala	1.53	2.59	0.71	1.26	0.07	0.06	1.49	0.95
Lakshadweep	3.69	5.57	0.00	0.64	0.29	0.34	0.89	0.97
Madhya Pradesh	0.62	1.62	0.11	1.12	0.17	0.10	0.78	0.26
Maharashtra	0.97	2.39	0.42	1.44	0.19	0.17	0.80	0.09
Manipur	1.06	1.29	0.55	0.98	0.10	0.07	0.89	0.27
Meghalaya	0.87	1.67	0.11	1.28	0.13	0.10	1.45	0.27
Mizoram	0.84	1.72	0.71	1.97	0.11	0.08	2.27	0.32
Nagaland	0.73	1.05	0.78	1.44	0.03	0.02	1.85	1.02
Orissa	0.88	2.10	0.07	0.97	0.18	0.16	1.44	0.73
Pondicherry	3.57	4.59	1.35	1.74	0.17	0.08	0.21	0.11
Punjab	2.02	3.21	0.76	1.70	0.08	0.07	0.61	0.11
Rajasthan	0.82	2.14	0.19	1.18	0.15	0.06	1.30	0.27
Sikkim	0.98	1.58	0.92	1.72	0.09	0.04	0.68	0.01
Tamil Nadu	1.50	3.21	0.65	1.52	0.19	0.16	0.88	0.18
Tripura	0.65	1.41	0.13	1.45	0.21	0.18	2.74	1.07
Uttar Pradesh	0.33	1.70	0.11	1.11	0.15	0.10	0.57	0.22
Uttarakhand	1.13	2.09	0.58	1.66	0.14	0.09	1.68	0.35
West Bengal	0.54	1.90	0.14	1.28	0.21	0.26	0.83	0.18

Source: Ganesan & Vishnu (2015)

CHAPTER 5

HOUSEHOLD ENERGY CONSUMPTION PATTERN IN URBAN NAGALAND

5.1 INTRODUCTION

Energy consumption in households is an integral part of total energy consumption. The rise in population, urbanization process, increase in income and requirements for comfort will increasingly impose pressure on the future energy demand in the State. Of this energy demand, household is an important consumer with great savings potential. Therefore, knowledge of the household energy consumption pattern, factors influencing this consumption and demand, and its behavior across geo-climatic and socio economic groups is a prerequisite for sound policy formulation. This chapter attempts to understand the nature of urban household energy consumption and appliance stock in the sample areas.

5.2 PURPOSE OF ENERGY USAGE

Households generally use electricity, LPG, firewood, kerosene oil, charcoal and solar energy for domestic purposes. Table 5.1 presents in detail the types of energy used by the households and their purposes in the study areas. The table revealed that electricity and LPG are used by every household in both the study areas. Most households use electricity for lighting, cooking and heating purposes, while LPG is used for cooking and water heating purposes. Households also used kerosene for cooking along with LPG and firewood. Firewood is used for cooking and heating, while charcoal is used only for heating purpose during winter. A few households use solar energy for lighting and heating water. However, solar lights are used only as an alternative to electricity in case of power failure.

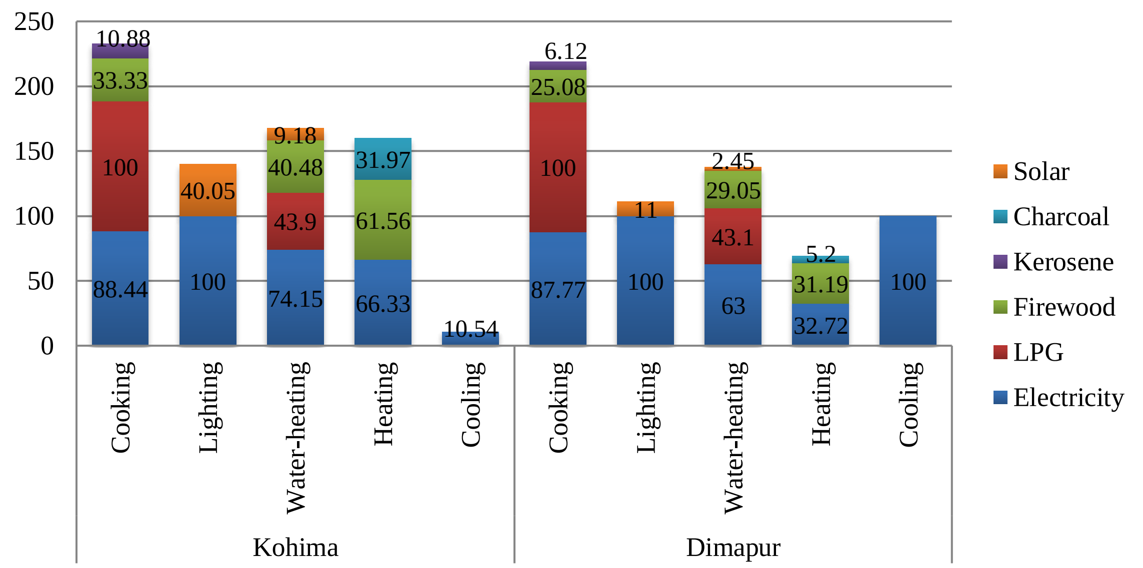
As also can be observed from Figure 5.1, the proportion of households using electricity, kerosene and firewood for cooking is higher in Kohima than in Dimapur. In addition, households using solar, electricity, LPG and firewood for water heating; and those using electricity, firewood and charcoal for space heating are also higher in Kohima as compared to Dimapur. This might be because of Kohima's colder climate and therefore, the households' heating requirements are higher. On the other hand, households using electricity for cooling are higher in Dimapur than Kohima. This is because of the higher cooling requirement in Dimapur due to the warmer climate.

Table 5.1: Types of Energy and Their End Use (% of Households)

Types of energy	End use	Kohima (N=294)	Dimapur (N=327)	Total (N=621)
Electricity	Cooking	88.44	87.77	88.08
	Lighting	100.00	100.00	100.00
	Water heating	74.15	63.00	68.28
	Heating	66.3	32.72	48.63
	Cooling	10.54	100.00	73.75
	Total	100.00	100.00	100.00
LPG	Cooking	100.00	100.00	100.00
	Water heating	43.90	43.10	43.50
	Total	100.00	100.00	100.00
Firewood	Cooking	33.33	25.08	29.00
	Water heating	40.48	29.05	34.46
	Heating	61.56	31.19	45.57
	Total	66.00	46.20	55.60
Kerosene	Cooking	10.88	6.12	8.40
Charcoal	Heating	31.97	5.20	17.90
Solar system[1]	Lighting	40.05	11.00	25.96
	Water heating	9.18	2.45	5.64
	Total	59.18	14.37	35.59

Source: Household Survey, 2016-17.

Figure 5.1: End Use of Energy in Sample Areas (in %)



Source: From Table 5.1.

[1] Solar was used as an alternative in case of power failure, and its use in water heating was negligible therefore, consumption of solar energy has been excluded in the present analysis.

5.3 COMBINATION OF FUELS IN THE HOUSEHOLDS

Table 5.2 provides the combinations of fuel usage in the sample households. It can be observed in the sample aggregate that all the households used at least two combinations of fuels. Electricity and LPG appear in all categories. Electricity plus LPG and firewood (41.42%) is the most common combination, followed by electricity plus LPG (36.06%), electricity plus LPG with firewood and charcoal (10.13%), and electricity plus LPG with charcoal (4.02%). Kerosene appears in fewer categories, where it is used with electricity and LPG by 2.62% of households, 2.13% used it with electricity, LPG and firewood, and 1.75% used it with electricity, LPG and charcoal. 1.87% of the households used the combination of all five fuels.

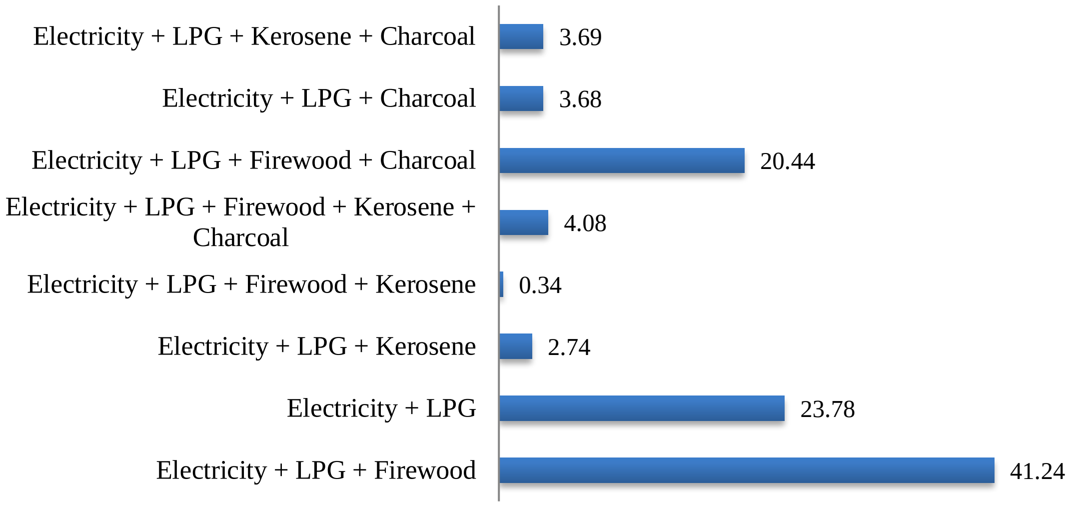
Table 5.2: Type of Fuel Combination Used by Households

Fuel combination	Kohima	Dimapur	Overall
Electricity + LPG + Firewood	121 (41.24)	136 (41.57)	257 (41.42)
Electricity + LPG	70 (23.78)	154 (47.13)	224 (36.06)
Electricity + LPG + Kerosene	8 (2.74)	8 (2.39)	16 (2.62)
Electricity + LPG + Firewood + Kerosene	1 (0.34)	12 (3.71)	13 (2.13)
Electricity + LPG + Firewood + Kerosene + Charcoal	12 (4.08)	-	12 (1.87)
Electricity + LPG + Firewood + Charcoal	60 (20.44)	3 (0.92)	63 (10.13)
Electricity + LPG + Charcoal	11 (3.68)	14 (4.28)	25 (4.02)
Electricity + LPG + Kerosene + Charcoal	11 (3.69)	-	11 (1.75)
Total	294 (100.00)	327 (100.00)	621 (100.00)

Source: Household Survey, 2016-17.
Note: Figures in parentheses represent percentages of households to the respective household totals.

In Kohima, electricity with LPG and firewood (41.24%) is the dominant fuel combination, followed by electricity plus LPG (23.78%) and electricity plus LPG plus firewood and charcoal (20.44%), as shown in Figure 5.2. It can be seen that only 4.08% of households used all the five fuels combination and only 0.34% used electricity, LPG and firewood along with kerosene.

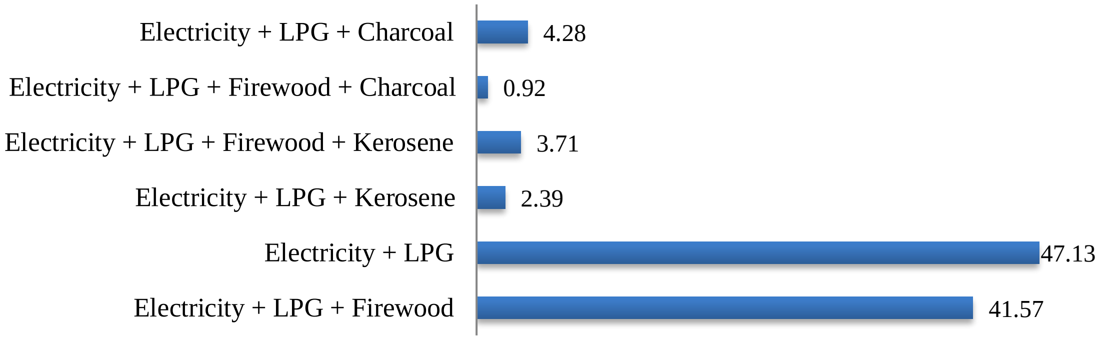
Figure 5.2: Percentage of Households by Fuel Combination in Kohima



Source: From Table 5.2

Similarly, in Dimapur, electricity plus LPG is the dominant fuel combination (47.13%), followed by electricity plus LPG and firewood (41.57%). It can be seen from Figure 5.3 that households used the electricity plus LPG mix with charcoal (4.28%), firewood and kerosene (3.71%), kerosene (2.39%) and firewood and charcoal (0.92%).

Figure 5.3: Percentage of Households by Fuel Combination in Dimapur



Source: From Table 5.2

5.4 HOUSEHOLD ENERGY USE PATTERN BY INCOME

This section brings out the energy use pattern of households in the study area. Table 5.3 gives the various energy types used by the households according to the disposable income group.

Table 5.3: Energy Use Pattern of the Sample Households by Disposable Income

	Types of Energy Used	No. of Households by Level of Disposable Income (₹)					
		<20,000	20,000-50,000	50,001-80,000	80,001-100,000	>100,000	Total
Overall	Electricity	27 (4.35)	241 (38.81)	211 (33.98)	94 (15.14)	48 (7.73)	621 (100)
	LPG	27 (4.35)	241 (38.81)	211 (33.98)	94 (15.14)	48 (7.73)	621 (100)
	Firewood	57 (9.18)	112 (18.04)	72 (11.59)	74 (11.92)	30 (4.83)	345 (55.56)
	Kerosene	6 (0.97)	24 (3.86)	10 (1.61)	8 (1.29)	4 (0.64)	52 (8.37)
	Charcoal	5 (0.81)	38 (6.12)	31 (4.99)	23 (3.70)	14 (2.25)	111 (17.87)
Kohima	Electricity	16 (5.44)	118 (40.14)	80 (27.21)	51 (17.35)	29 (9.86)	294 (100)
	LPG	16 (5.44)	118 (40.14)	80 (27.21)	51 (17.35)	29 (9.86)	294 (100)
	Firewood	31 (10.54)	77 (26.19)	31 (10.54)	37 (1.26)	18 (6.12)	194 (65.99)
	Kerosene	4 (1.36)	15 (5.10)	6 (2.04)	5 (1.70)	2 (0.68)	32 (10.88)
	Charcoal	5 (1.70)	34 (11.56)	23 (7.82)	20 (6.80)	12 (4.08)	94 (31.97)
Dimapur	Electricity	11 (3.36)	123 (37.61)	131 (40.06)	43 (13.15)	19 (5.81)	327 (100)
	LPG	11 (3.36)	123 (37.61)	131 (40.06)	43 (13.15)	19 (5.81)	327 (100)
	Firewood	26 (7.95)	35 (10.70)	41 (12.54)	37 (11.31)	12 (3.67)	151 (46.18)
	Kerosene	2 (0.61)	9 (2.75)	4 (1.22)	3 (0.92)	2 (0.61)	20 (6.11)
	Charcoal	0 (0.00)	4 (1.22)	8 (2.45)	3 (0.92)	2 (0.61)	17 (5.20)

Source: Household Survey, 2016-17.

Note: Figures in parentheses represent percentages to respective household totals.

In the aggregate sample, electricity, LPG and charcoal users are the highest in the ₹20,000-50,000 income group (electricity and LPG-38.81% each, and charcoal-6.12%), followed by ₹50,001-80,000 group (electricity and LPG-33.98% each, and charcoal-4.99%) and the lowest in the <₹20,000 group (electricity and LPG-4.35% each, and charcoal-0.81%). Kerosene users also show a similar trend but with the lowest in the income group of >₹100,000. In the case of firewood users, income group ₹20,000-50,000 constituted the highest share (18.04%), followed by ₹80,001-100,000 group (11.92%) and the lowest in the >₹100,000 group (4.83%). Among the sample areas, income group ₹20,000-50,000 is the highest user of all the individual fuels in Kohima, followed by ₹50,001-80,000 group, whereas in Dimapur, users of electricity, LPG and charcoal are highest in the income group ₹50,001-80,000, followed by ₹20,000-50,000 group. In the case of charcoal, the lowest user belongs to income group <₹20,000 in Kohima (1.70%), whereas in Dimapur, households in this income group use electricity, LPG, firewood and kerosene only.

Cooking is an important activity in households that consumes energy. It has been observed that households use multiple fuels for cooking purpose in the study area. While LPG is the primary energy used in every household for cooking purpose, households are also found to combine LPG with firewood for the same. Table 5.4 provides the usage pattern of LPG combined with firewood for cooking in households by income groups. The table reveals that in the aggregate sample, 28.99% of households used firewood along with LPG for cooking. It can be seen that income group ₹20,000-50,000 is the highest user of firewood (7.25%) for cooking, followed by ₹80,001-100,000 group (6.76%), ₹50,001-80,000 group (6.44%), <₹20,000 group (5.48%) and the lowest in the >₹100,000 group (3.06%).

Table 5.4: Distribution of Households Using Multiple Fuels for Cooking by Disposable Income

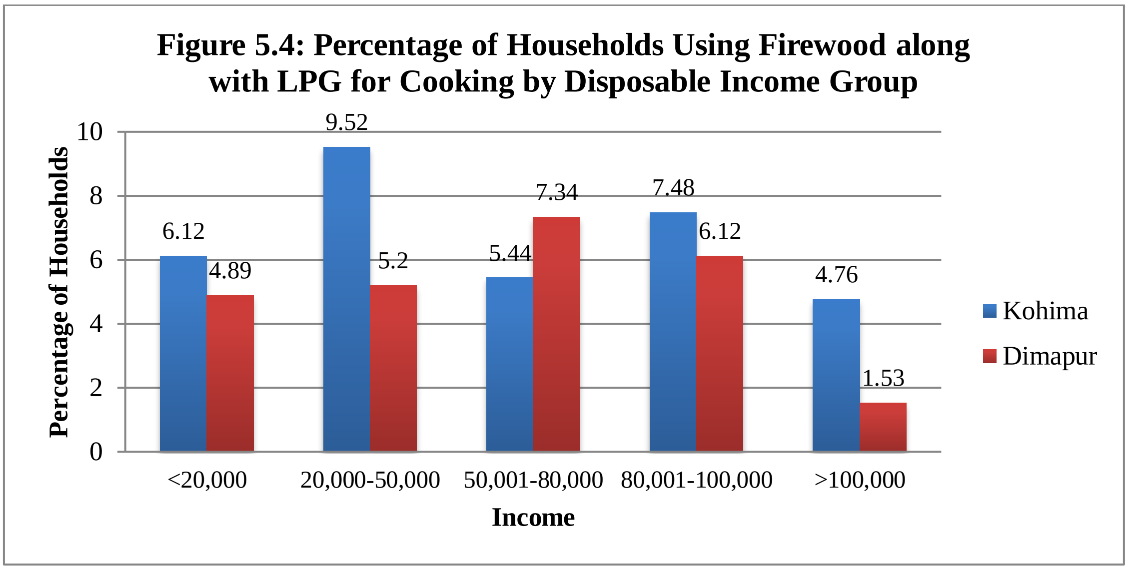
	Households by Level of Disposable Income (₹)					
	<20,000	20,000-50,000	50,001-80,000	80,001-100,000	>100,000	Total
Overall	34 (5.48)	45 (7.25)	40 (6.44)	42 (6.76)	19 (3.06)	180 (28.99)
Kohima	18 (6.12)	28 (9.52)	16 (5.44)	22 (7.48)	14 (4.76)	98 (33.33)
Dimapur	16 (4.89)	17 (5.20)	24 (7.34)	20 (6.12)	5 (1.53)	82 (25.08)

Source: Household Survey, 2016-17.

Note: Figures in parentheses represent percentages to respective household totals.

Among the sample areas, 33.33% of households in Kohima and 25.08% in Dimapur used firewood for cooking. A similar trend can be seen in Kohima, whereas in Dimapur, the highest user of firewood is exhibited by the income group ₹50,001-80,000 (7.34%), followed by ₹80,001-100,000 group (6.12%) and ₹20,000-50,000 group

(5.20%). In both the sample areas, income group >₹100,000 has the least share that combines LPG with firewood for cooking purpose.



Source: From Table 5.4.

It is evident from Table 5.4 and Figure 5.4 that firewood is used in the households irrespective of income level. The findings suggest that an increase in income does not lead to a complete switch from traditional fuel to modern fuel but instead use a combination of both. This shows that households do not abandon traditional fuel even as their income increases, indicating that the fuel stacking model explains the energy combination quite well in urban households, proving the first hypothesis true.

5.5 Household Energy Consumption Pattern across Geo-Climatic Regions

Household energy consumption differs significantly across regions. These differences are driven by differences in energy uptake, usage, appliance stock and household characteristics. The geo-climatic conditions also play a vital role in household energy consumption. Kohima, being located at a higher altitude, has colder climatic conditions throughout the year, while Dimapur being in plains, summer is humid and hot, but winter is quite pleasant. These extreme climatic conditions in different seasons impact household energy consumption. In this section, a break-up of the aggregate data on all fuel types by geo-climatic regions season-wise is given to examine the variations in energy consumption in the study areas.

5.5.1 Energy Consumption during Summer

Data show that households consume both traditional and modern fuels. Traditional fuel comprises firewood and charcoal, and modern fuel comprises electricity, LPG and kerosene. Table 5.5 presents the monthly energy consumption pattern of the sample households during summer.

It is revealed from Table 5.5 that during summer months, 52.04% of sample households in Kohima and 26.61% in Dimapur use traditional source of energy (firewood). The higher proportion of households in Kohima than in Dimapur is due to colder climatic conditions at Kohima, and people tend to use more firewood combined with modern energy sources. It can be observed from the table that the aggregate monthly energy consumption of the sample households amounts to 1086898.58 MJ, of which 287434.25 MJ (26.45%) is contributed by traditional fuel, i.e., firewood and 799464.33 MJ (73.55%) by modern fuels. Evidently, modern fuels dominate energy sources used in urban areas.

Among the modern fuels, LPG (476055.00 MJ) which is being used for cooking, is the most important source of energy (59.55%) and in fact, it is the single largest source of energy in the urban areas (43.80%). Electricity contributes 317091.83 MJ of energy, which accounts for 39.66% of modern fuels and 29.17% of all fuels. Interestingly, these two fuels, taken together, contribute 72.97% of urban households' energy requirements. Kerosene, amounting to 6561.50 MJ, accounts for 0.79% of modern fuels and 0.58% of all fuels.

The total energy use in Kohima during summer is 561381.10 MJ, of which 192716.00 MJ (34.33%) is contributed by the traditional source and 368664.90 MJ (65.67%) by the modern sources. Among the modern sources, LPG, which contributes 234939.00 MJ of energy (41.85%) and consumed in every household, is the single largest source of energy in Kohima. Electricity (129718.43 MJ, 23.11%) is another important modern energy source. In Dimapur, the aggregate energy use is 525517.48 MJ, of which 94718.00 MJ (18.02%) is contributed by traditional source and 430799.40 MJ (81.98%) by modern sources. LPG contributes 241116.00 MJ (45.88%), and is the most important single source of energy in Dimapur, followed by electricity (187373.40 MJ, 35.66%).

5.5.1 Energy Consumption during Winter

The monthly energy consumption pattern of the sample households during winter is given in Table 5.6. The table reveals that during winter, 65.99% of sample households in Kohima and 46.18% in Dimapur use traditional sources of energy (firewood and charcoal). It may be noted that the proportions of households using traditional energy sources in both the sample areas increase during winter, indicating that more people generally use these energy sources due to extreme climatic conditions during these months.

Table 5.6 reveals that the aggregate consumption by the sample households amounts to 1479617.00 MJ, of which 682707.00 MJ (46.14%) is contributed by traditional fuels and 796910.00 MJ (53.86%) by modern fuels. Among the traditional fuels, firewood (669552.00 MJ) contributes 98.07% and is the most prominent source of energy in urban areas during winter (45.25%). Charcoal amounts to 13155.00 MJ, contributing 1.93% of total traditional fuel and 0.89% of all fuels. Among the modern fuels, LPG (498500.83 MJ) contributes 62.55% and 33.69% of all fuels. Electricity, amounting to 292091.73 MJ contributes 36.65% of the modern fuels and 19.74% of all fuels, whereas kerosene accounts for 0.79% of the modern fuels and 0.43% of all fuels.

The total energy use among the sample households in Kohima during winter is 806370.69 MJ, of which 406124.00 MJ (50.36%) is contributed by the traditional sources and 400246.69 MJ (49.64%) by the modern sources. Firewood contributes 394784.00 MJ of energy (48.96%) and is consumed by 65.99% of households, and is the largest source of energy in Kohima during the winter season. This is followed by LPG (245881.37 MJ), electricity (150357.82 MJ), charcoal (11340.00 MJ) and kerosene (4224.50 MJ) with a relative share of 30.49%, 18.65%, 1.41% and 0.50%, respectively. This may be due to extreme weather conditions in Kohima during winter, as households generally use firewood. In Dimapur, the aggregate energy use is 673246.41 MJ, of which 276580.00 MJ (41.08%) is contributed by traditional sources and 396663.40 MJ (58.92%) by modern sources. Firewood contributing 274768.00 MJ of energy (40.81%) and consumed by 46.18% of the households, is the largest source of energy in Dimapur during the winter season, followed by LPG (252619.50 MJ), electricity (141733.91 MJ), kerosene (2460.50 MJ) and charcoal (1815.00 MJ) with a respective share of 37.52%, 21.05%, 0.34% and 0.27%.

Table 5.5: Energy Consumption Pattern of the Sample Households during **Summer** (in MJ Per Month)

Category	Fuel Type	Kohima				Dimapur				Overall			
		No. of HH	Quantity	% in Total	Per Capita	No. of HH	Quantity	% in Total	Per Capita	No. of HH	Quantity	% in Total	Per Capita
Traditional	Firewood	153 (52.04)	192716.00 (100)	34.33	224.61	87 (26.61)	94718.00 (100)	18.02	214.78	240 (38.65)	287434.25# (100)	26.45	220.26
Modern	Electricity	294 (100)	129718.43 (35.19)	23.11	90.78	327 (100)	187373.40 (43.49)	35.66	130.48	621 (100)	317091.83 (39.66)	29.17	110.68
	LPG	294 (100)	234939.00 (63.73)	41.85	164.41	327 (100)	241116.00 (55.97)	45.88	167.83	621 (100)	476055.00 (59.55)	43.80	166.16
	Kerosene	32 (10.88)	4187.50 (1.14)	0.71	35.56	20 (6.12)	2374.00 (0.55)	0.44	30.38	52 (8.37)	6561.50 (0.79)	0.58	33.98
	All Modern	294 (100)	368664.90 (100)	65.67	128.99	327 (100)	430799.40 (100)	81.98	145.39	621 (100)	799464.33 (100)	73.55	137.34
	All	294 (100)	561381.10	100	146.08	327 (100)	525517.48	100	154.38	621 (100)	1086898.58	100	149.86

Source: Household Survey, 2016-17.

Note: 1) Figures in parentheses show percentages to respective categories; 2) #Total consumption including 143706.00 MJ used for preparing animal feed which is excluded in 'cooking' and 'lighting and others' categories.

Table 5.6: Energy Consumption Pattern of the Sample Households during **Winter** (in MJ Per Month)

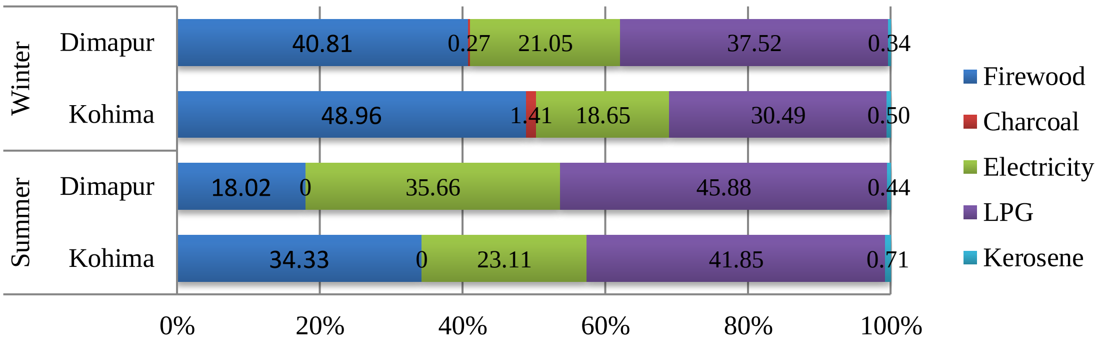
Category	Fuel Type	Kohima				Dimapur				Overall			
		No. of HH	Quantity	% in Total	Per Capita	No. of HH	Quantity	% in Total	Per Capita	No. of HH	Quantity	% in Total	Per Capita
Traditional	Firewood	194 (65.99)	394784.00 (97.21)	48.96	370.34	151 (46.18)	274768.00 (99.34)	40.81	363.45	345 (55.56)	669552.00[#] (98.07)	45.25	367.48
	Charcoal	94 (31.97)	11340.00 (2.79)	1.41	24.13	17 (5.20)	1815.00 (0.66)	0.27	22.65	111 (17.87)	13155.00 (1.93)	0.89	23.91
	All Traditional	215 (73.13)	406124.00 (100)	50.36	355.00	165 (50.46)	276583.00 (100)	41.08	336.48	380 (61.19)	682707.00 (100)	46.14	347.26
Modern	Electricity	294 (100)	150357.82 (37.57)	18.65	105.22	327 (100)	141733.91 (35.73)	21.05	98.70	621 (100)	292091.73 (36.65)	19.74	101.95
	LPG	294 (100)	245881.37 (61.43)	30.49	172.07	327 (100)	252619.50 (63.69)	37.52	175.92	621 (100)	498500.83 (62.55)	33.69	174.00
	Kerosene	32 (10.88)	4224.50 (1.06)	0.50	37.56	20 (6.12)	2460.50 (0.62)	0.34	32.38	52 (8.37)	6685.00 (0.79)	0.43	34.98
	All Modern	294 (100)	400246.69 (100)	49.64	134.09	327 (100)	396663.40 (100)	58.92	133.87	621 (100)	796910.00 (100)	53.86	133.98
	All	294 (100)	806370.69	100	178.36	327 (100)	673246.41	100	188.01	621 (100)	1479617.00	100	182.62

Source: Household Survey, 2016-17.

Note: 1) Figures in parentheses show percentages to respective categories; 2) [#]Total consumption including 152000.00 MJ used for preparing animal feed which is excluded in ‘cooking’ and ‘lighting and others’ categories.

Figure 5.5 shows a comparison of the share of different energy types in the total energy consumption of households for both summer and winter. It can be seen from the figure that during summer, the share of modern fuels is more prominent in both Kohima and Dimapur. However, the share of traditional fuels also increases during winter in both areas. The share of traditional fuels is higher in Kohima in both seasons. In case of modern fuels, the share is more in Dimapur during summer, whereas it is higher in Kohima during winter.

Figure 5.5: Proportion of Energy Consumption by the Households (Season-Wise)



Source: From Tables 5.5 and 5.6.

From the preceding discussions, it can be inferred that modern energy is the predominant energy source consumed by the urban households in both sample areas. However, the proportion of modern energy consumption is higher in Dimapur compared to Kohima during both summer and winter seasons.

5.6 PER CAPITA ENERGY CONSUMPTION OF HOUSEHOLDS

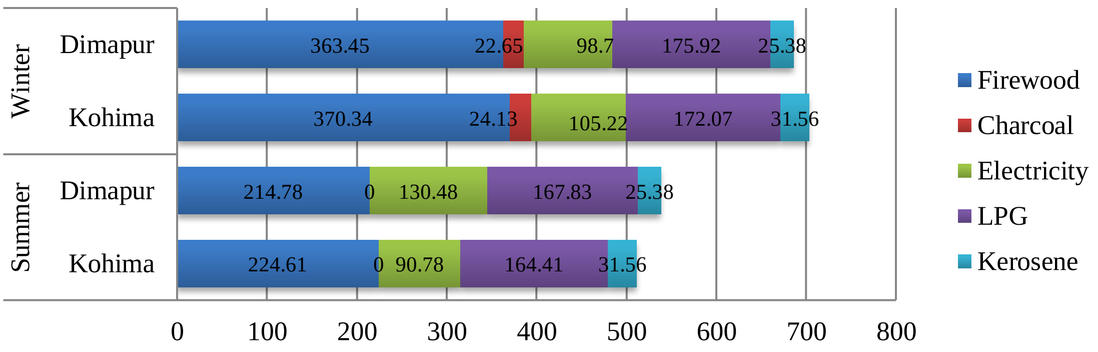
Tables 5.5 and 5.6 also present information on energy consumption in terms of per capita figures for summer and winter respectively. Per capita consumption of all energy is 149.86 MJ during summer and 182.62 MJ during winter. It may be noted that per capita consumption of traditional fuels is higher compared to modern fuels in both seasons. During summer, per capita energy consumption for traditional fuel is 220.26 MJ, whereas it is 137.34 MJ for modern fuels. Similarly, during winter, the corresponding figures for traditional and modern fuels are 347.26 MJ and 133.98 MJ.

Table 5.5 reveals that during summer, per capita energy consumption is higher in Dimapur (154.38 MJ) than in Kohima (146.08 MJ). When traditional fuel alone is considered, the per capita consumption is higher in Kohima (224.61 MJ) than in

Dimapur (214.78 MJ). However, this trend is reversed when modern fuels alone are considered. That is, the per capita consumption of modern fuels is higher in Dimapur (145.39 MJ) than in Kohima (128.99 MJ). Similarly, Table 5.6 reveals that during winter, in respect of total energy consumption, Dimapur has a higher per capita consumption (188.01 MJ) as compared to Kohima (178.36 MJ). When traditional fuels alone are considered, per capita consumption is higher in Kohima (355 MJ) compared to Dimapur (336.48 MJ). On the other hand, when modern fuels alone are considered, both sample areas have similar per capita consumption, that is, 134.09 MJ in Kohima and 133.87 MJ in Dimapur.

Figure 5.6 presents the total energy use in the study areas in per capita terms. It is evident that the total average per capita energy use in both areas during winter is higher than during summer because of the increased use of traditional energy during winter.

Figure 5.6: Pattern of Energy Consumption for the Average Urban Resident



Source: From Tables 5.5 and 5.6.

5.7 END USES OF ENERGY

End use energy of households is assumed to be dependent on the availability and accessibility of the fuel item. The major end uses of household energy include cooking, lighting, water heating, room heating and cooling. In the present study, these end uses have been clubbed into two categories, viz., (i) cooking and (ii) 'others'. 'Others' include the energy used for water heating, room heating and cooling for domestic purposes and lighting. Energy consumption patterns of the sample households based on the share in the various end use during summer and winter are presented in Tables 5.7 and 5.8.

Table 5.7: Energy Consumption Pattern by Fuels Used in Various End Uses during **Summer** (in MJ)

	Kohima				Dimapur				Total			
	Cooking	% to Total	Others	% to Total	Cooking	% to Total	Others	% to Total	Cooking	% to Total	Others	% to Total
FW	58832.00 (61.43)	18.06	36944.00 (38.57)	31.57	46752.00 (97.50)	14.16	1200.00 (2.50)	0.82	105584.00 (73.46)	16.10	38144.00 (26.54)	14.55
ELE	29581.00 (27.41)	9.08	78352.41 (72.59)	66.95	39949.00 (21.74)	12.10	143776.26 (78.26)	99.13	69530.00 (23.84)	10.60	222128.67 (76.16)	84.76
LPG	233375.87 (99.33)	71.63	1563.13 (0.67)	1.34	241116.00 (100)	73.04	0.00 (0.00)	0.00	474491.87 (99.67)	72.34	1563.13 (0.33)	0.60
KER	4007.50 (99.57)	1.23	180.00 (0.43)	0.15	2310.00 (97.30)	0.70	64.00 (2.70)	0.04	6317.50 (96.28)	0.96	244.00 (3.72)	0.09
AMO	266964.37 (76.96)	81.94	79915.54 (23.04)	68.43	283375.00 (66.34)	85.84	143776.26 (33.66)	99.18	550339.37 (70.06)	83.90	223691.80 (29.94)	85.45
All	325796.37 (75.69)	100	116859.54 (24.31)	100	330127.00 (69.49)	100	144976.26 (30.51)	100	655923.37 (71.47)	100	261835.80 (28.53)	100

Source: Own Calculation from Household Survey, 2016-17. Note: Figures in brackets show percentages to total individual fuel; FW = Firewood, ELE = Electricity, LPG = Liquefied Petroleum Gas, KER = Kerosene, AMO = All modern.

Table 5.8: Energy Consumption Pattern by Fuels Used in Various End Uses during **Winter** (in MJ)

	Kohima				Dimapur				Total			
	Cooking	% to Total	Others	% to Total	Cooking	% to Total	Others	% to Total	Cooking	% to Total	Others	% to Total
FW	58832.00 (19.93)	18.06	236432.00 (80.07)	65.33	46752.00 (21.03)	14.16	175536.00 (78.97)	62.42	105584.00 (20.40)	16.10	411968.00 (79.60)	64.06
CHA	0.00 (0.00)	0.00	11340.00 (100)	3.13	0.00 (0.00)	0.00	1812.00 (100)	0.64	0.00 (0.00)	0.00	13152.00 (100)	2.05
ATR	58832.00 (19.19)	18.06	247772.00 (80.81)	68.47	46752.00 (20.86)	14.16	177348.00 (79.14)	63.07	105584.00 (19.90)	16.10	425120.00 (80.10)	66.10
ELE	29581.00 (22.59)	9.08	101393.41 (77.41)	28.02	39949.00 (30.25)	12.10	92106.26 (69.75)	32.75	69530.00 (26.43)	10.60	193499.67 (73.57)	30.09
LPG	233375.87 (94.91)	71.63	12505.50 (5.09)	3.46	241116.00 (95.40)	73.04	11610.00 (4.60)	4.13	474385.37 (95.16)	72.34	24115.50 (4.84)	3.75
KER	4007.50 (95.74)	1.23	180.00 (4.26)	0.06	2310 (97.40)	0.70	64.00 (2.60)	0.05	6317.50 (96.35)	0.96	244.00 (3.65)	0.06
AMO	266964.37 (70.09)	81.94	114115.91 (29.91)	31.53	283375.00 (73.21)	85.84	103866.26 (26.79)	36.93	550232.87 (71.66))	83.90	217982.67 (28.34)	33.90
All	325796.37 (47.39)	100	361670.91 (52.61)	100	330020.50 (54.01)	100	281064.26 (45.99)	100	655816.87 (50.50)	100	642735.17 (49.50)	100

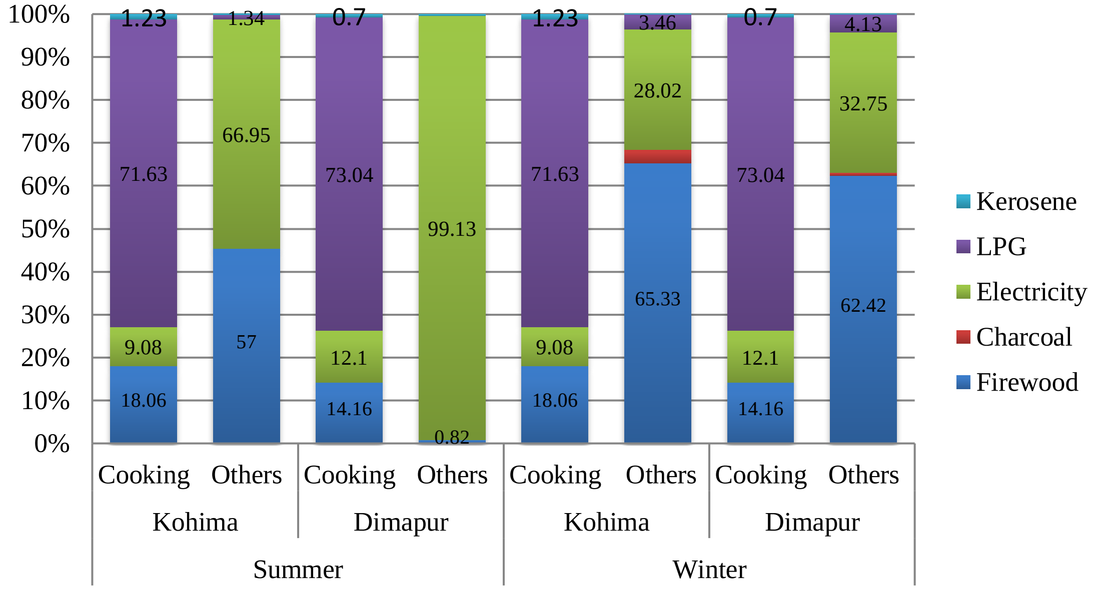
Source: Own Calculation from Household Survey, 2016-17. Note: Figures in brackets show percentages to total individual fuel; FW = Firewood, ELE = Electricity, LPG = Liquefied Petroleum Gas, KER = Kerosene, ATR = All traditional, AMO = All modern.

It can be observed from the tables that the amount of energy used for cooking is as high as 655923.37 MJ which accounts for 71.47% of the total energy used during summer and 50.50% during winter. LPG alone meets 72.34% of cooking energy requirements in the urban areas. When only traditional fuels are considered, 73.46% is used for cooking, and 26.54% is used for 'others' during summer. However, during winter, it contributes as much as 80.10% for 'others' end use and only 19.90% for cooking. Likewise, when only modern fuels are considered, 70.06% is used for cooking and 29.94% for 'others' during summer. On the other hand, during winter, 71.66% of the modern fuels are used for cooking and 28.34% for 'others'. The tables also reveal that 83.90% of the cooking energy requirement is met by modern fuels and 16.10% by traditional fuel during summer as well as winter. Hence it is inferred that modern fuels dominate cooking fuels in the urban households. For 'others', modern fuels (85.45%) dominate during summer, but traditional fuels (66.10%) dominate during winter.

Table 5.7 reveals that during summer in Kohima, most of the household energy is used for cooking (75.69%). In total traditional fuel consumption, the share for cooking is 61.43% and that of modern fuels is 76.96%. It can be further observed from the table that a greater share of all the fuels except electricity is used for cooking. Other purpose accounted for 72.59% of the share of electricity in Kohima. The table further reveals that in Kohima, LPG is the most important source (71.63%) of cooking fuels. Modern fuels account for 81.94% of the cooking and 68.43% of the 'others'. Among the fuels used in 'others', electricity and firewood account for 66.95% and 31.57%, respectively, during summer. Similarly, in Dimapur, cooking is the dominant end use (69.49%) where a major share of all the fuels except electricity is used for this purpose. The share of firewood in cooking is 97.50% and that of modern fuels is 66.34%. A major share of electricity is used for other purposes (78.26%) in Dimapur. LPG is the most important fuel consuming 73.04% of the 'cooking energy' whereas firewood, electricity and kerosene account for 14.16%, 12.10% and 0.70%, respectively. The share of all modern fuels taken together in cooking is 85.84%. In the fuels used for 'others', electricity accounts for 99.13% during summer in Dimapur.

Table 5.8 shows that during winter, 47.39% of all fuels are used for cooking in Kohima while 52.61% are for 'others'. A major portion of the traditional fuels (80.81%) is used for other purposes, and 19.19% is used for cooking. On the other hand, the share of modern fuels in cooking is 70.09%, and that of 'others' is 29.91%. During the winter season, firewood is the most used fuel among all the fuels for 'others' (65.33%), followed by electricity (28.02%). For energy used in 'others', the shares of both traditional and modern fuels are 68.47% and 31.53%, respectively. Similarly, in Dimapur, a major share of all the fuels is used for cooking (54.01%), while 45.99% is used for other purposes. The share of all modern fuels taken together in cooking is 73.21% and 26.79% in 'others'. However, there is a reverse in this trend when the traditional fuels alone are considered, i.e., a major share is used for other purposes (79.14%). Traditional fuels alone account for 63.07% for use in 'others'. Among the fuels used in 'others', firewood is the most important fuel accounting for 62.42%, followed by electricity (32.75%). Charcoal contributes only 0.64% of fuels used for 'others'.

Figure 5.7: Season-Wise Share of End Use Energy in Urban Households



Source: From Tables 4.7 and 4.8.

The share of end use patterns in the study areas is presented in Figure 5.7. It can be seen from the figure that LPG provided the bulk of cooking energy in the study areas during both summer and winter. On the other hand, while electricity provides the bulk of energy for ‘others’ during summer, firewood is the major fuel for the same purpose during winter in both Kohima and Dimapur. It is also evident that the share of electricity for ‘others’ in Dimapur is much higher during summer due to the high use of cooling appliances compared to winter.

Table 5.9: Per Household and Per Capita Energy Consumption by Fuels Used in Various End Uses during **Summer** (in MJ)

	Kohima				Dimapur				All			
	Cooking		Others		Cooking		Others		Cooking		Others	
	Per HH	PC	Per HH	PC	Per HH	PC	Per HH	PC	Per HH	PC	Per HH	PC
FW	600.33	105.45	461.80	81.37	570.15	118.06	600.00	100.00	586.58	110.68	465.17	81.85
ELE	113.77	23.72	348.23	73.57	139.20	30.50	439.68	100.12	127.11	27.19	402.41	88.82
LPG	793.80	163.31	91.95	20.04	737.03	167.83	0.00	0.00	763.91	165.58	91.95	20.04
KER	125.23	31.56	18.00	6.00	115.5	25.38	16.00	5.33	121.49	28.98	17.00	5.81
AMO	455.57	95.24	330.23	69.92	446.96	99.89	423.74	95.23	451.10	97.58	393.13	86.74
All	476.31	96.93	362.92	73.17	461.07	102.11	440.66	98.32	468.52	99.46	402.21	85.99

Source: Own Calculation from Household Survey, 2016-17. Note: PC = Per Capita, HH = Household, FW = Firewood, ELE = Electricity, LPG = Liquefied Petroleum Gas, KER = Kerosene, AMO = All modern.

Table 5.10: Per Household and Per Capita Energy Consumption by Fuels Used in Various End Uses during **Winter** (in MJ)

	Kohima				Dimapur				All			
	Cooking		Others		Cooking		Others		Cooking		Others	
	Per HH	PC	Per HH	PC	Per HH	PC	Per HH	PC	Per HH	PC	Per HH	PC
FW	600.33	105.45	1218.72	221.79	570.15	118.06	1162.49	232.19	586.58	110.68	1194.11	226.11
CHA	0.00	0.00	120.64	24.13	0.00	0.00	106.59	22.65	0.00	0.00	118.49	23.49
ATR	600.33	105.45	860.32	161.31	570.15	118.06	1055.64	212.14	586.58	110.68	932.28	179.22
ELE	113.77	23.72	382.62	83.52	139.20	30.50	281.67	64.14	127.11	27.19	326.86	73.02
LPG	793.80	163.31	96.94	20.37	737.03	167.83	82.34	18.49	763.91	165.58	89.32	19.42
KER	125.23	31.56	14.47	4.82	115.50	25.38	15.50	5.02	121.49	28.98	14.70	4.90
AMO	455.57	95.24	289.08	59.08	446.80	99.85	221.62	50.25	451.01	97.58	252.45	55.91
All	476.31	96.65	530.31	107.51	460.92	102.08	441.92	96.92	468.52	99.46	487.66	102.61

Source: Own Calculation from Household Survey, 2016-17. Note: PC = Per Capita, HH = Household, FW = Firewood, CHA = Charcoal. ELE = Electricity, LPG = Liquefied Petroleum Gas, KER = Kerosene, ATR = All traditional, AMO = All modern.

Tables 5.9 and 5.10 show the energy consumption patterns by the end use in terms of per household and per capita figures during summer and winter respectively. The corresponding figures for per household and per capita consumption of the total fuel for cooking in the sample aggregate are 468.52 MJ and 99.46 MJ. It can be observed from the tables that the per household and per capita figures in terms of energy consumption for cooking are higher in the case of traditional fuel (586.58 MJ and 110.68 MJ respectively) as compared to modern fuels (451.10 MJ and 97.58 MJ respectively). It is interesting to note that for cooking, per household consumption is higher in Kohima than in Dimapur but per capita figure is higher in Dimapur than in Kohima. The same trend is exhibited by both traditional fuel and modern fuels also.

Among all the fuels used for cooking, LPG has the highest per capita in both the sample areas, whereas the lowest per capita is exhibited by electricity in Kohima and kerosene in Dimapur. Furthermore, it can be noted from Table 5.9 that during summer for 'others', the per capita figure is higher in Dimapur for all types of fuels as compared to Kohima. On the other hand, Table 5.10 reveals that per capita for 'others' during winter is higher in Kohima than in Dimapur. This trend can be seen in modern fuels also. In contrast, when traditional fuels alone are considered, per capita for 'others' is higher in Dimapur compared to Kohima during winter.

5.8 HOUSEHOLD ENERGY CONSUMPTION BY DISPOSABLE INCOME

In order to provide deeper insight into the relative importance of household income to consumption of each energy type, figures 5.8, 5.9, 5.10 and 5.11 display average energy consumption by disposable income deciles for both summer and winter.[2] The figures show that firewood, charcoal, electricity, LPG and overall energy consumption increase with increasing levels of disposable income in the two seasons, while kerosene has a negative relationship. Thus, the findings suggest that charcoal, electricity, LPG and overall energy are normal goods, whereas firewood and kerosene are inferior goods.

The correlation coefficients between household energy consumption and income for the sample total are given in Table 5.11. It shows a positive correlation between

[2] The underlying data for all figures based on calculations against disposable income deciles are presented in the Appendix to the chapter.

income and electricity, LPG, charcoal overall energy consumption. On the other hand, the correlation coefficients between income, and firewood and kerosene are negative.

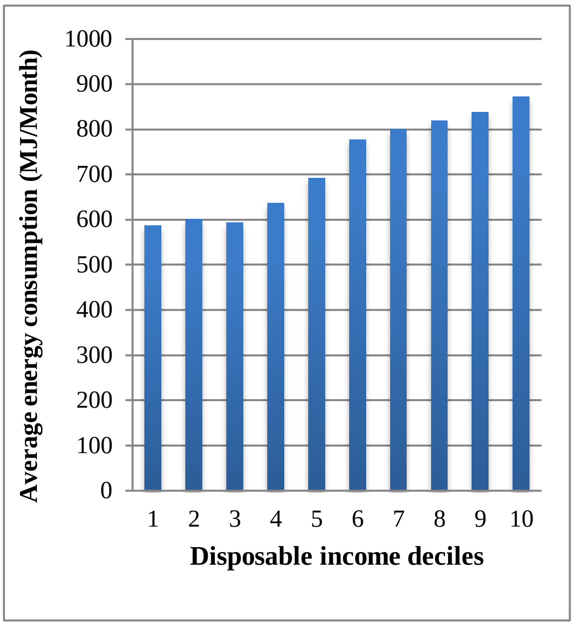


Figure 5.8: SUMMER – Average Overall Energy Consumption (MJ/Month) by Disposable Income Deciles

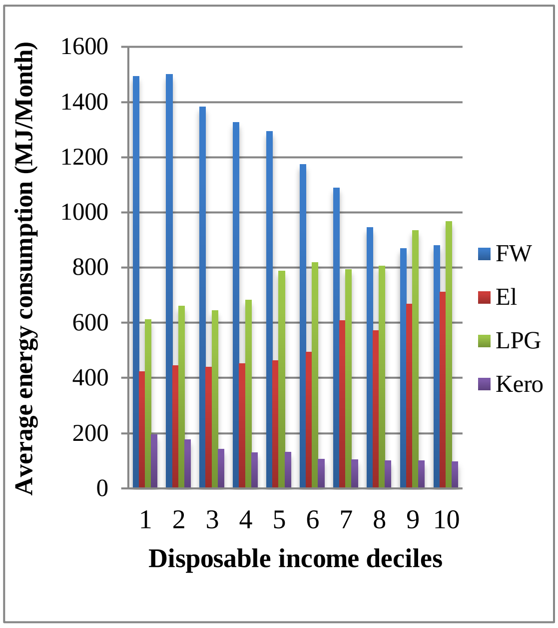


Figure 5.9: SUMMER – Average Individual Energy Consumption (MJ/Month) by Disposable Income Deciles

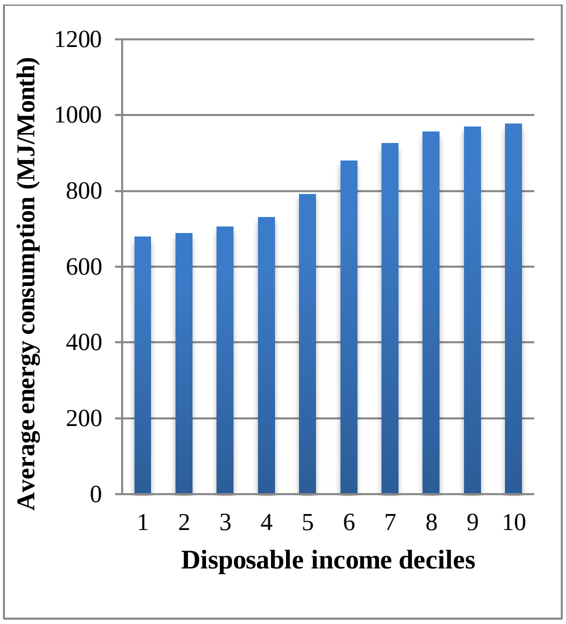


Figure 5.10: WINTER – Average Overall Energy Consumption (MJ/Month) by Disposable Income Deciles

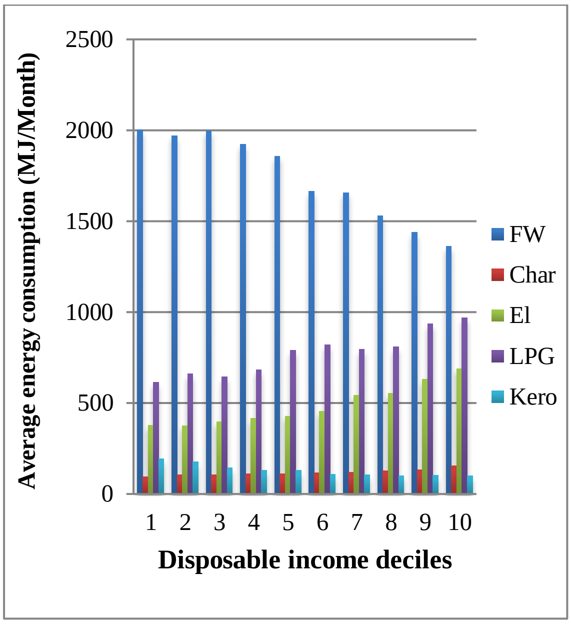


Figure 5.11: WINTER – Average Individual Energy Consumption (MJ/Month) by Disposable Income Deciles

Table 5.11: Pearson Correlation Coefficients between Household Energy Consumption and Income in the Aggregate Sample

	Overall	Electricity	LPG	Firewood	Kerosene	Charcoal
Summer	.318**	.399**	.369**	-.296**	-.179*	-
Winter	.348**	.363**	.368**	-.262**	-.178*	.141

Note: Significance at the 1% and 5% levels are indicated by ** and * respectively.

5.9 STOCK ON ELECTRICAL APPLIANCES

Electricity forms an integral part of energy consumption for an average household and is used for heating water, cooking, space heating and lighting. However, electricity has another main use, to power electrical appliances. Table 5.12 presents the proportion of households having a particular electrical appliance.

Table 5.12: Level of Possession of Electrical Appliances (% of Households)

	Kohima	Dimapur	Total
Regular TV	57.14	47.09	51.85
Smart TV	43.54	44.04	43.80
Fridge	68.71	99.39	84.86
Washing Machine	48.64	54.13	51.53
Fan	12.24	100.00	58.45
Water Pump	14.29	59.33	38.00
CD Player	32.31	13.15	22.22
Desktop	57.14	44.34	50.40
Laptop	64.63	64.53	64.57
Printer	40.14	31.19	35.43
Rice Cooker	84.01	83.79	83.90
Electric Iron	90.48	87.77	89.05
Hair Dryer	27.21	25.69	26.41
Microwave	20.75	25.38	23.19
Water Heater	73.47	64.83	68.92
Room Heater	65.99	32.72	48.47
Water Boiler	41.84	47.71	44.93
Induction Cooktop	27.89	45.26	37.20
Mixer Grinder	31.29	50.15	41.22

Source: Household Survey, 2016-17.

The data is for all households on nineteen electrical appliances and also separately for Kohima and Dimapur. The table shows that most of the homes possess a fridge, fan, laptop, rice cooker, electric iron and water heater. Around half of homes possess regular TV, washing machine and desktop. Households in Kohima have higher levels of possession of regular TV, CD player, desktop, printer, water heater and room heater. On the other hand, households in Dimapur show significantly higher levels of possession of fridge, fan, water pump, water boiler, induction cook top and mixer grinder.

To illustrate the extent of the possession of electrical appliances across households, an index is constructed by adding the total number of appliances a household possesses. The index is based on the nineteen electrical items given in Table 5.12 and graphed first for the sample areas and then against disposable household income. The closer the value of the index is to 19, the greater the number of electrical appliances households have in their possession.

Figure 5.12 shows the average index for Kohima, Dimapur and all households. Households in the overall sample possessed an average of 51% of the 19 appliances (9.63 divided by 19) listed in Table 5.12. Among the sample areas, households in Kohima possessed an average of 47% and those in Dimapur possessed 54% of the listed appliances. Figure 5.13 shows the positive relationship that disposable income has on the possession of electrical appliances, although it is likely that disposable income is associated with other factors that influence the possession of electrical appliances, such as household size or the number of rooms in the house.

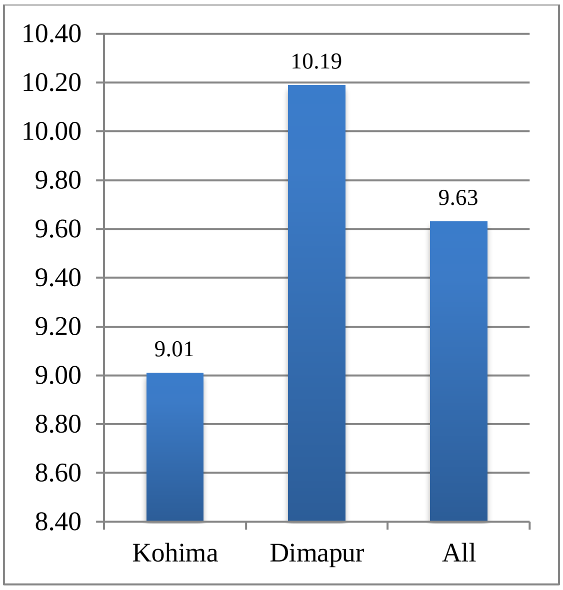


Figure 5.12: Index of Possession of Electrical Appliances

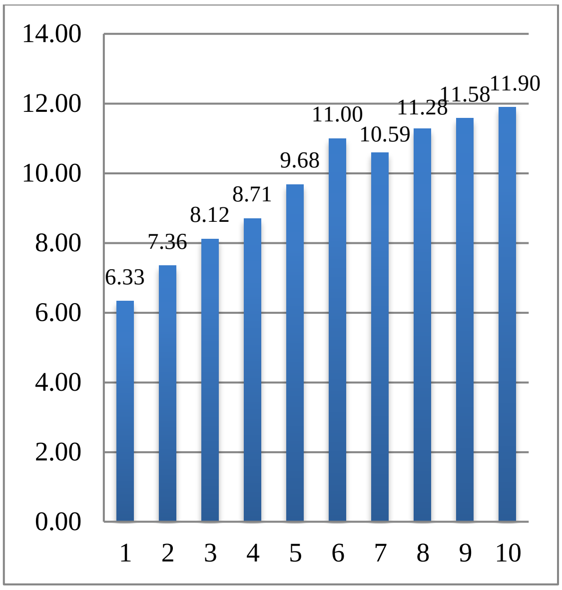


Figure 5.13: Possession of Electrical Appliances by Disposable Income Deciles

5.10 CONCLUSION

This chapter examined the general household and per capita energy consumption patterns and the inter-regional variation in urban Nagaland based on the sample drawn from the two study areas. From the preceding discussions, the following conclusion may be drawn. Electricity and LPG are used in every household. Electricity is used for lighting, cooking and heating; LPG is used for cooking and water heating; kerosene is used for cooking; firewood is used for cooking, water heating and space heating; and charcoal is used for space heating. Irrespective of season and region, electricity is the primary source of energy for lighting. An important finding is that households commonly use firewood which is a traditional source, regardless of income level. The finding supports the energy stack model, which states that households do not completely abandon traditional fuels as their income rises but rather follow a stacked behavior in which traditional fuels are used in conjunction with modern fuels. The relation between the consumption level of individual energy items and income level suggests that charcoal, electricity, LPG and overall energy are normal goods, whereas firewood and kerosene are inferior goods, whose consumption reduces with an increase in disposable income.

The household energy consumption scenario is dominated by modern sources of energy, which are mostly used for cooking. Among the modern fuels, LPG is the most important fuel providing nearly half of the household energy requirements. Cooking is the most important end use and LPG is the dominant cooking fuel. For the end use of ‘others’, electricity is the most important fuel during summer whereas during winter, it is firewood. The most important use of traditional fuels during summer is for cooking, whereas during winter, it is mainly utilized for other purposes. The energy demand for households is higher during winter. An interesting revelation is that whereas modern fuels dominate during summer, traditional fuel also contributes nearly half of the energy needs of households during winter. Among the sample areas, total energy consumption is higher in Kohima during the summer and winter seasons. However, in the case of modern fuels, the share is higher in Dimapur during summer, but it is higher in Kohima during winter. In the case of traditional fuels, the share is higher in Kohima irrespective of the seasons.

Households in the overall sample possessed an average of 51% of 19 selected electrical appliances. Majority of the households possess fridge, fan, laptop, rice cooker, electric iron and water heater, and around half of homes possess regular TV, washing machine and desktop. Households in Kohima have higher levels of possession of regular TV, CD player, desktop, printer, water heater and room heater. On the other hand, households in Dimapur have significantly higher levels of possession of fridge, fan, water pump, water boiler, induction cook top and mixer grinder.

APPENDIX

Table 5A: Average Household Energy Consumption (MJ/Month) during **Summer** by Disposable Income Deciles

	1	2	3	4	5	6	7	8	9	10
Firewood	1492.77	1500.00	1382.35	1326.62	1294.11	1174.23	1089.60	945.12	868.78	880.23
Electricity	423.00	445.00	440.14	453.00	463.67	494.00	608.30	572.58	667.80	711.61
LPG	611.39	660.30	643.95	682.16	787.89	918.56	794.05	806.61	934.54	968.18
Kerosene	194.50	177.00	142.00	130.33	131.79	107.00	104.08	101.17	101.17	97.25
All	586.85	600.96	593.58	636.53	692.36	776.65	800.26	819.48	838.48	872.33

Table 5B: Average Household Energy Consumption (MJ/Month) during **Winter** by Disposable Income Deciles

	1	2	3	4	5	6	7	8	9	10
Firewood	2002.09	1970.44	1998.67	1924.12	1858.64	1664.36	1657.33	1530.41	1439.12	1362.86
Charcoal	96.00	105.00	105.00	110.00	110.63	116.23	118.13	128.57	132.5	156.25
Electricity	377.90	376.53	396.53	416.69	428.16	455.53	543.37	553.91	631.70	688.96
LPG	613.73	661.04	645.52	683.41	789.47	821.35	795.31	808.72	936.42	969.44
Kerosene	193.70	178.00	143.00	131.35	131.81	108.00	105.10	101.19	102.17	99.27
All	678.79	687.72	706.08	730.91	791.48	879.01	925.24	956.45	969.31	977.30

Table 5C: Possession of Electrical Appliances by Disposable Income Deciles

	1	2	3	4	5	6	7	8	9	10
Appliance Index	6.33	7.36	8.12	8.71	9.68	11.00	10.59	11.28	11.58	11.90

CHAPTER 6

DETERMINING FACTORS OF HOUSEHOLD ENERGY CONSUMPTION IN URBAN NAGALAND

6.1 INTRODUCTION

The previous chapter examined the energy consumption pattern at the aggregate level and the extent of variations among sample areas. The socio-economic profile of an area, including gender, age, educational status, occupation, income, household size, etc., has considerable influence on the level of living of households. Besides, energy is a commodity that is also derived from the type and extent of energy using items in the home, including water heating systems, space heating systems, cooking appliances, and other electrical appliances. Therefore, in order to provide an understanding of the factors underlying energy use in the home, it is necessary to identify the characteristics of households that possess particular types of electrical appliances. Furthermore, the energy-related behaviors of the residents are also important in influencing household energy consumption. The behavior of residents plays a significant role as they have direct control over their actions, decision-making, and interventions regarding energy use in their homes. Hence, an attempt has been made in this chapter to examine the association between socio economic characteristics and energy consumption patterns and behavior.

Section 6.2 of the chapter defines various variables used in the analyses and the summary statistics of the variables. Section 6.3 presents an analysis of the factors affecting household energy consumption using the OLS regression method. Furthermore, section 6.4 focuses on the possession of electrical appliances in the home and the household and dwelling characteristics associated with higher or lower levels of possession by using Poisson regression. Section 6.5 looks at the households' choice of cooking fuel by using binary logistic regression. The models in all the sections mentioned above relate a dependent variable to a range of household and dwelling characteristics which will be outlined in section 6.2. Section 6.6 focuses on the energy-saving behavior of residents, while the impact of this behavior on energy consumption is discussed in section 6.7. Section 6.8 provides an overall conclusion.

6.2 DEFINITION OF VARIABLES AND SUMMARY STATISTICS

The dependent variables in the regression analyses will represent the level of energy consumption across individual fuel items and also the aggregate consumption, stock of electrical appliances, and household choice of cooking fuel. The various types and units of independent variables and the factor type of each variable are illustrated in Table 6.1.

Table 6.1: Definition of Variables

Variable	Type	Unit	Factor Type
Location:	Categorical		Geographic
Kohima		Dummy	
Dimapur		Reference category	
Gender of HoH:	Categorical		Socio economic
Male		Reference category	
Female		Dummy	
Age of HoH	Continuous	Years	Socio economic
Household Size	Continuous	Number of persons	Socio economic
Education of HoH	Continuous	Years	Socio economic
Work Status of HoH:	Categorical		Socio economic
Retired		Dummy	
Salaried		Reference category	
Self-employed		Dummy	
Unemployed		Dummy	
House Ownership:	Categorical		Dwelling
Own		Reference category	
Rent		Dummy	
Number of Rooms	Continuous		Dwelling
Number of Appliances	Continuous		Socio economic
Income	Continuous	In ₹10,000s	Socio economic

Note: HoH = Head of household

The variables given in Table 6.1 are represented by the socio-economic and dwelling characteristics and include gender, age, educational qualification and work status of head of household, house ownership, the number of persons in the home, number of rooms, stock of appliances and annual income. Regarding house ownership, those families residing in government quarters have been adjusted and included under rented accommodation. Therefore, the variable is reduced to two categories – own and rent. Location as a geographic factor is also included to consider the different geo-climatic conditions of the sample areas. The analyses that are carried out in sections 6.3, 6.4 and 6.5 of the present chapter will use this information as explanatory variables in the various models of household energy use. The summary statistics of the variables are provided in Table 6.2.

Table 6.2: Summary Statistics of Variables

	Mean	Median	St. Dev.
Location:			
Kohima	0.47	0.00	0.50
Dimapur	0.53	1.00	0.50
Gender of Household Head:			
Male	0.83	1.00	0.38
Female	0.17	0.00	0.38
Age of Household Head	49.46	50.00	13.67
Household Size	4.61	5.00	1.79
Education of Household Head	14.10	17.00	4.86
Work Status of Household Head:			
Retired	0.16	0.00	0.37
Salaried	0.55	1.00	0.50
Self-employed	0.11	0.00	0.31
Unemployed	0.12	0.00	0.33
House Ownership:			
Own	0.61	1.00	0.49
Rent	0.33	0.00	0.47
Number of Rooms	5.26	5.00	2.63
Number of Appliances	18.39	12.00	6.57
Income (in ₹10,000s)	74.09	64.80	34.36

The first set of variables in the table relates to the location of the households. Location in this study implies whether the household is located in a hilly area referring to Kohima, or a plain area referring to Dimapur, which is assumed to influence the household energy choice and consumption. Majority of the household heads were male which is 83% of the total households, with an average age of 49 years. An average household in the study area contains around five members, and a typical size of house contains five rooms, owning around eighteen electrical appliances. Education level of household heads was converted from level attained to years of education. The average level of education was 14.10 years which translates to higher secondary education. Majority of the household heads were employed in organized sector (55%) and residing in their own house (61%), and the average annual income per household was ₹740,900.

6.3 RELATIONSHIP BETWEEN HOUSEHOLD ENERGY CONSUMPTION, SOCIO ECONOMIC AND DWELLING CHARACTERISTICS

This section examines the relationship between household energy consumption and a range of socio-economic and dwelling characteristics representing the gender and age of the head of household, number of persons in the home, stock of appliances, income, etc. The five individual fuel items, namely, electricity, LPG, firewood, kerosene and charcoal are regressed on a number of variables representing household socio-economic and dwelling characteristics. Since the consumption data were collected separately for winter and summer seasons for the individual fuel items except for charcoal[1], consideration needs to be taken for the potential seasonality before estimating the models. The consumption of individual fuel items and total fuel consumption in the analysis are therefore de-seasonalised by removing the average seasonal effect from consumption data.

6.3.1 Estimated Results of Household Energy Consumption Models

The Ordinary Least Square (OLS) regression method was used to examine the determining variables, and a semi-log specification was chosen in all the models. The individual fuels are in terms of per capita consumption and in their own unit of measure, i.e., electricity in kWh, LPG, firewood and charcoal in kg and kerosene in litre, whereas for overall energy, the different units are converted into the common unit of measure which is in mega joule (MJ). The dependent variables are regressed on the given independent variables with the exception of the number of rooms on LPG and kerosene, which is assumed not to influence the consumption of these fuels, and also appliance stock on LPG, firewood and kerosene for the same reason. The estimated results for the five fuels and total energy are presented in Tables 6.3 to 6.5.

[1] Charcoal is used only during winter for heating purpose.

The following discussion focuses specifically on the significant variables and their interpretation. It also summarises the results across the fuels rather than individually, despite the fact that each model is estimated separately.

Table 6.3: OLS Regression Estimates of Electricity, LPG, Firewood, Kerosene, Charcoal and Total Energy Consumption in Sample Total

	Electricity	LPG	Firewood	Kerosene	Charcoal	Overall Energy
Gender of HoH:						
Male (ref.)						
Female	0.067***	-0.019	-0.034	-0.069	0.078	0.058**
	(0.021)	(0.044)	(0.057)	(0.068)	(0.109)	(0.022)
Age of HoH	0.003**	0.005**	0.009*	0.002	0.006	0.005*
	(0.001)	(0.002)	(0.004)	(0.008)	(0.004)	(0.002)
Household Size	-0.093***	0.069***	0.046***	-0.039**	-0.033***	0.092***
	(0.019)	(0.008)	(0.013)	(0.014)	(0.010)	(0.022)
Education of HoH	0.010**	0.013***	-0.039***	-0.013	-0.003	0.013**
	(0.003)	(0.004)	(0.011)	(0.024)	(0.009)	(0.005)
Status of HoH:						
Retired	0.035***	0.048	0.066**	-0.058**	-0.025**	0.036**
	(0.011)	(0.046)	(0.025)	(0.019)	(0.011)	(0.015)
Salaried (ref.)						
Self-employed	-0.043	0.037	-0.035*	-0.076	0.019	-0.086**
	(0.047)	(0.049)	(0.014)	(0.046)	(0.012)	(0.035)
Unemployed	0.090	-0.017	-0.082	0.086	-0.086	0.114
	(0.054)	(0.057)	(0.062)	(0.082)	(0.048)	(0.069)
House ownership:						
Own (ref.)						
Rent	-0.044**	0.003	-0.031**	0.027	-0.055	-0.051***
	(0.016)	(0.036)	(0.012)	(0.052)	(0.108)	(0.015)
No. of rooms	0.017***		0.043		0.028	0.032***
	(0.005)		(0.026)		(0.017)	(0.009)
No. of appliances	0.020***					0.021***
	(0.003)					(0.003)
Income	0.028***	0.024**	-0.058**	-0.030	0.015	0.024**
	(0.006)	(0.009)	(0.022)	(0.034)	(0.014)	(0.010)
Constant	6.157	4.352	4.691	3.583	2.492	8.379
	(0.081)	(0.104)	(0.324)	(0.678)	(0.263)	(0.132)
R^2	0.523	0.200	0.180	0.212	0.173	0.648
F statistic	60.630***	8.651***	3.978***	6.938***	9.876***	16.138***
No. of observations	621	621	345	52	111	621

Note: Standard errors are in brackets. Significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

Table 6.3 reveals that households headed by females show higher levels of electricity and total energy consumption compared to male-headed households. It could be that female household heads require a higher level of appliance and light usage than male household heads, all else being equal. *A priori*, the older the head of household, the more fuel is consumed for cooking and heating as older people stay at home more regularly and have a higher energy requirement. This appears to be the case in the electricity, LPG, firewood and overall energy models. Similarly, those households with retired heads consume more electricity, firewood and overall energy but consume lesser kerosene and charcoal. Additionally, families with self-employed heads are found to consume lesser firewood and overall energy as compared to salaried-headed households.

Household size is an important variable in all the models. The coefficient on the variable is negative and significant in the electricity, kerosene and charcoal models. The negative sign associated with this variable in these models implies that each additional person per household increases energy consumption at a decreasing rate. This can be simply explained by the example of a heater which, if used for one person, also warms another in the same room, indicating economies of scale in the households. This means an additional person in the house decreases per capita electricity consumption, kerosene and charcoal in the aggregate sample by 9.3%, 3.9%, and 3.3%, respectively. However, household size is positively related to LPG, firewood and overall energy, indicating that an additional person increases the dependent variable by 6.9%, 4.6% and 12.9%, respectively.

Education has a significant and positive relationship with electricity, LPG and overall energy consumption but is negatively related to firewood consumption. This means an increase in the educational level of the household head by one year increases electricity consumption by 1% and that of LPG by 1.3% and overall energy by 11.3%, but decreases firewood consumption by 3.9%. This could imply that a higher level of education has motivated people to use more cleaner energy sources and lesser traditional fuels. Families residing in rented accommodations consume less electricity, firewood and overall energy than those residing in their own houses.

It is found that the houses with more rooms consume more electricity and overall energy. Given that electricity is used primarily for lighting and operating appliances, this effect of the number of rooms in these models is not unexpected. This means an additional room in a house increases per capita electricity consumption by 1.7% and overall energy consumption by 3.2%. Also, a household consumes more electricity if they possess a higher number of electrical appliances. The findings suggest that an increase in the electrical appliance by one unit leads to an increase in electricity and overall energy consumption by 2% and 2.1%, respectively. Finally, income is positive and significant in electricity, LPG and overall energy models, whereas it is negative and significant in the firewood model. This implies that higher income households consume more electricity, LPG and overall energy but lesser firewood. An increase in an annual income by ₹10,000 per household is associated with a 2.8%, 2.4% and 2.4% increase in consumption of electricity, LPG and overall energy respectively, and a 5.8% decrease in firewood consumption.

Table 6.4 reveals that in Kohima, gender positively and significantly affects electricity and overall energy consumption. Age of the household head also has a significant and positive relationship with electricity, LPG, firewood and overall energy consumption. The effects of these two variables on the dependent variables are similar to that of the sample total. Likewise, household size shows a similar relationship with the sample total, except that it is not significant in the firewood model.

Education is significant and is negatively related to firewood consumption but positively related to overall energy consumption. However, it is not significant in electricity and LPG models compared to the sample total. In the case of work status, while households with retired heads consume more electricity, firewood and overall energy and lesser charcoal, it is indifferent in kerosene compared to the sample total. Households in Kohima residing in rented accommodations also consume less electricity, firewood and overall energy than those residing in their own houses. Number of rooms also shows similar results to that of the sample total, with a significant and positive relationship in electricity and overall energy models, and also in the charcoal model. That is, an additional increase in one room increases electricity, charcoal and overall energy consumption by 1.3%, 4.6% and 3.3%, respectively. The number of appliances positively influences electricity and overall energy similar to the sample total. While income has a significant and positive relationship with electricity, LPG and overall energy, its impact on firewood consumption is not significant compared to the sample total.

In Dimapur, gender has interesting contrast to the results from the sample total and Kohima as shown in Table 6.5. While it shows no significant relationship in the individual fuel models, it is significant and negatively related to overall energy consumption. This would suggest that households headed by a male in Dimapur consume higher overall energy than female-headed households. In case of age, while the effect is similar to sample total and Kohima in electricity and overall energy models, it has no significant relation with firewood consumption.

Table 6.4: OLS Regression Estimates of Electricity, LPG, Firewood, Kerosene, Charcoal and Total Energy Consumption in Kohima

	Electricity	LPG	Firewood	Kerosene	Charcoal	Overall Energy
Gender of HoH:						
Male (ref.)						
Female	0.079**	0.068	0.032	0.042	0.069	0.060*
	(0.029)	(0.054)	(0.096)	(0.077)	(0.133)	(0.028)
Age of HoH	0.005**	0.005**	0.008*	0.004	0.006	0.005**
	(0.002)	(0.002)	(0.003)	(0.015)	(0.005)	(0.002)
Household Size	-0.026***	0.036**	0.023	-0.021**	-0.024***	0.072***
	(0.006)	(0.011)	(0.058)	(0.008)	(0.004)	(0.021)
Education of HoH	0.004	0.001	-0.013***	0.001	0.002	0.019*
	(0.005)	(0.005)	(0.003)	(0.037)	(0.010)	(0.007)
Status of HoH:						
Retired	0.043**	0.037	0.023***	-0.023	-0.065**	0.133**
	(0.014)	(0.060)	(0.004)	(0.053)	(0.029)	(0.046)
Salaried (ref.)						
Self-employed	-0.016	0.065	-0.088*	-0.061	0.086	-0.093**
	(0.071)	(0.070)	(0.040)	(0.048)	(0.094)	(0.038)
Unemployed	0.085	-0.090	-0.090	-0.059	-0.063	0.117
	(0.070)	(0.069)	(0.058)	(0.071)	(0.047)	(0.110)
Ownership:						
Own (ref.)						
Rent	-0.067**	0.042	-0.082**	0.042	-0.094	-0.101**
	(0.024)	(0.044)	(0.029)	(0.058)	(0.137)	(0.035)
No. of rooms	0.013***		0.071		0.046*	0.033***
	(0.004)		(0.040)		(0.022)	(0.009)
No. of appliances	0.036***					0.040***
	(0.006)					(0.009)
Income	0.022**	0.020**	0.007**	-0.043	0.013	0.128**
	(0.008)	(0.007)	(0.002)	(0.048)	(0.017)	(0.045)
Constant	6.402	3.943	4.119	3.258	2.257	8.485
	(0.143)	(0.143)	(0.200)	(1.125)	(0.308)	(0.221)
R^2	0.587	0.132	0.115	0.256	0.122	0.541
F statistic	38.891***	6.068***	3.154***	4.890***	7.788***	18.342***
No. of observations	294	294	194	32	94	294

Note: Standard errors are in brackets. Significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

Table 6.5: OLS Regression Estimates of Electricity, LPG, Firewood, Kerosene, Charcoal and Total Energy Consumption in Dimapur

	Electricity	LPG	Firewood	Kerosene	Charcoal	Overall Energy
Gender of HoH:						
Male (ref.)						
Female	0.084	0.105	-0.048	0.086	0.046	-0.068*
	(0.063)	(0.068)	(0.045)	(0.103)	(0.112)	(0.027)
Age of HoH	0.005**	0.008**	0.004	0.018	0.011	0.007***
	(0.002)	(0.003)	(0.006)	(0.012)	(0.010)	(0.002)
Household Size	-0.075***	0.031***	0.092***	-0.043**	-0.090**	0.090***
	(0.014)	(0.009)	(0.025)	(0.017)	(0.039)	(0.013)
Education of HoH	0.018**	0.029***	-0.026***	-0.009	-0.011	0.018**
	(0.006)	(0.006)	(0.004)	(0.039)	(0.043)	(0.007)
Status of HoH:						
Retired	0.084**	0.025	0.078*	-0.046	-0.068	0.034**
	(0.034)	(0.069)	(0.034)	(0.070)	(0.118)	(0.014)
Salaried (ref.)						
Self-employed	-0.020	0.038	-0.048**	-0.081	0.029	-0.092***
	(0.063)	(0.067)	(0.022)	(0.047)	(0.210)	(0.027)
Unemployed	0.088**	-0.038	-0.043	0.055	-0.092	-0.089
	(0.028)	(0.067)	(0.051)	(0.065)	(0.048)	(0.093)
Ownership:						
Own (ref.)						
Rent	-0.032***	0.030	-0.035**	-0.048	0.104	-0.101**
	(0.009)	(0.056)	(0.014)	(0.146)	(0.148)	(0.046)
No. of rooms	0.027***		0.021		0.001	0.032**
	(0.005)		(0.039)		(0.064)	(0.009)
No. of appliances	0.015***					0.018***
	(0.004)					(0.004)
Income	0.029**	0.026**	-0.008**	-0.008	0.073	0.123**
	(0.009)	(0.009)	(0.003)	(0.064)	(0.056)	(0.041)
Constant	6.013	4.756	6.162	3.074	3.228	8.443
	(0.139)	(0.150)	(0.666)	(2.307)	(0.740)	(0.150)
R^2	0.463	0.191	0.281	0.228	0.147	0.648
F statistic	25.639***	8.348***	6.858***	5.647**	9.855**	16.333***
No. of observations	327	327	151	20	17	327

Note: Standard errors are in brackets. Significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

Regarding household size and education, the effects are similar to that of the sample total; with household size having a significant and negative relationship with electricity, kerosene and charcoal, and positive relationship with LPG, firewood and overall energy; and education having significant and positive relation with electricity, LPG and overall energy and negative relation with firewood. As in the sample total, households with retired heads consume more electricity, firewood and overall energy. However, it has no significant relationship with kerosene and charcoal consumption. Unemployed-headed households also consume more electricity in Dimapur compared to salaried-headed households. The inference could be that those who are retired or unemployed are spending more time at home and thus using more energy. Households with self-employed heads consume less firewood than salaried-headed households.

The effect of house ownership is similar to sample total and Kohima, i.e., those residing in rented accommodations are consuming less electricity, firewood and overall energy. Larger houses also consume a higher level of electricity and overall energy like that in Kohima and sample total. The effects in appliance stock and income cases compare well with the sample total and Kohima. It is evident from the above results that household socio economic factors significantly impact energy consumption. Therefore, the assertion made in the hypothesis of this study that "socio economic variables have effect on household energy consumption" is accepted.

6.4 AN ANALYSIS OF POSSESSION OF ELECTRICAL APPLIANCES

As already highlighted in chapter 5, electricity is the most important energy source used by all households and, therefore, is an important form of energy requiring policy attention concerning energy efficiency. Electricity is not directly consumed but is derived from the type and extent of energy-using appliances and services in the home. These include water-heating systems, lighting, space-heating systems, cooling, cooking and other electrical appliances. Therefore, to provide an understanding of the factors underlying electricity use in the home, it is essential to identify the characteristics of households with greater levels of possession of electrical appliances. For example, all else being equal, a house with more appliances is expected to use more electricity than those with fewer appliances.

Table 5.12 in the previous chapter provided information on the rate of possession of electrical items across all sample households that a total of 19 major electrical appliances are used. Majority of homes possess a fridge, fan, laptop, rice cooker, electric iron and water heater. About half of the homes in the sample total possess a TV, washing machine and desktop. Households in Kohima have higher levels of possession of TV, CD player, desktop, printer, water heater and room heater. On the other hand, households in Dimapur have significantly higher levels of possession of fridge, fan, water pump, water boiler, induction cooktop and mixer grinder.

This section will focus on identifying those households with higher or lower levels of possession of electrical appliances by applying the Poisson model – equation (1.3) as given in Chapter 1. A variable representing the number of electrical items possessed by a household is constructed for each household using the nineteen items in Table 5.12. This variable is then regressed on a range of socio economic and dwelling characteristics. It is to be noted that the location variable is included for this analysis to take into account the difference between the sample areas and hence no separate analysis for the areas is performed. Also, number of children and adults are separated from household size in order to identify the effect of each group on the dependent variable. It is also important to stress that the analysis does not take into account the level of energy efficiency of an appliance which could plausibly be influenced by the income of a household. A brief discussion on energy efficiency will be given in chapter 7. The following section presents the results

6.4.1 Results of Possession of Electrical Appliances Model

Table 6.6 highlights the results of the analysis of determinants of the possession of electrical appliances, estimated using the Poisson regression method. The coefficients are given as incidence rate ratios (IRR). A variable with an estimated coefficient above one is positively related to the dependent variable, while the opposite is true for a coefficient less than one. The greater the difference, either above or below one, the greater the magnitude of the positive/negative effect. Also, results for a sub-sample of households who possess 9 electrical items or less are presented to assess the sensitivity of the results. The rationale for picking 9 electrical items or fewer is based on the fact that the majority of households have between 10-12 electrical appliances. So estimates from this model will represent households with a level of electrical appliances which is below the norm. In both models, the Likelihood Ratio test for over-dispersion indicated that the Poisson regression is the best fit for the data (Mean = Variance, χ^2 test statistic = 0.00 and p = 1.000 for both models).

The results showed evidence of difference in the expected level of possession of electrical appliances between the two study areas. Compared to the omitted category, i.e., Dimapur, appliance possession is lower in Kohima. Those households with lower levels of electrical appliances include those with older or unemployed household heads and those households residing in rented accommodations. The households with more electrical appliances include those that are headed by females, having higher educational qualifications with more adults and living in houses with more rooms. Income also has a positive effect on appliance possession. Quantifying this, a ₹10,000 increase in total household income increases the expected level of electrical appliances by 1.7% in the aggregate sample households.

Table 6.6: Poisson Regression Results for Number of Stock of Electrical Appliances

Variable	19 Electrical Appliances (or less)			9 Electrical Appliances (or less)		
	Coeff.	Std. Err.	IRR	Coeff.	Std. Err.	IRR
Location - Kohima	-0.147***	0.038	0.863	-0.101***	0.012	0.904
Gender - Female	0.034	0.022	1.034	0.026**	0.013	1.027
Age of HoH	-0.025**	0.012	0.975	-0.037**	0.016	0.964
No. of children (<18 years)	-0.004	0.008	0.996	-0.007	0.009	0.994
No. of adults (>18 years)	0.044**	0.021	1.045	0.028**	0.013	1.029
Education of HoH	0.016***	0.004	1.017	0.028***	0.009	1.029
Work - Retired	0.061	0.035	1.062	0.070	0.117	1.072
Work - Self-employed	0.136	0.109	1.145	0.153	0.163	1.165
Work - Unemployed	-0.061***	0.012	0.941	-0.051***	0.015	0.951
Ownership - Rent	-0.043***	0.012	0.958	-0.052***	0.013	0.950
No. of rooms	0.044***	0.015	1.045	0.053***	0.018	1.055
Income	0.016**	0.007	1.017	0.026**	0.009	1.027
Constant	1.705***	0.042		1.341***	0.067	
LR χ^2 statistic	176.452***			78.23***		
Pseudo R^2	0.102			0.043		
Log-Likelihood	-2524.56			-879.43		
No. of observations	621			302		

Note: 1) Number of children and adults are separated from household size in order to identify the effect of each group on the dependent variable.
2) Significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

The results are very similar for the sub-sample of households with only 9 electrical appliances (or less) in terms of significant coefficients. However, differences in the value of the coefficients are apparent. For households with an older head or higher education, those residing in rented accommodations with lesser rooms and lower income, the effect level is smaller in the full sample model with 19 appliances (or less). Therefore, it can be seen from the table that in the full sample model, having an older head of household reduces the expected level of electrical appliances by 2.5%. In contrast, for the sub-sample of households with only 9 electrical appliances (or less), the expected reduction is 3.6%. Putting it differently, if the age of household head were to increase by one year, the rate ratio for appliance possession would be expected to decrease by a factor of 0.975 for the full sample while for the sub-sample, the expected decrease in the rate ratio would be 0.964, while holding all other variables constant. Likewise, staying in rented accommodation reduces the expected level of electrical appliances by 4.2% in the full sample model, while in the sub-sample model, it is 5%. On the other hand, household heads having higher educational qualification increases the expected level of electrical appliances in the full sample model by 1.7%, whereas it is 2.9% in the sub-sample model. Similarly, larger houses represented by the number of rooms, increase the expected level by 4.5% and 5.5% respectively, in the two models.

For all other significant coefficients, i.e., location, gender, number of adults and unemployed household heads, the effect size is larger for the full sample of households. Of these, gender and number of adults represent positive influences, and for location and unemployed, it is negative. Therefore, a larger number of adults increase the expected level of electrical appliances by 4.5% and 2.9% respectively, in the full and sub-sample models. Regarding location, the expected level decreases in households located in Kohima by 13.7% in the full sample model and 9.6% in the sub-sample model. Additionally, having female household heads increase the expected level by 2.7% in the sub-sample model. In other words, households headed by females are expected to have a rate 1.027 times greater for appliance possession than male-headed ones, while holding the other variables in the model constant. For the full sample, the expected level of electrical appliances for households with unemployed heads is 5.9% less than one with salaried heads (reference category), whereas, it is 4.9% in the sub-sample model. The income effect is more significant in the sub-sample model. For the sub-sample model, an increase in annual household income by ₹10,000 increases the expected level of electrical appliances by 2.7% against 1.7% in the full sample model.

6.5 AN ANALYSIS OF HOUSEHOLD CHOICE OF FUEL FOR COOKING

The theory of consumer behavior can describe household energy use. This theory proposes that a rational consumer will always choose the most preferred bundle of a set of feasible alternatives (Varian, 2019). Households in the study area rely on different types of fuels simultaneously. A household may use electricity for lighting, whereas the same household may use firewood, kerosene or LPG, or a combination of some of these for cooking. Therefore, for cooking purpose, households decide on the types of fuels they will use based on factors such as socio economic, affordability, accessibility, cultural, tastes and preferences.

Whereas all the households in the study area have access to LPG, and despite the adverse effects associated with the use of firewood on health and the environment, many still use firewood as a secondary fuel for cooking. This section aims to determine the factors influencing the choice of households for firewood for cooking which is a solid fuel. To account for the simultaneity in choosing and using fuels for cooking, a binary logistic regression (equation 1.4 given in chapter 1) is used in elucidating the choice of fuels by urban households in the sample areas. For the purpose of the study, the cooking fuels are categorized into two types: a mix of solid fuel (firewood) and non-solid fuels which include electricity, LPG and kerosene; and non-solid fuels only. This binary dependent variable is regressed on the explanatory variables given in Table 6.1.

6.5.1 Results of Household Choice of Cooking Fuel Model

This section contains the findings of the study on the household choice of fuel for cooking which include results of the regression analysis and interpretation of the results. The results from the estimation of the binary logistic regression are presented in Table 6.7. Out of twelve variables in the model, seven of the explanatory variables have significant effects and show the expected signs. The results clearly show that there are a number of factors influencing the choice of household cooking fuels in urban Nagaland.

The full model containing all predictors was statistically significant: χ^2 = 81.343, $p < .001$, indicating that the model was able to distinguish between households that use a mix of solid fuel with non-solid fuels and those that use only non-solid fuels for cooking. The Hosmer & Lemeshow test provides a second global fit test, testing the 'estimated model to one that has perfect fit' (Pituch & Stevens, 2016, p. 455). The statistically insignificant Hosmer and Lemeshow [$\chi^2(12) = 9.112$, p=0.333] indicates adequate fit of the model.

As shown in Table 6.7, seven of the independent variables made a unique statistically significant contribution to the model. Income, education and appliance stock do not affect solid fuel use. The strongest predictor in the model was house ownership, recording an odds ratio of 0.562. This indicated that households residing in rented accommodations were 0.562 times less likely to use solid fuel than those who reside in their own house, controlling for other variables in the model. In other words, the odds of using solid fuel decrease by 43.8% for rented householders. Gender was the second most significant predictor of the probability of choosing a clean fuel source. The coefficient for female household heads was negative, indicating that for female-headed households, the odds of using solid fuel decrease by 41.4%.

Table 6.7: Binary Logistic Regression Results for Choice of Fuels

Variable	β	Std. Err.	Odds Ratio
Location - Kohima	0.403**	0.188	1.496
Gender - Female	-0.534**	0.274	0.586
Age of HoH	0.031***	0.007	1.032
Household size	0.108***	0.048	1.081
Education of HoH	-0.021	0.021	0.979
Work status of HoH - Retired	0.015	0.275	1.015
Work status of HoH - Self-employed	-1.026**	0.399	0.059
Work status of HoH - Unemployed	-0.137	0.379	0.872
Ownership - Rent	-0.576**	0.235	0.562
No. of rooms	-0.212***	0.025	0.809
No. of appliances	-0.015	0.021	0.985
Income	-0.002	0.036	0.998
Constant	-3.351***	2.218	0.026
Prob>$\square^2$ 0.000		LR $\square^2$ (12)	81.343
Pseudo R^2 0.238		Log Likelihood	-666.368
Goodness-of-fit test			
H-L statistic $\square^2$ (12, N = 621) = 9.112, p = 0.333			
Percentage of correct prediction of the model: 71.7			

Note: Significance at the 5% and 1% levels are indicated by ** and *** respectively.

Older household heads are more likely to choose solid fuel by a factor of 1.032. In other words, an increase in a year of age of the household head increases the odds of using solid fuel by 3.2%. Furthermore, staying in a higher altitude area increases the odds of using solid fuel by 49.6% and an additional person in the home is expected to increase the chance of using firewood by 8.1%. The negative coefficient for number of rooms indicates that for each increase in an additional room, a decrease of 0.809 is expected or is associated with a decrease of 19.1% in the chance of choosing solid fuel, keeping other variables constant. Households with self-employed heads are also less likely to use firewood compared to those with salaried heads.

6.6 AN ANALYSIS OF ENERGY-SAVING BEHAVIOUR IN HOUSEHOLDS

The household sector is one of the main consumers of energy in almost every country of the world. It is an undeniable fact that the behavior and lifestyles of individuals at home are very closely related to various energy demands. Households are similar to each other in many respects, but their energy use may differ a lot (Gram-Hanssen, 2014). Household energy consumption can depend on numerous socio economic and dwelling factors such as household size, income, gender, age, appliances, house area, or work status of the household head. However, besides these factors, the energy-saving behavior of individuals is also important in influencing household energy consumption. The behavior of individuals plays a big part as they have direct control over their actions, decision-making and interventions made regarding energy use in their homes.

In order to achieve a sustainable energy system in the future, it is important to reduce the energy consumption of society which can be realized by improving energy efficiency and changing consumption behavior. Accordingly, energy-saving behavior has been classified into efficiency and curtailment (Barr et al., 2005), which implies actions that aim to reduce energy consumption and the negative impact on the environment. Efficiency-related behavior includes the acquisition of energy-efficient technologies. This type of behavior substitutes capital for energy and involves one-time purchase decisions, which are associated with an initial financial expense and a potential for future savings. On the other hand, curtailment behavior focuses on reducing energy use in everyday life (Barr et al., 2005), such as by switching off lights when leaving a room. This type of behavior is made on an everyday basis which involves frequent efforts and often results in discomfort for the person performing the behavior (Jansson et al., 2010).

Therefore, energy consumption in households can be affected by the energy-saving behavior of consumers by investing in energy-efficient technologies or by undertaking energy-conservation activities. Kahnemann and Tversky (1979), who laid the foundations for behavioral economics, suggested that long-term investment decisions are governed by rational decision-making while habitual patterns are intuitive in nature and driven by different decision-making processes. Efficiency is considered the easier one-time effort, while conservation is considered a continuous effort that is hard to maintain (Spandagos et al., 2020). Moreover, energy saving involves a trade-off between short and long-term outcomes (Enzler et al., 2019). For instance, purchasing an energy-efficient refrigerator or air conditioner results in lower energy costs and helps protect the environment in the long run, although it involves a higher initial cost. However, consumers often do not always perceive it as associated with energy efficiency and when not used properly, can lead to increased energy consumption. Energy-saving decisions, dependent and independent variables and the results are discussed in the following sub-sections.

6.6.1 Energy-Saving Decisions

The two energy-saving behavior counterparts are different but are interlinked in their functions. As pointed out by Lopes et al. (2012), energy efficiency may not be fully achieved only by investing in technologies but also by the way they are used. Matsumoto, Mizobuchi and Managi (2022) also pointed out that the total amount of energy consumed is determined by how households use energy-consuming products. Moreover, people's energy decision-making process is driven by different objectives. These objectives can be either personal or altruistic. Economic or monetary objectives, such as aiming for energy bill reductions and comfort objective belong to the first category, where decisions are driven by the desire to maximize one's utility. On the other hand, the objective of protecting the environment or the altruistic objective belongs to the second category. Hence people not only consider the comfort and costs of energy-saving, but also moral aspects such as environmental conservation and impact on future generations (Oikonomou et al. 2009). Therefore, it is essential to examine the different objectives as the decisions related to these differ and the commitment also differs between the two counterparts as efficiency is considered a one-time action and conservation is a continuous effort.

Since efficiency and conservation are driven by different mechanisms, it is important to make a clearer distinction between the two in energy-saving from a policy perspective, as specific strategies might be effective towards encouraging changes in efficiency but not in conservation and vice-versa (Spandagos et al., 2020). This section, therefore, focuses on identifying the antecedents that underlie energy-saving behavior within households by examining the two main counterparts – efficiency and conservation from the point of environmental, monetary and comfort objectives of the consumers following Spandagos et al. (2020). Since these objectives affect energy-saving behavior, it looked into the determining factors of energy-saving behavior in terms of consumers' environmental, monetary and comfort objectives.

6.6.2 Dependent Variables

The dependent variables include the environmental, monetary and comfort objectives during energy management decisions. The environmental objective is to protect the environment, whereas the monetary objective is to secure household finance, and the comfort objective is to maintain personal comfort of the consumers. These objectives are evaluated using five Likert-type questions where each question is related to a different type of objective related either to efficiency or conservation. The respondents were provided response options with 5-point Likert scale, coded as 'Strongly disagree' = 1, 'Disagree' = 2, 'Moderately agree' = 3, 'Agree' = 4 and 'Strongly agree' = 5. The various objectives relating to energy-saving decisions and the corresponding statements are given as follows:-

(i) Environmental objective during an efficiency decision (ENV_e) = I have a responsibility to save the environment/energy by using energy-efficient technologies.

(ii) Environmental objective during a conservation decision (ENV_c) = I believe if my household adopts some energy-saving practices, it would have a positive effect on the environment.

(iii) Monetary objective during an efficiency decision (MON_e) = I only buy appliances with high energy efficiency ratings even if they cost more.

(iv) Monetary objective during a conservation decision (MON_c) = I primarily pay attention to energy conservation in the house to achieve a reduction in electricity bills.

(v) Comfort objective during an efficiency decision (COM_e) = I do not feel good when energy is consumed unnecessarily in the house.

(vi) Comfort objective during a conservation decision (COM_c) = I want to enjoy life without giving a thought on energy conservation. This statement is negatively-phrased, therefore, the scale is reversed coded to match the others for analysis.

6.6.3 Independent Variables

The independent variables considered in the analysis include personal capabilities, awareness/knowledge, psychological traits and habits which are given as:-

(i) Personal characteristics and capabilities are represented by income, age, education, gender and household size;

(ii) Awareness/knowledge is represented by environmental awareness which is assumed to be a significant driver for energy-saving actions where respondents were asked 'Are you aware that inefficient use of appliances has negative effects on the environment?' with response option provided as 'Yes' or 'No';

(iii) Psychological traits are represented by discussion with others about energy efficiency issues which is related to the establishment of social connection where respondents were asked ''Do you discuss with your friends or neighbours about the benefits of energy efficiency or related issues?' with response option provided as 'Yes' or 'No'; and

(iv) Habits are represented by the habitual behaviour of the individuals in daily activities where respondents were asked 'How often do you behave on this? - Leaving lights on when not in use at home' with response options using 5-point Likert scale, coded as 'Always' = 1, 'Often' = 2, 'Sometimes' = 3, 'Hardly' = 4 and 'Never' = 5.

(v) Location is also included in order to know the difference in effect of behavior between the sample areas.

Individuals exhibiting high environmental awareness or well-educated are assumed to practice pro-saving activities in their routine intentionally; those with more interpersonal connection as in psychological trait; and, also the lifestyle and consumers' daily habits are expected to impact energy-saving and consumption.

6.6.4 Measurement of Variables and Descriptive Statistics

The summary of descriptive statistics is presented in Table 6.8. Majority of the respondents were male (52%), having an average age of 35.48 years and mostly having a graduate degree. As for awareness/knowledge, 86% of the respondents expressed that they are aware of the negative impact of inefficient use of appliances. In addition, about 72% of the respondents identified themselves to discuss with others about the benefits of purchasing appliances that ensure energy efficiency. Regarding habitual behavior, 53% declared they do not leave lights on in the house when not in use.

Table 6.8: Descriptive Statistics

	Mean	SD	Minimum	Maximum
ENV_e	4.17 (0)	0.65 (1)	2 (-3.34)	5 (1.27)
ENV_c	4.38 (0)	0.69 (1)	2 (-3.46)	5 (0.89)
MON_e	3.49 (0)	0.85 (1)	2 (-1.76)	5 (1.77)
MON_c	3.87 (0)	0.82 (1)	2 (-2.28)	5 (1.37)
COM_e	4.10 (0)	0.98 (1)	1 (-3.17)	5 (0.91)
COM_c	4.05 (0)	0.91 (1)	1 (-3.35)	5 (1.04)
Gender (Female)	0.48	0.50	0	1
Age	35.48	12.26	15	78
Education	16.37	3.88	0	20
Household size	4.61	1.79	1	10
Income (in ₹10,000s)	6.18	2.86	1	24
Location (Kohima)	0.47	0.50	0	1
Awareness/knowledge	0.86	0.34	0	1
Discussion	0.72	0.45	0	1
Habit	3.67 (0)	0.99 (1)	2 (-1.68)	5 (1.35)

Note: Figures in brackets are the statistics for the standardized version of the variables.

Table 6.8 also reveals the mean values of environmental, monetary and comfort objectives in terms of the values assigned by the respondents for efficiency and conservation behaviors. The respondents assign a value of 3 and above to the environmental, economic and comfort objectives for both energy behaviors. The mean value for ENV_c is 4.38, which is 5% higher than the corresponding value for ENV_e

(4.17). A similar trend is observed for monetary objectives, where the average value for MON_c (3.87) is 11% higher than for MON_e (3.49). On the other hand, the scores for COM_c (4.05) are lower than the ones for COM_e (4.10) by 1%.

For a clearer understanding of the observations, the distribution among the respondents of the Likert score (1-5) assigned to the three objectives for both behaviours is illustrated in Figures 6.1 and 6.2. It can be seen from the figures that the respondents assign a higher value to the objectives that affect conservation compared to the ones that affect efficiency. In both efficiency and conservation, the environmental objective is identified as the most important, followed by comfort and monetary objectives. By analyzing the distribution of scores between 4 and 5 regarding efficiency, the results indicate that 88.6% of the respondents assigned them to ENV_e, 49% to MON_e and 80.3% to COM_e. On the other hand, regarding conservation, 91.6% of the respondents assigned scores between 4 and 5 to ENV_c, while 63.6% and 82% did so for MON_c and COM_c respectively.

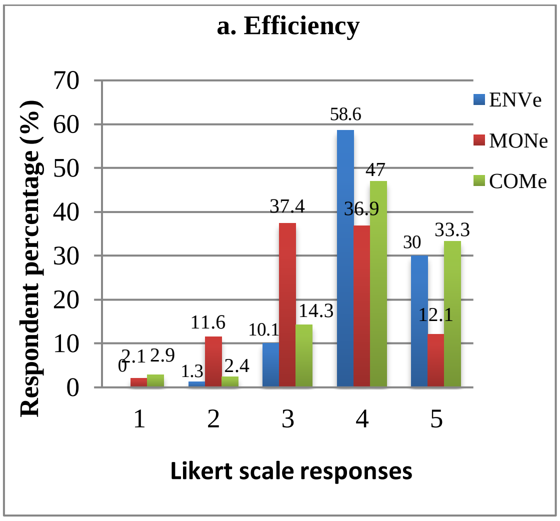


Figure 6.1: The Distribution of the Scores of Objectives in Energy Efficiency Behaviour (ENV_e, MON_e and COM_e) among the Respondents.

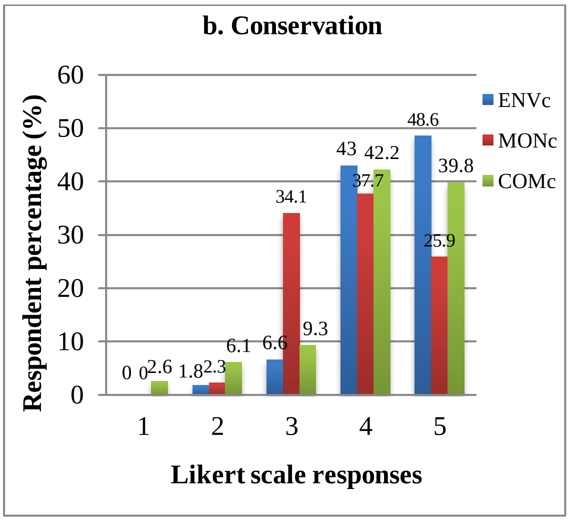


Figure 6.2: The Distribution of the Scores of Objectives in Energy Conservation Behaviour (ENV_c, MON_c and COM_c) among the Respondents.

6.6.5 Regression Results on Energy-Saving Behavior

Multi-linear regression is used to estimate the influence of the energy-saving behavior of consumers. The standardized version (z-scores) of the dependent variables is used for analysis. The dependent variables are originally on different scales, ranging from 1 to 5 for efficiency and conservation. In order to facilitate further interpretation of the results, the independent variable on habit was also standardized. Z transformation converts separate distributions into standardized distributions, allowing the comparison of dissimilar metrics (Allen, 2017). These variables do not follow a normal distribution, however, the fact that the number of observations N is large allows for linear regression to be applied (Pek, Wong & Wong, 2018).

The regression results are presented in Table 6.9. Environmental awareness and habit are identified as the major factors influencing all three objectives relating to efficiency. In addition, relating to efficiency, psychological trait also influences both the environment and monetary objectives, whereas household size influences the comfort objective. On the other hand, pertaining to conservation; the environmental objective is explained by gender, education, household size, knowledge and habit; the monetary objective is explained by household size, income, location and habit, and; that of the comfort objective is explained by gender, age and knowledge. This highlights the difference between the factors influencing efficiency and those influencing conservation.

Table 6.9: Regression Result on Energy-Saving Behavior

Variable	ENV_e	ENV_c	MON_e	MON_c	COM_e	COM_c
Gender	-0.05	0.37**	0.04	0.01	0.11	0.19*
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Age	-0.01	0.01	0.01	-0.01	0.01	-0.01**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Education	0.01	0.03*	0.04**	0.01	0.01	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
HH size	-0.01	0.07**	-0.03	0.07**	-0.06*	0.02
	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)
Income	0.03	0.02	0.08**	-0.05*	0.02	0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Location	-0.14	-0.10	-0.09	0.23*	-0.10	0.03
	(0.10)	(0.09)	(0.09)	(0.10)	(0.09)	(0.10)
Awareness/Knowledge	0.23**	0.22**	0.44**	-0.21	0.23*	0.38**
	(0.12)	(0.02)	(0.12)	(0.12)	(0.12)	(0.12)
Psychological trait	0.19*	0.13	0.39**	-0.03	0.06	0.05
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Habit	0.09*	0.08*	0.18**	0.14**	0.17**	0.05
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Constant	-0.24	-1.35**	-0.36	-0.71*	-0.91**	0.14
	(0.33)	(0.32)	(0.31)	(0.33)	(0.32)	(0.33)
R^2	0.04	0.09	0.14	0.06	0.11	0.06
Adjusted R^2	0.02	0.07	0.13	0.05	0.09	0.05

Note: Standard errors are in brackets. Significance at the 5% and 1% levels are indicated by * and ** respectively.

The results provide valuable insights into explaining the determining factors of energy-saving behavior. Personal characteristics and capabilities such as gender, age, education, household size and income; knowledge; psychological trait and habit shaped energy-saving behavior, from both efficiency and conservation perspectives. However, the extent of the impact of personal characteristics and capabilities is lesser than that of knowledge, psychological trait and habit. The findings suggest that people who are aware of the negative impact of using inefficient appliances, those who are more open to discussing energy-related issues with friends and neighbours and make simple daily conservation habits are more prone to make decisions to save energy by undertaking efficiency and conservation-related actions. In addition, the findings also reveal that females have more influence on environmental and comfort objectives relating to conservation than males. Older people are less influential than younger ones on the comfort objective relating to conservation. In other words, older people do not give much thought to conserving energy when making decisions relating to comfort. A higher level of education is also significantly related to environmental conservation and monetary efficiency. Also, larger families are more influential than smaller families on the environmental and monetary objectives relating to conservation but lesser influence on the comfort objective relating to efficiency. A higher level of income is also significant and positively influential on monetary objective relating to efficiency but negatively influences the objective relating to conservation. There is no significant difference in efficiency and conservation behaviors between the sample areas except that residents of Kohima (located at higher altitude) pay more attention to energy conservation at home to reduce electricity bill compared to those of Dimapur. From the above discussion, it is clear that energy-saving behavior of individuals is influenced by personal capabilities, knowledge, psychological trait and habit, thus proving the third hypothesis true. Therefore, the third hypothesis is accepted.

It is plausible that the importance of environmental objective for both behaviours – efficiency and conservation is significantly determined by environmental awareness and habit which indicate that the respondents who are most aware of the environmental effects of energy use are more likely to prioritize highly the environment and act upon it which is reflected by their habit at home. This creates room for optimism that when the environmental awareness levels are maintained in a society, the consumers' actions and sense of environmental responsibility can be increased.

6.7 IMPACT OF ENERGY-SAVING BEHAVIOUR ON ENERGY CONSUMPTION

The behavior and lifestyles of individuals at home are very much related to the energy demands of the households. Households being an important consumer of energy, it has great savings potential. The preceding sections have provided evidence that socio economic and dwelling factors influence household energy consumption. However, besides these factors, the behaviors of the individuals also significantly influence household energy consumption. This is because individuals have direct control over their actions, decision-making and interventions regarding energy use in their homes. This section, therefore, examines the impact of energy-saving behavior of individuals on household energy consumption. Electricity being the most widely used forms of energy in the homes for various purposes; hence, it is taken as a proxy of all the other types of energy in the analysis. The results and interpretation are provided in the subsequent section.

6.7.1 Estimated Results of Extended Energy Consumption Models

In order to assess the impact of energy-saving behavior on energy consumption, the electricity model in section 6.3 is extended to include the objectives relating to energy use decisions (which is named Model 2). It is then further extended by adding awareness, psychological trait and habit (Model 3). The models are given as:

$$\ln(Y) = \alpha + \beta_n X_n + \gamma_m W_m + \varepsilon \quad \text{[Model 2]} \qquad (6.1)$$

$$\ln(Y) = \alpha + \beta_n X_n + \gamma_m W_m + \lambda_p Z_p + \varepsilon \quad \text{[Model 3]} \qquad (6.2)$$

Where, X_n is a vector of the socio-economic and dwelling factors, W_m denote the three objectives of energy-saving behaviour relating to efficiency and conservation, Z_p denote the environmental awareness, discussion and habit of the individuals, β_n, γ_m and λ_p are the respective vector coefficients of X_n, W_m and Z_p, and ε is error term.

Naming the electricity model in section 6.3 as Model 1, the estimated results of the three models are presented in Table 6.10. It can be seen from the table that in Model 2, the environmental objective relating to efficiency and monetary objective relating to conservation are significant and negatively related to electricity consumption in the overall sample. This indicates that using energy-efficient technologies at home and paying attention to energy use to reduce electricity bills contribute to lower electricity consumption, which is not unexpected. However, the individual analysis of the study areas shows mixed patterns; while Dimapur exhibits a similar pattern to the overall analysis, comfort objective relating to conservation is also significantly related to the dependent variable. On the other hand, in Kohima while both monetary and comfort objectives relating to efficiency are significantly related to the dependent variable, the impact of comfort objective is negative but that of monetary objective is positive. The negative coefficient of comfort objective indicates that altruistic behavior is linked with other personal norms, which leads to lesser use of energy at home.

The positive relationship of monetary objective relating to efficiency could be because of the rebound effect, which results from an imbalance relationship between efficiency and conservation. In this case, efficiency makes an energy-consuming technology cheaper; therefore, consumers use it more often and/or spend the remaining savings on other products. Therefore, future policy measures should also target instilling efficient energy consumption behavior among the consumers to match with the use of efficient technologies. Model 2 explains about 55%, 61% and 53% of electricity consumption in the overall, Kohima and Dimapur, respectively.

In Model 3 where environmental awareness, discussion and habit are added, the results show that awareness and habits are significantly related to the dependent variable. The negative relationship between individual awareness and electricity consumption indicates that the individuals' environmental knowledge might contribute to the decisions that reduce electricity consumption. The same relation is also seen in the sub-sample models. The significant relationship between habit and the dependent variable also indicates that the simple daily habit of individuals relating to switching off lights in the rooms when not in use results in lower electricity consumption, as indicated by the negative coefficients which is exhibited in all the models. Model 3 explains about 57%, 64% and 55% of per capita electricity consumption in the overall, Kohima and Dimapur, respectively. Thus it can be inferred from Models 2 and 3 that the energy-saving behavior of individuals has a significant negative relationship with household energy consumption. Hence, the fourth hypothesis, which states that energy-saving behavior has impact on energy consumption, is accepted.

Table 6.10: Results from Regression Models of Electricity Consumption (kWh)

Variable	Overall			Kohima			Dimapur		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Gender of HoH: Male (ref.)									
Female	0.067***	0.073***	0.069***	0.079**	0.066**	0.065**	0.084	0.085	0.077
	(0.021)	(0.021)	(0.020)	(0.029)	(0.025)	(0.024)	(0.063)	(0.060)	(0.059)
Age of HoH	0.003**	0.003**	0.004**	0.005**	0.005**	0.003**	0.005**	0.004**	0.004**
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
Household Size	-0.093***	-0.101***	-0.108***	-0.026***	-0.029***	-0.022***	-0.075***	-0.101***	-0.120***
	(0.019)	(0.019)	(0.020)	(0.006)	(0.006)	(0.004)	(0.014)	(0.023)	(0.024)
Education of HoH	0.010**	0.010**	0.007*	0.004	0.004	0.003	0.018**	0.010	0.005
	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.004)	(0.006)	(0.006)	(0.006)
Work Status of HoH: Salaried (ref.)									
Retired	0.035***	0.037***	0.035***	0.043**	0.051**	0.055**	0.084**	0.099**	0.082**
	(0.011)	(0.011)	(0.010)	(0.014)	(0.018)	(0.018)	(0.034)	(0.037)	(0.036)
Self-employed	-0.043	-0.046	-0.049	-0.016	-0.011	0.022	-0.020	-0.046	-0.067
	(0.047)	(0.046)	(0.045)	(0.071)	(0.071)	(0.069)	(0.063)	(0.060)	(0.060)
Unemployed	0.090	0.081	0.045	0.085	0.095	0.087	0.088**	0.064**	0.062**
	(0.054)	(0.054)	(0.054)	(0.070)	(0.069)	(0.068)	(0.028)	(0.027)	(0.027)
Ownership: Own (ref.)									
Rent	-0.044**	-0.045**	-0.047**	-0.067**	-0.059**	-0.061**	-0.032***	-0.035***	-0.034**
	(0.016)	(0.016)	(0.016)	(0.024)	(0.023)	(0.024)	(0.009)	(0.010)	(0.009)
No. of rooms	0.017***	0.018***	0.019***	0.013***	0.015***	0.015***	0.027***	0.029***	0.031***
	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)
No. of appliance	0.020***	0.022***	0.022***	0.036***	0.043***	0.045***	0.015***	0.014***	0.015***
	(0.003)	(0.002)	(0.002)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)

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Variable	Overall			Kohima			Dimapur		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Income	0.028*** (0.006)	0.031*** (0.006)	0.034*** (0.006)	0.022* (0.008)	0.021* (0.008)	0.021** (0.008)	0.029** (0.009)	0.036*** (0.008)	0.039*** (0.008)
ENVe		-0.060*** (0.015)	-0.059*** (0.014)		-0.020 (0.021)	-0.030 (0.020)		-0.079** (0.022)	-0.070** (0.022)
ENVc		0.004 (0.015)	0.004 (0.014)		0.020 (0.020)	0.029 (0.020)		0.001 (0.021)	0.001 (0.021)
MONe		0.016 (0.014)	0.020 (0.015)		0.072*** (0.020)	0.080*** (0.020)		-0.025 (0.023)	-0.021 (0.023)
MONc		-0.051*** (0.014)	-0.053*** (0.014)		-0.010 (0.020)	-0.002 (0.020)		-0.079*** (0.020)	-0.090*** (0.019)
COMe		-0.026 (0.015)	-0.019 (0.015)		-0.049* (0.021)	-0.041* (0.020)		0.015 (0.021)	0.014 (0.021)
COMc		-0.025 (0.015)	-0.023 (0.015)		0.015 (0.021)	0.021 (0.021)		-0.038** (0.021)	-0.063** (0.021)
Awareness			-0.027* (0.013)			-0.057** (0.020)			-0.049* (0.020)
Discuss			-0.025 (0.031)			-0.048 (0.042)			-0.023 (0.045)
Habit			-0.139** (0.042)			-0.139** (0.046)			-0.205** (0.065)
Constant	6.093*** (0.081)	6.113*** (0.081)	6.225*** (0.090)	6.177*** (0.113)	6.151*** (0.110)	6.232*** (0.119)	5.984*** (0.122)	6.183*** (0.126)	5.997*** (0.137)
Observations	621	621	621	294	294	294	327	327	327
Adjusted R^2	0.523	0.551	0.565	0.582	0.613	0.636	0.463	0.526	0.545
F statistic	82.722***	53.158***	46.504***	49.938***	32.756***	29.791***	34.686***	25.803***	23.021***

Note: Standard errors are in brackets; Significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

6.8 CONCLUSION

This chapter comprehensively analyses the relationship between the quantity of energy consumed, stock of electrical appliances, cooking fuel choice and energy-saving behavior in urban households in Nagaland and a range of household and dwelling characteristics. The first analysis looked at the effect that household socio economic and dwelling characteristics have on household energy consumption. One of the important findings is the importance of household size on energy consumption. Household size had a positive influence on LPG, firewood and overall energy, while its influence on electricity, kerosene and charcoal is negative. A number of variables are significant in the electricity and overall energy models, suggesting that electricity is an important component of household energy. Also of interest is that households residing in rented accommodations consume less electricity and overall energy. Other important explanatory variables include gender, age, education and working status of household head with female-headed households using more electricity and overall energy, older-headed households using more electricity, firewood and overall energy, the less educated using more firewood, and those retired using more electricity, firewood and overall energy.

Section 6.4 analysed the characteristics of households that affected the level of possession of electrical appliances. The results suggest that households with higher levels of electrical appliances include those of Dimapur (living in area with higher temperature), those headed by females and having higher education level, who live in houses with more number of rooms and those with higher income. Those households with lower units of electrical appliances include those households living in Kohima (colder climate), those with older household head and household heads who are unemployed and those that are residing in rented accommodation. Further, the study provided a comparison with results for a sub sample of households with less than average level of appliances and found that location had the largest negative change in the coefficients while number of adults in the home, education and income had the largest positive changes in the coefficients.

In section 6.5, the results of binary logistic regression analysis show the effect of the explanatory variables on the likelihood of households' choice of firewood for cooking purpose. Households more likely to use solid fuel include those with having older heads, living in higher altitude places and houses with more rooms. On the other hand, households less likely to use solid fuel include smaller families, female-headed ones, those residing in rented accommodations and self-employed household heads.

Personal characteristics and capabilities such as gender, age, education, household size, income and number of appliances; knowledge; psychological trait and habit shaped the energy-saving behavior of individuals. However, the extent of impact of personal characteristics and capabilities is lesser than that of knowledge, psychological trait and habit. Individuals' environmental, monetary and comfort objectives in energy management decisions, particularly the three objectives of efficiency and monetary and comfort relating to conservation significantly impact energy consumption. Awareness and habits are also significantly related to energy consumption, indicating that the individuals' environmental knowledge and the simple daily habit of individuals might be contributing to making decisions that reduce electricity consumption.

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CHAPTER 7

ATTITUDES OF THE URBAN HOUSEHOLDS TOWARD ENERGY CONSUMPTION AND SAVING

7.1 INTRODUCTION

Household energy consumption is also assumed to depend on residents' attitudes towards energy consumption and saving in the home. Therefore, limited knowledge on these might mislead policy makers and tend to make wrong decisions and provide inefficient strategies for encouraging households to save energy. This chapter attempts to understand and address this issue which is divided into three sections. The first section is an assessment of the attitudes toward energy sources and uses by urban households. In the second section, an attempt is made to examine the adoption of energy-saving practices and energy-efficient technologies at the household level in urban areas. The third section focuses on households' energy expenditure and its relationship with income.

7.2 HOUSEHOLD ATTITUDES TOWARDS ENERGY SOURCES AND USES

The attitudes of the households toward energy sources and uses may vary across different locations depending on the availability and accessibility to fuels. This section examines the attitudes of urban households in this regard to understand the factors responsible for a household's decision to use a particular fuel for specific purposes. Focus is made on the attitude of the households towards two important end uses of energy sources, namely, cooking and lighting.

7.2.1 Attitude towards Energy Used for Cooking

A household's choice of fuel for particular end use is influenced by a number of factors, varying from the availability of the fuel, efficiency and tradition. The various reasons for households' choice of fuel for cooking purposes are given in Table 7.1. In both the sample areas, among the households using electricity for cooking, the most important reasons are affordability and efficiency, followed by time-saving, easy availability and cleanliness. Households use LPG for reasons like easy availability, affordability, efficiency, cleanliness and time-saving. Among these, efficiency and cleanliness are the most important reasons in both the study areas.

For firewood, the most important reason is specific cooking purpose and tradition in both Kohima and Dimapur. It is revealed in the table that 58 households in Kohima and 50 households in Dimapur use firewood for certain culinary purpose and the tradition associated with its use. Other major reasons for using firewood in Kohima are easy and free availability. This may be because Kohima town is in the vicinity of forest where households procured firewood from their own forest land. In Dimapur also, easy availability is one of the important reasons for using firewood. The important reasons for using kerosene are easy availability, affordability and efficiency of the fuel in both the study areas. It may be noted that some of the households use kerosene as a fuel for starting fire (with firewood) rather than for cooking.

From the above discussion, it can be inferred that the reasons for using modern fuels are easy availability, affordability, efficiency, cleanliness and time-saving, whereas for traditional fuel, it is attributed to easy and free availability and tradition.

Table 7.1: Reasons for Choice of the Cooking Fuel (No. of Households)

Reason	Kohima				Dimapur			
	ELE	LPG	FW	KER	ELE	LPG	FW	KER
Easy availability	61	46	43	9	64	47	34	12
Free availability	-	-	45	-	-	-	14	-
Affordability	107	55	18	22	120	81	20	13
Efficiency	101	123	-	18	84	138	-	7
Specific cooking/Tradition	-	-	58	-	-	-	50	-
Cleanliness	27	95	-	-	40	154	-	-
Time-saving	80	47	-	-	71	39	-	-

Source: Household Survey, 2016-17.
Note: Households were allowed to provide more than one reason; ELE = Electricity, FW = Firewood and KER = Kerosene. Charcoal is excluded since no household use it for cooking.

7.2.2 Attitude towards Energy Used for Lighting

Electricity is the most commonly used energy for lighting in urban households. There are five common types of lighting fixtures used in households, namely, incandescent light bulbs (ILBs), halogen lamps, tubular fluorescent lamps (TFLs), compact fluorescent lamps (CFLs) and light-emitting diode lamps (LEDs). Energy efficient lights are replacing the inefficient ones as a result of the efforts of the government in the past decade[1]. Of these, CFL users are the highest in the aggregate sample (82.29%), followed by LED users (49.28%) and TFL users (37.20%). Similarly, in both the sample areas, CFL users are the highest (80.61% and 83.79% in Kohima and Dimapur, respectively). In Kohima, it is followed by TFL users (44.56%) and LED users (38.78%), and in Dimapur, it is followed by LED users (58.72%) and TFL users (30.58%). The users of CFL and LED are higher in Dimapur as compared to Kohima. On the other hand, users of TFL, ILB and halogen lamps are higher in Kohima.

Table 7.2: Types of Lights Used in Homes (% of Households)

Type of light	Kohima	Dimapur	All
ILB	19.73	8.56	13.85
Halogen lamp	11.56	5.50	8.37
TFL	44.56	30.58	37.20
CFL	80.61	83.79	82.29
LED	38.78	58.72	49.28

Source: Household Survey, 2016-17.
Note: Most households use more than one type of light in their homes.

7.2.1a Alternate energy sources for lighting among urban households: Households used different types of alternative energy sources during power outages. Among the alternative sources, inverter is most commonly used in the urban households, followed by solar light, and battery and chargeable light. It can be seen in Table 7.3 that inverter is used in 52.13% of total sample households, solar light in 25.96% of households, whereas battery and chargeable light is used in 25.17% of the households. In Kohima, solar light is the most common alternate source (40.05%), followed by inverter (30.42%), and battery and chargeable light (28.38%). On the other hand, in Dimapur inverter is the most common alternate source used by majority of the households (75.50%), followed by battery and chargeable light (23.50%). Candle is the least common alternate energy source for lighting in both study areas (11.14% in Kohima and 10.40% in Dimapur).

[1] In 2009, the Bureau of Energy Efficiency (BEE) launched Bachat Lamp Yojana (BLY) to support the adoption of compact fluorescent lamps (CFLs). In 2015, the Government of India also launched the Unnat Jyoti by Affordable LEDs for All (UJALA) scheme.

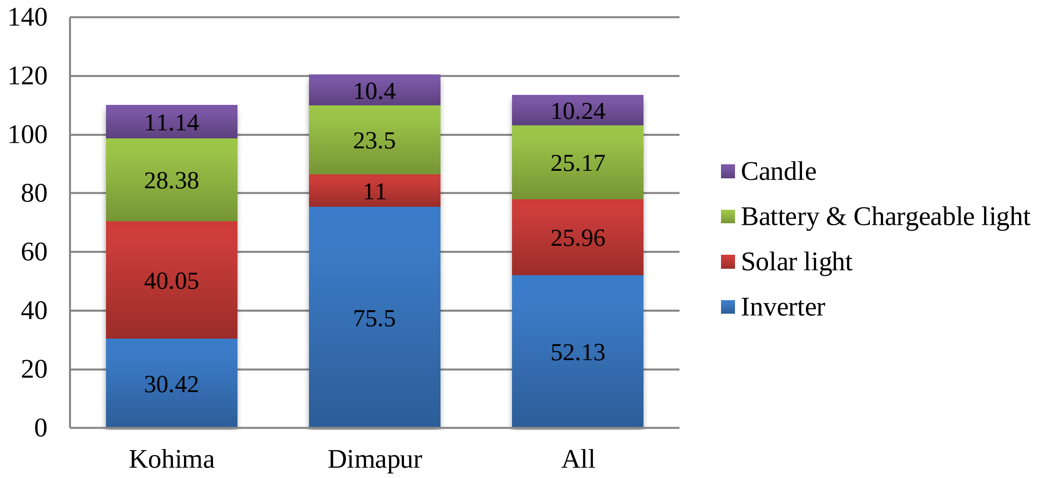
Table 7.3: Alternative Energy Sources for Lighting (% of Households)

Source	Kohima	Dimapur	All
Inverter	30.42	75.50	52.13
Solar light	40.05	11.00	25.96
Battery & Chargeable light	28.38	23.50	25.17
Candle	11.14	10.40	10.24

Source: Household Survey, 2016-17.

Note: Some households use more than one alternative source of lighting.

Figure 7.1: Percentage of Households Using Various Alternative Energy Sources for Lighting



Source: From Table 7.3.

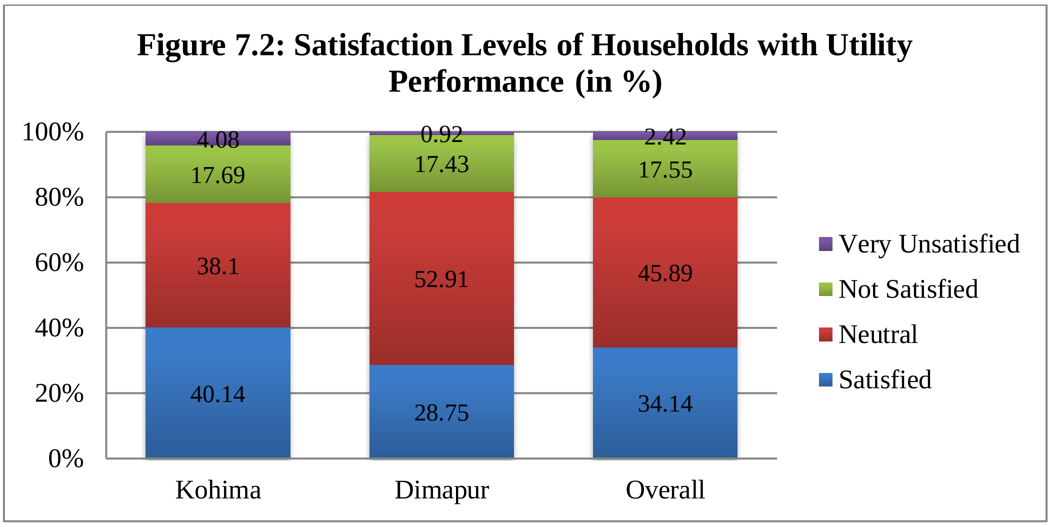
7.2.2b Household satisfaction with grid electricity: The satisfaction levels of electricity users in the study areas are provided in Table 7.4. It can be observed from the table that 34.14% of the aggregate electricity users are satisfied with the utility service, 20% are not satisfied and 45.89% are neutral in their opinion. The study areas, however, show different satisfaction levels. In Kohima, 40.14% of the users are satisfied with the utility service, 21.77% are not satisfied and 38.10% do not have a clear opinion. On the other hand, only 28.75% are satisfied with the utility service in Dimapur and 18.35% are not satisfied, whereas 52.91% do not have a clear opinion on the performance. It can be seen from the table that none of the users are very satisfied with the utility performance. This could be due to frequent power outages experienced by the households in the State.

Table 7.4: Household Satisfaction with Utility Performance

	Kohima	Dimapur	Overall
Very Satisfied	-	-	-
Satisfied	118 (40.14)	94 (28.75)	212 (34.14)
Neutral	112 (38.10)	173 (52.91)	285 (45.89)
Not Satisfied	52 (17.69)	57 (17.43)	109 (17.55)
Very Unsatisfied	12 (4.08)	3 (0.92)	15 (2.42)

Source: Household Survey, 2016-17.

Note: Figures in parentheses represent percentages to respective totals.



Source: From Table 7.4.

7.2.3 Energy Transition at the Household Level

It is essential to investigate the pattern of household energy transition in order to mitigate the adverse impact of the use of inefficient fuels on the environment and human well-being. The details of the changes in household energy use over the last five years are presented in Tables 7.5, 7.6, 7.7 and 7.8.

Major fuels abandoned during the last five years are kerosene, firewood and charcoal. It can be seen from Table 7.5 that many households have abandoned firewood (6.44%) and kerosene (5.80%). In case of firewood, households that abandoned the fuel are more in Kohima (7.82%)) as compared to Dimapur (5.20%). In case of kerosene and charcoal, more households in Dimapur (7.65%) as compared to Kohima (3.74%) have abandoned these fuels.

In urban households, major fuels adopted during the last five years are LPG[2] (6.47%) and solar (3.70%). It may be noted that a few households have also taken up firewood and charcoal while others abandoned. Comparing the adoption and abandonment of these fuels by the households, it is revealed that 40 households (6.44%) have abandoned firewood, while 4 households (0.64%) have adopted it. For charcoal, while 28 households (4.51%) have abandoned the fuel, 8 households (1.29%) have adopted it. It may be noted that none of the households have abandoned LPG and solar nor taken up kerosene in both the study areas during the reference period.

From the above discussion, it can be inferred that the adoption rate is more significant in the case of cleaner energy like LPG and solar, while the abandonment rate is more significant in the case of kerosene and firewood.

Table 7.5: Adoption and Abandonment of Fuel over the Last Five Years

		LPG	Kerosene	Firewood	Charcoal	Solar
Kohima	Abandoned	-	11 (3.74)	23 (7.82)	8 (2.72)	-
	Adopted	26 (8.84)	-	4 (1.36)	5 (1.70)	14 (4.76)
Dimapur	Abandoned	-	25 (7.65)	17 (5.20)	20 (6.12)	-
	Adopted	13 (3.98)	-	-	3 (0.92)	9 (2.75)
All	Abandoned	-	36 (5.80)	40 (6.44)	28 (4.51)	-
	Adopted	29 (4.67)	-	4 (0.64)	8 (1.29)	23 (3.70)

Source: Household Survey, 2016-17.
Note: Figures in brackets indicate percentages of the respective household totals.

Table 7.6 provides the changes in the consumption pattern of individual household fuels during the past five years. It can be seen that in the aggregate sample, consumption of electricity and LPG have gone up in majority of the households (76.81% in case of electricity and 62.96% in case of LPG). In case of firewood, 23.48% of households have indicated that the consumption has gone up. Households whose consumption remained the same constitute 19.32% in case of electricity, 30.60% in case of LPG, 37.97% in case of firewood and 55.86% in case of charcoal. On the other hand, households whose consumption has gone down constitute 3.86%, 6.44%, 38.55% and 44.14%, respectively for electricity, LPG, firewood and charcoal. All the households

[2] Since every household use LPG, it can be inferred from the findings that majority of the households have already adopted the fuel prior to the period under consideration.

that use kerosene indicated that the fuel consumption had gone down during the past five years.

While similar trends are also exhibited in both the study areas, however, there are notable differences between the two in case of individual fuels. The shares of households whose electricity and LPG consumption has gone up are higher in Dimapur compared to Kohima, while the trend is reversed in the case of households whose consumption of these fuels remained the same. In the case of firewood, the share of households whose consumption has gone up is higher in Kohima compared to Dimapur, while the trend is reversed in case of households whose consumption of the fuel has either remained the same or gone down. Consumption of charcoal remained the same in majority of the households in Kohima, whereas it has gone down in majority of the households in Dimapur.

It can be inferred from Table 7.6 that increase in consumption is more significant in the case of electricity and LPG, while decline in consumption is more significant in the case of kerosene, firewood and charcoal in the households over the past five years.

Table 7.6: Change in Energy Consumption Pattern over the Last Five Years

		Electricity	LPG	Kerosene	Firewood	Charcoal
Kohima	Gone up	217 (73.81)	181 (61.56)	-	55 (28.35)	-
	Same	63 (21.43)	98 (33.33)	-	69 (35.57)	59 (62.77)
	Gone down	14 (4.76)	16 (5.44)	32 (100.00)	70 (36.08)	35 (37.23)
	Total	294 (100.00)	294 (100.00)	32 (100.00)	194 (100.00)	94 (100.00)
Dimapur	Gone up	260 (79.51)	210 (64.22)	-	26 (17.22)	-
	Same	57 (17.43)	93 (28.44)	-	62 (41.06)	3 (17.65)
	Gone down	10 (3.06)	24 (7.34)	20 (100.00)	63 (41.72)	14 (82.35)
	Total	327 (100.00)	327 (100.00)	20 (100.00)	151 (100.00)	17 (100.00)
All	Gone up	477 (76.81)	391 (62.96)	-	81 (23.48)	-
	Same	120 (19.32)	190 (30.60)	-	131 (37.97)	62 (55.86)
	Gone down	24 (3.86)	40 (6.44)	52 (100.00)	133 (38.55)	49 (44.14)
	Total	621 (100.00)	621 (100.00)	52 (100.00)	345 (100.00)	111 (100.00)

Source: Household Survey, 2016-17.

Note: 1) Figures in parentheses represent percentage of households to respective fuel-using households.

2) Include fuels that are in current use only.

The attitude of the households behind increase or decrease in consumption of a specific fuel is examined in Tables 7.7 and 7.8. Table 7.7 examines the reasons for increase in consumption of the given fuel. Table 7.8 analyses the reasons for decease in the consumption of fuel.

Table 7.7 reveals that the most important reason for increase in electricity consumption is due to changes in household fittings and appliances, followed by climate change, changing cultural practices and changes in family size. This perhaps indicates the increased use of electrical appliances at home and more extreme temperatures during both summer and winter seasons. For LPG, the major reasons for increase in consumption are increased availability, changes in family size and changes in household fittings and appliances. Consumption of LPG also increased due to climate change and changes in cultural practices. For firewood, climate change (extreme winter) and changes in family size are the reasons for increased consumption.

The major reason for decline in electricity consumption is 'Others', which includes changes in costs and increased availability of other fuels. Awareness of ways to save energy around the house and changes in household fittings and appliances are also important reasons. For LPG and kerosene, consumption has decreased because of changes in family size and changes in household fittings and appliances. Consumption of kerosene has declined in all households mainly due to changes in costs and increased availability of alternate fuels, which are cleaner and more efficient. For firewood, the most important reason is changes in cultural practices. Consumption of firewood declined in seventeen households (12 in Kohima and 5 in Dimapur) because of awareness of ways to save energy around the home. Besides, changes in family size, increase in costs and increased availability of other fuels are other important reasons. For charcoal, changing in cultural practices is the most important reason, followed by ‘Others’ and changes in family size.

It can be inferred from the above analysis that the major reasons for increase in consumption of modern fuels are climate change, change in family size, changes in household fittings and appliances and changing cultural practices; whereas for traditional fuel, it is attributed to climate change. On the other hand, decrease in consumption is due to changes in household fittings and appliances, changes in costs and increased availability of other fuels in case of modern fuels, and changing cultural

Table 7.7: Reasons for Increase in Energy Consumption (No. of Households)

Energy Type	Kohima					Dimapur				
	A	B	C	D	E	A	B	C	D	E
Electricity	-	99	34	149	80	-	118	45	134	83
LPG	77	27	71	32	30	81	26	50	48	29
Firewood	-	31	28	-	-	-	18	14	-	-

Source: Household Survey, 2016-17

Code for reasons: A = Increased availability, B = Climate change, C = Change in family size, D = Changes in household fittings and appliances, E = Changing cultural practices.

Note: 1) Households were allowed to provide more than one reason.

2) Kerosene and charcoal are excluded since consumption did not increase in case of these fuels.

Table 7.8: Reasons for Decline in Energy Consumption (No. of Households)

Energy Type	Kohima					Dimapur				
	A	B	C	D	E	A	B	C	D	E
Electricity	5	4	7	-	16	6	5	6	-	12
LPG	-	11	9	-	-	-	7	19	-	-
Kerosene	-	7	27	-	9	-	4	15	-	6
Firewood	12	10	-	34	16	5	19	-	29	21
Charcoal	-	4	-	14	6	-	6	-	31	8

Source: Household Survey, 2016-17

Code for reasons: A = Awareness of ways to save energy around the home, B = Change in family size, C = Changes in household fittings and appliances, D = Changing cultural practices, E = Others.

Note: Households were allowed to provide more than one reason.

practices, changes in costs and increased availability of other fuels in the case of traditional fuels.

7.3 HOUSEHOLDS' ENERGY CONSERVATION AND EFFICIENCY PRACTICES

This section of the chapter discusses the households' energy conservation and efficiency practices. Energy consumption behavior is driven by different factors that influence final energy use behavior. Poor energy management decisions like wasteful habits and reliance on inefficient fuels and technologies by households can lead to high energy consumption. An important measure to tackle household energy problems is to practice good energy management techniques, such as the adoption of energy conservation practices and energy-efficient technologies in the home.

7.3.1 Energy Conservation Practices

The awareness of energy conservation practices of the sample households was assessed through their energy-using actions. The households were given a set of negative actions and asked whether they practiced these on a regular basis. Activities in focus range from lighting to heating, which constitute activities that may have a significant impact on the energy consumption level of households. It is to be noted that this method is only believed to provide a crude indication of the urban households' approach towards energy conservation and is not expected to give a comprehensive picture of the energy conservation of the households. Table 7.9 explores the responses of the households regarding the given set of practices.

It can be observed from Table 7.9 that the number of negative responses is greater than the positive responses in both the study areas. However, the practices differ considerably from each other. It can be seen from the table that majority of the households (63.93%) in the aggregate sample do not leave on lights unnecessarily. However, when it comes to 'leaving appliances on standby mode', majority of the households (61.35%) respond in the affirmative. This indicates that households that practice saving energy from lighting do not necessarily mean doing the same for other activities. For cooling activity, the number of households that leave the fan on when no one is using it is as many as those that do not practice it in Kohima. On the other hand, in Dimapur most of the households (61.16%) leave the fan on when no one is using it.

Majority of the households (54.59%) boil water more than needed, 15.56% of the households indicated that they place hot food directly in the refrigerator and 32.45% responded to heating food immediately out of refrigerator. Regarding laundry, 35.94% of the households indicated that they usually use washing machine with less than a full load. Regarding water heating, 35.98% indicated that they prolonged the heating while using the water-heating system.

Table 7.9: Energy-Using Practices by the Households

	Kohima		Dimapur		All	
	Yes	No	Yes	No	Yes	No
Leaving on lights unnecessarily	101 (34.35)	193 (65.65)	123 (37.61)	204 (62.39)	224 (36.07)	397 (63.93)
Leaving appliances on standby mode	163 (55.44)	131 (44.56)	218 (66.67)	109 (33.33)	381 (61.35)	240 (38.65)
Leaving the fan on when no one is using it	18 (50.00)	18 (50.00)	200 (61.16)	127 (38.84)	218 (60.06)	145 (39.94)
Boiling more water than needed	171 (58.16)	123 (41.84)	168 (51.38)	159 (48.62)	339 (54.59)	282 (45.41)
Placing hot food directly in the refrigerator	28 (13.86)	174 (86.14)	54 (16.62)	271 (83.38)	82 (15.56)	445 (84.44)
Heating food immediately out of the refrigerator	69 (34.16)	133 (65.84)	102 (31.38)	223 (68.62)	171 (32.45)	356 (67.55)
Using a washing machine with less than a full load	50 (34.97)	93 (65.03)	65 (36.72)	112 (63.28)	115 (35.94)	205 (64.06)
Prolonging the heating while using a water heating system	81 (37.50)	135 (62.50)	73 (34.43)	139 (65.57)	154 (35.98)	274 (64.02)

Source: Household Survey, 2016-17.

Note: 1) These practices do not apply to every household. Responses are given by only the households that use the particular appliance.

2) Figures in brackets indicate percentages of Yes/No to total response.

Therefore, when the aggregate sample is considered, it is only in 'leaving appliances on standby mode', 'leaving fan on when no one is using it' and 'boiling more hot water than needed' that majority of the households responded in the affirmative. Hence it can be inferred from the above analysis that the urban households make some conscious efforts in energy conservation practices.

7.3.2 Energy-Efficient Technologies

The urban energy problem stems from the fact that the households have been consuming the energy far more than the rural areas because of higher income and living standards that allowed them to purchase more energy services. To tackle this problem, energy conservation needs to be practiced and to achieve this, more efficient technologies must be used. In section 7.3.1, it was revealed that many households make some conscious efforts in practicing energy conservation. In this section, the adoption rates of energy-efficient technologies and the reasons for adopting/not adopting them are discussed.

Table 7.10 shows the adoption of five energy-efficient technologies, namely, star-rated refrigerator, cooling appliance and washing machine, CFLs/TFLs/LED lights and solar water heater in urban households. It can be observed from the table that in the aggregate sample, 72.68% of the households using refrigerator have adopted energy-efficient ones and 60.94% have adopted energy-efficient washing machine. For cooling, 38.02% of households have adopted energy-efficient ceiling fans and air conditioners.

Table 7.10: Adoption of Energy-Efficient Technologies by Households

Type of Technology	Kohima	Dimapur	All
Energy-efficient refrigerator	136 (67.33)	247 (76.00)	383 (72.68)
Energy-efficient cooling appliance	11 (28.95)	128 (39.14)	139 (38.02)
CFLs/TFLs/LED lights	294 (100.00)	327 (100.00)	621 (100.00)
Energy-efficient washing machine	95 (66.43)	100 (56.50)	195 (60.94)
Solar water heater	27 (9.18)	8 (2.45)	35 (5.64)

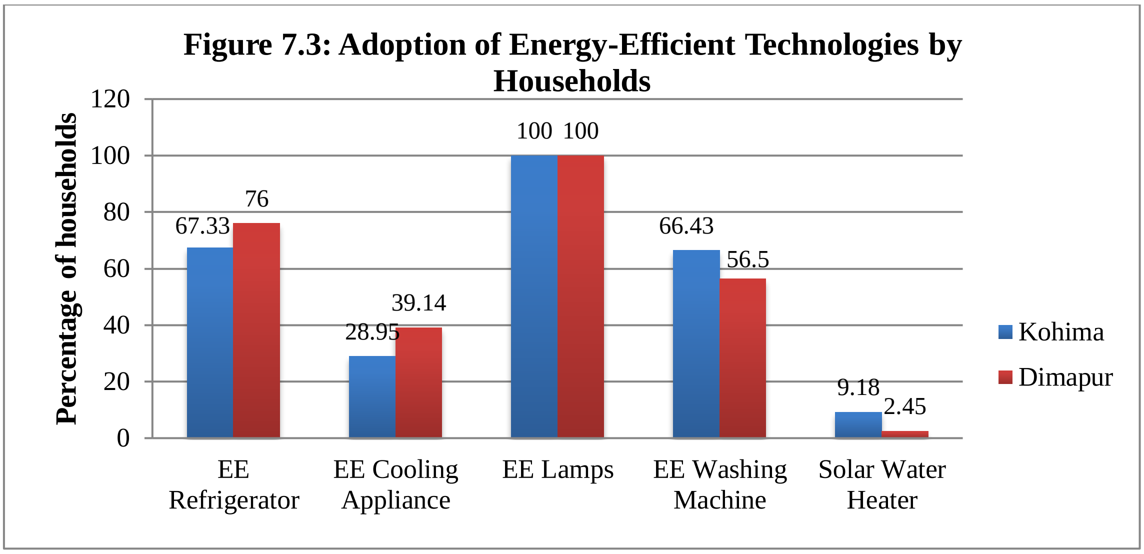
Source: Household Survey, 2016-17.

Note: 1) Figures in brackets indicate percentages to respective total households using both energy-efficient and inefficient technology.

2) Energy-efficient refrigerator, cooling appliance and washing machine here include those that are star-rated.

3) Cooling appliance includes both fan and air conditioner.

It may be noted that every household has adopted either one or all of the energy-efficient lights, whereas for solar water heater, 5.64% have adopted it. The table also reveals that the adoption rates of energy-efficient refrigerator and cooling appliance are higher in Dimapur compared to Kohima, whereas for energy-efficient washing machine and solar water heater, the adoption rates are higher in Kohima. The adoption rates of these technologies are also depicted in Figure 7.3.



Source: From Table 7.9

Table 7.11 explores the reasons for adopting energy-efficient technologies by households. As evident from the table, the rationale for adopting energy-efficient technologies is to save energy as well as for financial consideration. For energy-efficient refrigerator, the most important reason for adoption is to save energy in both study areas, followed by reducing expenditure on energy. Similarly, the important reason for adopting an energy-efficient cooling appliance is to save energy in both Kohima and Dimapur. It is interesting to note that a significant number of households adopted energy-efficient lighting systems to save energy. However, the most important reason is to reduce energy bills in both the study areas.

Table 7.11: Reasons for Adopting the Energy-Efficient Technologies

	Kohima			Dimapur		
	A	B	C	A	B	C
EE refrigerator	82 (27.89)	62 (21.09)	-	164 (50.15)	142 (43.43)	-
EE cooling appliance	10 (3.40)	4 (1.36)	-	123 (37.61)	15 (4.59)	-
CFLs/TFLs/LED lamps	135 (45.92)	156 (53.06)	-	145 (44.34)	199 (60.86)	-
EE washing machine	56 (19.05)	36 (12.24)	35 (11.90)	80 (24.46)	41 (12.54)	21 (6.42)
Solar water heater	16 (5.44)	24 (8.16)	5 (1.70)	3 (0.92)	8 (2.45)	2 (0.61)

Source: Household Survey, 2016-17.

Code for reason: A = To save energy, B = To save money/to reduce expenditure on energy, C = To save time

Note: 1) Figures in brackets indicate percentages to total households.

2) Multiple responses were given by households in some cases.

Saving energy is the most important reason for adopting energy-efficient washing machine in both Kohima and Dimapur. Saving energy bills and saving time are also important considerations indicated by the households. For solar water heater, the most important reason is to save energy bills. However, it may be noted that five households in Kohima and two households in Dimapur adopted it to save time.

It can be inferred from the above analysis that achieving energy bill reduction was an important motive in adopting energy-efficient technologies by the urban households. Moreover, the households also seemed to realize the importance of saving energy since many of the households have adopted the energy-efficient technologies for this purpose.

Thus, from the above discussions on energy conservation practices and the adoption of energy-efficient technologies, it is evident that saving energy is an important decision that households make in their energy-usage activities. Hence the hypothesis which states that urban households make efforts to adopt practices and efficient technologies to save energy is accepted.

The reasons for not adopting energy-efficient technologies are presented in Table 7.12. For energy-efficient refrigerator, the relevant reasons are high cost and lack of information about the benefits. It may be noted that 32 households in Kohima have indicated 'have not felt the need' for non-adoption. This could be because Kohima is colder, and households have not considered adopting the technology, regardless of its efficiency. For the same reason, a significant number of households do not adopt energy-efficient cooling appliance in Kohima. High cost is another important reason for not adopting, followed by lack of information about the benefits. In Dimapur, high cost is the most important reason, followed by ‘have not felt the need’ and lack of information. For washing machine, 'have not felt the need' have a dominant role in Kohima, whereas in Dimapur, high cost is the most important reason for non-adoption. For solar water heater, most important reasons are high cost and ‘have not felt the need’ in Kohima. In Dimapur, ‘have not felt the need’ have a dominant role. Non-availability/limited availability and lack of information about the benefits are also major reasons for not adopting the technology. It may be noted that households have indicated limited availability of solar water heater in the market and comes with a high cost even if available.

Table 7.12: Reasons for Not Adopting Energy-Efficient Technologies

	Kohima				Dimapur			
	A	B	C	D	A	B	C	D
EE refrigerator	-	91 (30.95)	44 (14.97)	32 (10.88)	-	64 (19.57)	18 (5.50)	-
EE cooling appliance	-	61 (20.75)	35 (11.90)	184 (62.59)	-	179 (54.74)	26 (7.95)	97 (29.66)
EE washing machine	-	51 (17.35)	17 (5.78)	145 (49.32)	-	104 (31.80)	28 (8.56)	102 (31.19)
Solar water heater	36 (12.24)	111 (37.76)	22 (7.48)	110 (37.41)	30 (9.17)	44 (13.46)	36 (11.01)	237 (72.48)

Source: Household Survey, 2016-17.

Code for reason: A = Non-availability/limited availability, B = High cost, C = Lack of information about the benefits, D = Have not felt the need

Note: 1) Figures in brackets indicate percentages to total households.

2) Multiple responses were given by households in some cases.

3) Energy-efficient lighting system is excluded as every household has adopted it.

Therefore, it can be inferred that high cost is an important reason for non-adoption of energy-efficient technologies. Moreover, it is also evident that many households have not felt the need to adopt these technologies which could be due to lack of information about the benefits of the energy-efficient technologies.

7.3.3 Measures for Energy Efficiency

Taking energy conservation steps and investing in efficient technologies are important means that profoundly impact overall efficiency in the household sector. However, as revealed from the analyses, many households do not practice energy conservation practices or adopt energy-efficient technologies because of certain barriers. In order to assess the important measures that could help the households to become more energy efficient, respondents were provided 7 measures and were required to rate each on a 5-point Likert scale that required a ranking (1 - 5), where 1 represented strongly disagree and 5 represented strongly agree. The reliability of the 5-point Likert scale measure was determined by using Cronbach's alpha coefficient[3]. The 7 measures considered for energy efficiency are given in Table 7.13.

[3] According to Pallant (2016), the value for alpha should be greater than 0.7 for the scale to be reliable. The result of Cronbach's alpha was 0.746, indicating that the scale was consistent with the sample.

The overall mean scores were ranked based on their level of importance. Out of these 7 measures, education was rated as the most important by the respondents with a mean score of 4.23, followed by information on the environmental impact of wasting energy, and better labeling and information on appliances with mean scores of 4.20 and 4.02, respectively.

In general, education and information rank highest, whereas concerns such as cash incentives and raising energy prices seem to be of lower importance. While concerns about government campaigns and laws promoting energy sustainability are perceived/ranked lower than educational concerns, the response indicates that these have significant potential for households to become more energy-efficient. Implementing energy-efficient measures could significantly enhance energy use efficiency at homes relieving the pressure on the environment and the well-being of humanity while achieving maximum benefits from the available energy. The results will help policy makers develop guidelines for facilitating efficient household energy management in the urban household sector.

Table 7.13: Mean Score Ranking of Energy Efficiency Measures

Measures	Overall			Kohima			Dimapur		
	Mean Score	Std. Dev.	Rank	Mean Score	Std. Dev.	Rank	Mean Score	Std. Dev.	Rank
A	4.23	0.63	1	4.32	0.66	1	4.15	0.59	2
B	4.20	0.79	2	4.19	0.79	2	4.21	0.80	1
C	4.02	0.66	3	4.07	0.67	4	3.97	0.65	3
D	3.92	0.87	4	4.10	0.86	3	3.81	0.86	4
E	3.74	0.80	5	4.00	0.90	5	3.78	0.69	5
F	3.65	0.83	6	3.65	0.79	6	3.65	0.86	6
G	2.75	1.09	7	2.95	1.18	7	2.56	0.97	7

Source: Household Survey, 2016-17.

Code for measures**:** A = Education on how to become more energy efficient, B = More information on the environmental impact of wasting energy, C = Better labeling and information on appliances, D = Government campaign that promotes household energy sustainability, E = Laws that require that products and appliances are environmentally sustainable, F = More cash incentive, G = Increasing the energy prices beyond an agreed limit of usage.

7.4 HOUSEHOLD EXPENDITURES ON ENERGY

The previous sections have focused on the attitudes toward energy uses and energy conservation practices. In this regard, it might be relevant to examine household expenditure on fuels as the attitudes and practices of the households ultimately influence the final energy expenditure. It has been revealed in chapter 5 that energy consumption in households varies across different seasons. This section attempts to examine household expenditure on fuels during summer and winter. Table 7.14 shows the average expenditure on energy commodities by the sample households for both summer and winter seasons, along with total household income and energy expenditure.

7.4.1 Expenditure during Summer

During summer, households spend, on average ₹1622.73 monthly on overall energy purchases, accounting for 2.6% of total household income. Households in Dimapur spent proportionately more (2.8% of their average income) than those in Kohima (2.5% of their average income). In the aggregate sample, electricity has the largest expenditure, followed by LPG. In total energy share terms, this corresponds to 48.1% for electricity, followed by LPG at 45.2%. Firewood and kerosene constitute 6.1% and 0.6% of fuel expenditure in the average urban household, respectively. In Kohima, the share of expenditure is highest on LPG (50.3%), followed by electricity (41.3%), firewood (7.6%) and kerosene (0.9%). On the other hand, in Dimapur the share of expenditure is highest on electricity (53.7%), followed by LPG (41%), firewood (4.9%) and kerosene (0.5%). The table reveals that households in Dimapur spend more on firewood, electricity and kerosene but less on LPG than Kohima during summer.

7.5.2 Expenditure during Winter

Table 7.14 also reveals that during winter, households spent, on average, ₹1814.63 monthly on overall energy purchases, constituting 2.9% of total household income. It is interesting to note that households in Kohima spent proportionately more (3.1% of their average income) than those in Dimapur (2.8% of their average income) during winter. In the aggregate sample, LPG has the largest expenditure share accounting for 42.4%, followed by electricity (39.2%) and firewood (16.6%) among the individual fuels. Charcoal and kerosene constitute 1.2% and 0.6%, respectively of fuel expenditure in the average urban household during winter. Similar trend is also exhibited in both Kohima and Dimapur. The table further shows that households in Kohima spend more on electricity, LPG and charcoal than those in Dimapur but less on firewood and kerosene than Dimapur.

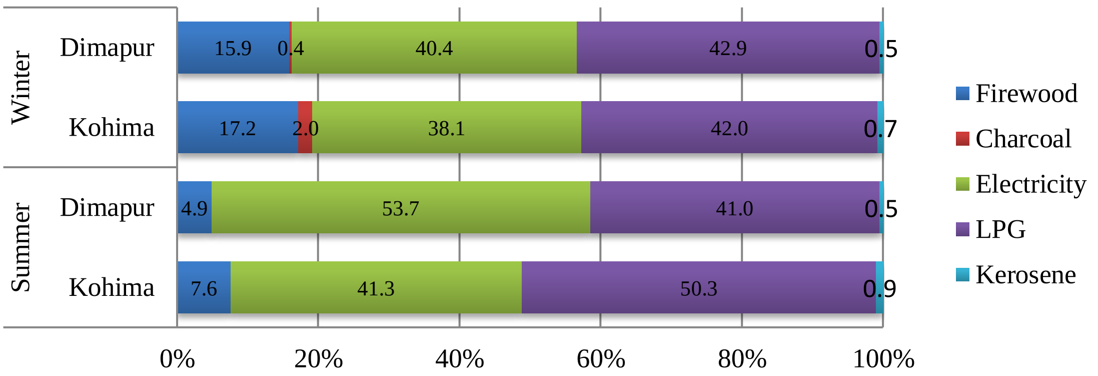
Table 7.14: Average Household Energy Expenditure in the Study Areas for One Month (in ₹)

	Kohima	Dimapur	Total
No. of HH	294	327	621
Average HH income	61880.95	61623.55	61745.41
Summer			
Average energy expenditure	1537.37	1699.48	1622.73
% of average HH income	*2.5%*	*2.8%*	*2.6%*
of which:			
Firewood expenditure per month	304.03	416.56	345.12
% of average energy expenditure	*7.6%*	*4.9%*	*6.1%*
Electricity	634.59	911.87	708.6
% of average energy expenditure	*41.3%*	*53.7%*	*48.1%*
LPG	772.83	697.00	732.90
% of average energy expenditure	*50.3%*	*41%*	*45.2%*
Kerosene	125.31	132.88	128.22
% of average energy expenditure	*0.9%*	*0.5%*	*0.6%*
Winter			
Average energy expenditure	1941.35	1700.70	1814.63
% of average HH income	*3.1%*	*2.8%*	*2.9%*
of which:			
Firewood expenditure per month	643.48	724.31	679.34
% of average energy expenditure	*17.2%*	*15.9%*	*16.6%*
Charcoal expenditure per month	121.50	115.29	120.54
% of average energy expenditure	*2%*	*0.4%*	*1.2%*
Electricity	739.42	687.19	711.92
% of average energy expenditure	*38.9%*	*40.4%*	*39.2%*
LPG	815.11	697.00	732.90
% of average energy expenditure	*42%*	*42.9%*	*42.4%*
Kerosene	126.31	133.88	129.22
% of average energy expenditure	*0.7%*	*0.5%*	*0.6%*

Source: Household Survey, 2016-17.

The proportion of energy expenditure in the sample households during both summer and winter is illustrated in Figure 7.4. It may be noted that bulk of the household energy expenditure is accounted by the modern fuels in both seasons. The figure shows that the share of modern fuel expenses is higher during summer. On the other hand, expenses on traditional fuels constitute only 7.6% of the total household energy expenditure in Kohima and 4.9% in Dimapur during summer. These increase to 19.2% in Kohima and 16.3% in Dimapur during winter. An important reason for low expenditure on traditional fuels is because many households are not spending on these fuels as they collected them from their own forest land for free. The expenditure on traditional fuels is more in Kohima than in Dimapur in both summer and winter. In contrast, the expenditure on modern fuels is more in Dimapur in both the seasons.

Figure 7.4: Proportion of Energy Expenditure by the Households



Source: From Table 7.14.

7.4.3 Relationship between Energy Expenses and Income

Monthly expense on fuels shows a high degree of correlation with household income. The Pearson correlation coefficients between household energy expense and income are given in Table 7.15. It reveals positive correlation between the two variables for the aggregate sample: r(519) = .657, p = .000 for summer, and r(519) = .665, p = .000 for winter. For Kohima, the Pearson correlation coefficient is .664 for summer and .683 for winter with corresponding p-values of .000. Similarly, the Pearson correlation coefficient for Dimapur is .661 for summer and .652 for winter with corresponding p-values of .000.

Table 7.15: Pearson Correlation Coefficients between Household Energy Expense and Income

	Kohima	Dimapur	Overall
Summer	.664**	.661**	.657**
Winter	.683**	.652**	.665**
No. of observations	294	327	621

** Correlation is significant at the 1% level (2-tailed).

The relationship between the energy expense of households and income is provided in Table 7.16. For the sample total, the average monthly expenses for the lowest income group (<₹20,000) stood at 1349.75 during summer and ₹1445 during winter. The expense during summer increased to ₹1359.12/month for the income group ₹20,000-50,000 and reached to ₹2045.82/month for the highest income group (>₹100,000). On the other hand, the expense during winter increased to ₹2262.19/month for the income group ₹80,001-100,000 and declined to ₹1909.97 for the highest income group.

Table 7.16: Average Expenses on Energy per Month by Households by Income Levels

		<20,000	20,000-50,000	50,001-80,000	80,001-100,000	>100,000
Overall	Summer	1349.75	1359.12	1715.32	1977.60	2045.82
	Winter	1445.00	1493.84	1583.31	2262.19	1909.97
Kohima	Summer	1316.70	1361.13	1546.31	1771.33	1945.67
	Winter	1538.27	1708.24	1996.81	2229.18	2470.85
Dimapur	Summer	1338.82	1420.83	1818.52	2222.26	2198.68
	Winter	1288.16	1309.33	1856.95	2301.35	2176.01

Source: Household Survey, 2016-17.

Among the sample areas, Kohima exhibited a high correlation between monthly fuel expense and income, whereby the expense during summer increased from ₹1316.70/month for the lowest income group to ₹1945.67/month for the highest income group. Similarly, the expense during winter increased from ₹1538.27/month for the lowest income group to ₹2470.85/month for the highest income group. On the other hand, in Dimapur the expense during summer increased from ₹1338.82/month for the lowest income group to ₹2222.26/month for income ₹80,001-100,000 and then declined to ₹2198.68/month for the highest income group. Similarly, the expense during winter for the corresponding income groups increased from ₹1288.16/month to ₹2301.35/month and declined to ₹2176.01/month.

The correlation between the average expenses and income levels for the sample areas are illustrated in Figures 7.5 and Fig. 7.6. The high correlation between monthly expense and income levels suggests that an increase in the earning capacity results in greater ability to purchase fuels by the households.

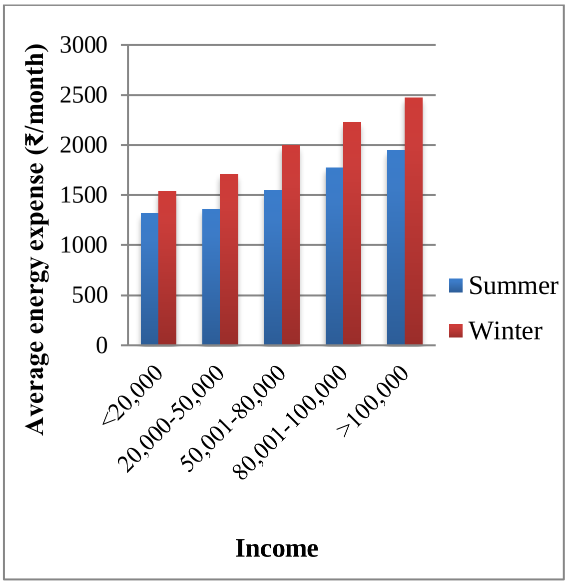


Figure 7.5: Correlation between Average Energy Expense and Income in Kohima

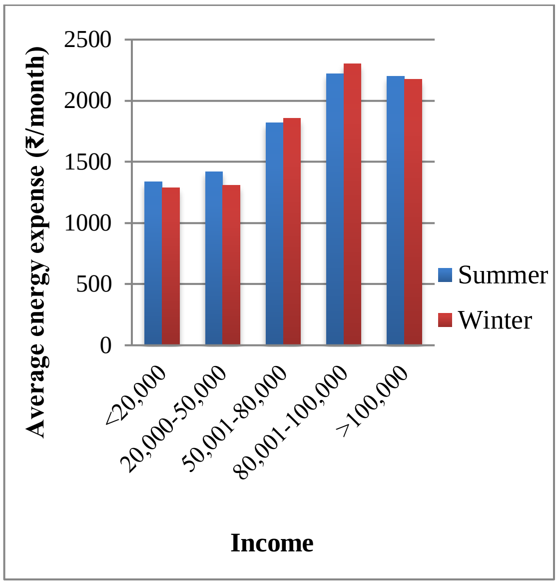


Figure 7.6: Correlation between Average Energy Expense and Income in Dimapur

7.5 CONCLUSION

This chapter focused on the attitudes of urban households towards energy consumption, conservation practices, energy efficiency and household expenditures on energy. It can be concluded from the analyses that households use a particular fuel mainly due to easy availability, affordability and efficiency of the fuel. It is also revealed that less than half of the electricity users are satisfied with the utility service, despite electricity being one of the most important sources of energy in the household sector.

Energy conservation which can be as simple as turning off appliances when not in use or reducing the use of energy-intensive technologies may result in the overall improvement in environmental quality and human well-being. Barriers to achieving a good level of energy-efficient improvement in households include the lack of information on potential benefits and high costs. The information about energy efficiency measures and programmes is often not well disseminated and the users are simply unaware of energy efficiency measures and their benefits to their homes.

Energy expenditure during winter is higher than in summer. Area-wise, energy expenditure in Kohima is higher during winter, whereas during summer, it is higher in Dimapur. The highest expenditure during summer is on electricity, and during winter, it is LPG. The bivariate analysis of the relationship between household energy expenses and income shows that household income correlates highly with energy expenses.

CHAPTER 8
SUMMARY AND CONCLUSIONS

8.1 BACKGROUND

The energy demand by the households in urban areas is basically for meeting end uses such as space heating, water heating, cooking, lighting and appliances. Urban households have a wide variety of energy commodities to choose. The most common energy sources used at the household level are electricity, LPG, solid biomass, including firewood and charcoal, and kerosene. The energy requirements of urban households are higher than that of their rural counterparts as they have greater accessibility to modern fuels such as LPG and electricity and energy end use equipment and appliances.

The growing population, along with increasing incomes and improved living standards, is increasing the energy demand by households in urban areas in Nagaland. As urban areas continue to expand, the result is likely to increase pressure on the future energy demand of the households sector. Moreover, household energy consumption is inextricably linked with individual or household behavior and lifestyles. Hence, understanding the energy consumption pattern and related behavior and attitudes is relevant and essential for formulating effective urban energy policies. Since the household energy use pattern differs across regions, micro-level studies are a prerequisite for an adequate understanding of the issues and problems related to the specific area.

Nagaland is a distinct and mountainous state in the northeastern region of India, having a unique geographical location and climatic and socio-economic conditions. With the expansion of urban areas, growing urban population, and climate change, energy demand is bound to increase at the household level. However, a study on urban household energy in Nagaland has not been done. Hence no reliable information is available for understanding the household energy consumption pattern and the factors that drive it. Therefore, this has resulted in a gap of vital information for formulating effective urban energy policies for the household sector.

Against this backdrop, the present study critically analyzed the issues influencing urban household energy consumption behavior in Nagaland. The objectives of the study were:

1. To examine the energy consumption pattern at the household level in urban Nagaland.
2. To examine the relationship between the types of energy and the various socio-economic determining variables.
3. To identify the factors influencing the adoption of energy-saving behavior at the household level and its impact on energy consumption in urban areas.
4. To assess the attitudes of urban households towards energy sources and uses.

Consistent with the above objectives, five hypotheses were formulated:

1. Higher income is associated with the use of cleaner fuels but do not lead households to abandon traditional fuels altogether.
2. Socio economic variables affect household energy consumption.
3. Energy-saving behavior of individuals is influenced by personal characteristics and capabilities, knowledge, psychological trait, and habit.
4. The energy-saving behavior and households' electricity consumption are negatively related.
5. Urban households make efforts to adopt practices and efficient technologies to save energy.

In order to collect the data required for analyzing the above objectives, a sample survey was conducted at the household level in two urban areas, representing different geo-climatic regions in Nagaland. The two urban areas were Dimapur Municipal Council area in Dimapur district and Kohima Municipal Council area in Kohima district. Data were collected from 621 households from the sample areas using a pre-tested questionnaire.

8.2 MAJOR FINDINGS

8.2.1 Household Energy Consumption in India

In India, the household sector is one of India's significant consumers of energy, in which traditional biomass fuels such as firewood, charcoal, dung cake, etc. constitute a major share of the total energy consumed. Besides traditional biomass, the household sector relies on LPG for cooking, kerosene for cooking and lighting, and electricity for various purposes. Energy consumption in households is fast growing due to changes in households' lifestyles and behavior from rapid economic development and higher disposable incomes.

During 2011-12, 96% of urban households in India consumed electricity, 71% consumed LPG, 23% used firewood and chips, and 22.85% used kerosene. In rural areas, 74.2% consumed electricity, 21% used LPG, 83.5% used firewood and chips, and 48.65% used kerosene. The monthly per capita expenditures on firewood and chips, kerosene and ‘other’ fuels were higher in the rural areas compared to urban areas, and expenditures on electricity and LPG were higher in the urban areas than the rural areas. For cooking, Indian households exhibited fuel stacking behavior, with 47% of households using exclusively clean fuel, 24% using primarily clean fuel, 14% using primarily solid fuel and 15% using only solid fuel during 2020. Thus, while 85% of Indian households use clean fuels, almost half of them stack them with solid fuels.

8.2.2 Household Energy Consumption in Nagaland

The overall household energy mix of the State is broadly classified as electricity, biomass and LPG, addressing household requirements such as lighting, cooking and heating. Traditional biomass is one of the predominant fuels in Nagaland, particularly for cooking and heating purposes. The household energy requirements for cooking are primarily met by LPG and firewood, while lighting requirements are met by electricity. As per the NSSO-68 round survey, every urban household used electricity, 47% used firewood and chips, 83.7% used LPG, and 7.6% used kerosene during 2011-12. In rural areas, 99.2% of households used electricity, 86% consumed firewood and chips, 37.1% used LPG, and 21.9% used kerosene. The monthly per capita expenditure on firewood and chips, kerosene and 'other' fuels were higher in rural areas, whereas expenditures on electricity and LPG were higher in urban areas.

8.2.3 Purpose of Energy Usage

Urban households use a mix of energy, of which electricity, LPG, firewood, kerosene and charcoal are the most common energy sources. Electricity and LPG are used in every household. Electricity is used for lighting, cooking and heating; LPG for cooking and water heating; kerosene for cooking; firewood for cooking, water heating and space heating; and charcoal is used for space heating. A few households also use solar energy for water heating and lighting during power outages. Households using electricity, kerosene, and firewood for cooking are more in Kohima than in Dimapur. Households using energy sources for heating purposes are also higher in Kohima because of higher heating requirements due to colder climatic conditions. On the other hand, the usage of electricity for cooling purposes is higher in Dimapur due to higher humidity in the area.

8.2.4 Combination of Fuels in the Households

The findings from households' use of fuel combinations show that electricity with LPG and firewood is the most common combination in Kohima, whereas, in Dimapur, it is electricity with LPG. Many of the households in Kohima use a combination of these fuels with charcoal and kerosene. However, most of the households in Dimapur use either electricity with LPG or electricity with LPG and firewood, as there are fewer kerosene and charcoal users in Dimapur compared to Kohima.

8.2.5 Household Energy Use and Income

Findings from the relationship between household energy use and income reveal that users of the various energy items are distributed across all income groups, with the least users in the lowest income group in cases of electricity, LPG and charcoal. An important finding is that households of all income levels commonly use firewood which is a traditional source of energy. For firewood and kerosene, the least users belong to the highest income group.

Analysis of cooking fuel usage shows that many households use a combination of fuels for cooking purposes. While LPG is the primary energy used in households, the study reveals that firewood is also an important cooking fuel, irrespective of income level. This indicates that high income does not lead households to completely switch from traditional fuels to modern fuels but instead use a combination of both. Hence, the hypothesis that higher income is associated with the use of cleaner fuels but does not lead households to abandon traditional fuels altogether is found true and thus accepted.

8.2.6 Household Energy Consumption Pattern across Geo-climatic Regions

Overall energy consumption is higher during winter (1479617 MJ) compared to summer (1086898.58 MJ). In both seasons, consumption is higher in Kohima (summer – 561381.10 MJ and winter – 806370.69 MJ) than in Dimapur (summer – 525517.48 MJ and winter – 673246.41 MJ). The share of traditional energy sources is higher in Kohima, which is situated in the vicinity of the forest, regardless of the season. Thus, it is evident that the easy availability of fuels is proportionally related to energy consumption. However, seasonal differences have been observed for use of modern fuels, where consumption is more in Dimapur during summer, whereas Kohima has higher consumption during winter. Nevertheless, modern energy sources dominate the energy consumption scenario in urban households.

Per capita consumption of overall energy is higher during winter (182.62 MJ) than in summer (149.86 MJ). In both seasons, per capita household energy consumption is higher in Dimapur (summer - 154.38 MJ and winter - 188.01 MJ) than in Kohima (summer - 146.08 MJ and winter - 178.36 MJ). Per capita consumption of traditional fuels is higher than modern fuels, and it is higher in Kohima than in Dimapur, regardless of the season. In the case of modern fuels, per capita consumption is higher in Dimapur during summer, and during winter, both sample areas have similar per capita consumption.

LPG is the dominant fuel among modern energy sources, providing nearly half of the household energy requirements. It has the largest consumption share among all the energy sources during summer, whereas firewood is the dominant fuel during winter in both study areas. Cooking is the most important end use of energy, and LPG is the dominant cooking fuel. For the end use of 'others' which include lighting and heating, electricity is the most important energy source during summer, whereas during winter, firewood becomes the dominant fuel in both the sample areas. Firewood is mainly used for cooking during summer, whereas during winter, it is mainly utilized for heating purposes.

By applying a simple bivariate analysis of the relationship between energy consumption and household income, it was found that electricity, LPG and charcoal are normal fuels, while firewood and kerosene are inferior fuels.

8.2.7 Relationship between Household Energy Consumption, Socio Economic and Dwelling Characteristics

Results from OLS regression analysis showed that household size, house ownership and income are important explanatory factors of energy consumption. Household size positively influences LPG, firewood and overall energy consumption, while those residing in rented accommodations use less electricity, firewood and overall energy. Households with more persons consume less electricity, kerosene and charcoal. Other important factors include age, education and working status of household heads, with older household heads consuming more electricity, LPG, firewood and overall energy, and retired heads consuming more electricity, firewood and overall energy, but less kerosene and charcoal. In addition, female-headed households and households having more number of rooms and electrical appliances consume more electricity and overall energy. Estimates across individual fuels indicate that household size has greater effects on electricity and overall energy use in the sample total than on other fuels. Similarly, the higher the education level of the household head, the more the consumption of LPG, electricity and overall energy but lesser consumption of firewood. Likewise, the higher the household income, the more electricity, LPG, and overall energy consumption but not other fuels. Thus, the socio economic variables impact household energy consumption, particularly on electricity, LPG, firewood and overall energy. Hence, the hypothesis, which states that socio economic variables affect household energy consumption, is accepted.

8.2.8 Possession of Electrical Appliances

Electrical appliances are necessities for a comfortable life in every household. Findings from the household stock on 19 major appliances reveal that households in the overall sample possessed an average of 51% of the listed electrical appliances. Households in Kohima possessed an average of 47%, and those in Dimapur possessed 54%. Most of the households possess a refrigerator, fan, laptop, rice cooker, electric iron and water heater, and around half of the homes possess a regular TV, washing machine and desktop. Households in Kohima have higher levels of possession of regular TV, CD player, desktop, printer, water heaters and room heaters. On the other hand, households in Dimapur have significantly higher levels of possession of fridges, fans, water pumps, water boilers, induction cooktops and mixer grinders. The possession of electrical appliances by households and disposable income are found to be positively related.

Analysis of electrical appliance possession revealed that households with a greater number of adults, higher educational level of household head, more number of rooms, and higher levels of income are more likely to have higher levels of possession. Households with older or unemployed heads or those residing in a colder region or renting accommodations have lower levels of possession. A comparison of results between the full sample of households having 19 appliances or less with that of a sub-sample of households having less than average level of appliances shows that location, number of adults in the home, education and income have the largest changes in the coefficients.

8.2.9 Household Choice of Cooking Fuel

The analysis of the household choice of cooking fuel suggests that firewood is used by households that have more members, with male heads, that reside in a colder region, have an older head, live in their own house, and have fewer rooms. The most significant factors were found to be house ownership and the gender of the household head. The odds of using solid fuel decrease by 43.8% for rented householders, and for female-headed households, it decreases by 41.4%. Education, number of appliances possessed, and income do not determine whether a household uses firewood for cooking purposes.

8.2.10 Energy-Saving Behavior in Households

Energy-saving behavior of individuals plays an important role in household energy consumption. This behavior is classified into efficiency and curtailment, and improvement in it can lead to achieving a sustainable energy system in the future. Efficiency-related behavior includes the acquisition of energy-efficient technologies, whereas curtailment behavior includes behaviour that focuses on reducing energy use in everyday life. People's energy decision-making process is driven by different objectives, which are mainly environmental, monetary and comfort. People’s commitment to energy decision-making is based on efficiency and curtailment.

In analyzing energy-saving behaviour in households, environmental awareness and habit are identified as the major factors influencing all three objectives relating to efficiency. Females have more influence on environmental and comfort objectives relating to conservation than males. Older people do not give much thought to conserving energy when making decisions relating to comfort. A higher level of education is also significantly related to environmental conservation and monetary efficiency. Larger families are more influential than smaller families on the environmental and monetary objectives relating to conservation but lesser influence on the comfort objective relating to efficiency. A higher income level is also significant and positively influential on monetary objective relating to efficiency but negatively influences the objective relating to conservation. There is no significant difference in efficiency and conservation behaviors between the sample areas except that residents of Kohima (located at a higher altitude) pay more attention to energy conservation at home to reduce electricity bills compared to those of Dimapur. The study also found that respondents who are most aware of the environmental effects of energy use are more likely to prioritize the environment highly and act upon it, which is reflected by their habits at home. This creates room for optimism that the consumers' actions and sense of environmental responsibility can be increased when environmental awareness levels are maintained in society.

Thus, personal characteristics and capabilities such as gender, age, education, household size and income; knowledge; psychological trait and habit shape the energy-saving behavior of individuals from both efficiency and conservation perspectives, though the extent of the impact of personal characteristics and capabilities is lesser than that of knowledge, psychological trait and habit. Hence, the third hypothesis, which states that energy-saving behavior of individuals is influenced by personal characteristics and capabilities, knowledge, psychological trait and habit, is accepted.

8.2.11 Impact of Energy-Saving Behavior on Energy Consumption

Individual behavior also has a significant influence on household energy consumption. This is because individuals have direct control over their actions, decision-making and interventions regarding energy use in their homes. The study has revealed that the environmental objectives relating to efficiency and monetary objective relating to conservation are significant and negatively related to electricity consumption in the overall sample. This indicates that using energy-efficient technologies at home and paying attention to energy use to reduce electricity bills contribute to lower electricity consumption. The study revealed that Dimapur exhibits a similar pattern to the overall analysis. In addition, the comfort objective relating to conservation is also negative and significantly related to the dependent variable. In Kohima, the monetary objective relating to efficiency is positive and significant at 1%, and the comfort objective relating to efficiency is negative and significantly related to the dependent variable. The results also showed that awareness and habits are significantly related to energy consumption.

Thus, the energy-saving behavior of individuals has a significant negative relationship with household energy consumption. Hence, the fourth hypothesis, which states that energy-saving behavior has impact on energy consumption, is accepted.

8.2.12 Attitude towards the Energy Used for Cooking

The study has also examined the factors responsible for a household's decision to use a particular fuel for cooking purposes. It was found that the major factors responsible for using a particular fuel for cooking are easy availability, affordability, efficiency, cleanliness and time-saving in the case of modern fuels, and easy and free availability, and tradition in the case of traditional fuel.

8.2.13 Attitude towards the Energy Used for Lighting

Most of the urban households are using energy-efficient lights, with CFL users constituting the majority (82.29%), followed by LED users (49.28%) and TFL users (37.20%). Households are found to use various alternative energy sources during power outages, such as inverters, solar light, battery and chargeable light, and candles. In examining the satisfaction level of households with grid electricity, it was found that only 34.14% of the electricity users are satisfied with the utility service, 20% are not satisfied and 45.89% are neutral in their opinion.

8.2.14 Energy Transition at the Household Level

The household energy transition pattern was also investigated in the study. It was found that over the last five years, the adoption rate is more significant in the case of LPG and solar, and the abandonment rate is more significant in the case of kerosene and firewood. Increase in consumption is more significant in the case of electricity and LPG, while decline in consumption is more significant in the case of kerosene, firewood and charcoal. Important reasons for the increased consumption of modern fuels are climate change, changes in family size, changes in household fittings and appliances and changing cultural practices. In the case of traditional fuel, the major reason is attributed to climate change. Major reasons for the decline in consumption are changes in household fittings and appliances, changes in costs and increased availability of other fuels in the case of modern fuels. In the case of traditional fuels, the major reasons are changing cultural practices, changes in costs and increased availability of other fuels.

8.2.15 Households' Energy Conservation Practices

It was found that most of the households have indicated that they do not leave lights unnecessarily, do not place hot food directly in the refrigerator, nor heat food immediately out of it, or do not use washing machine with less than a full load. It is only in 'leaving appliances on standby mode', 'leaving fan on when no one is using it' and 'boiling more hot water than needed' that majority of the households responded in the affirmative. This reveals that urban households make some conscious efforts in energy conservation practices.

8.2.16 Energy-Efficient Technologies

Energy conservation is a simple step that needs to be practiced for good energy management in households and to achieve this, more efficient technologies must also be used. The study found that 72.68% of the households using refrigerators have adopted energy-efficient ones, 60.94% have adopted energy-efficient washing machine, and for cooling, 38.02% have adopted energy-efficient ceiling fans and air conditioners. Every household has adopted energy-efficient lights and 5.64% of households have adopted solar water heaters. The adoption rates of energy-efficient refrigerators and cooling appliances are higher in Dimapur compared to Kohima. In contrast, for energy-efficient washing machines and solar water heaters, the adoption rates are higher in Kohima. Achieving energy bill reduction and saving energy were important motives for adopting energy-efficient technologies by urban households.

Thus, it is evident from energy conservation practices and the adoption of energy-efficient technologies that saving energy is an important decision that households make in their energy-usage activities. Hence the hypothesis, which states that urban households make efforts to adopt practices and efficient technologies to save energy, is accepted.

High cost is an important reason for the non-adoption of energy-efficient technologies. Moreover, many households have not felt the need to adopt these technologies which could be due to a lack of information about the benefits of energy-efficient technologies.

8.2.17 Measures for Energy Efficiency

The study found that despite households' efforts to adopt energy conservation practices and efficient technologies at home, certain barriers have caused many not to make these efforts. Implementing energy-efficient measures could, therefore, significantly enhance energy use efficiency at homes, relieving the pressure on the environment and the well-being of humanity while achieving maximum benefits from the available energy. Education and information were ranked as the most important energy efficiency measures. While concerns about government campaigns and laws promoting energy sustainability were ranked lower than educational concerns, these also have significant potential for households to become more energy-efficient. Concerns such as cash incentives and raising energy prices were found to be of lower importance for energy efficiency measures.

8.2.18 Household Expenditures on Energy

Household energy expenditures were found to be higher during winter compared to summer. During summer, households in Dimapur spent proportionately more (2.8%) compared to those in Kohima (2.5%). In contrast, households in Kohima spent proportionately more (3.1%) than those in Dimapur (2.8%) during winter. Bulk of the household energy expenditures is from the consumption of modern fuels in both seasons. The share of modern fuel expenses is higher during summer compared to winter, whereas for traditional fuels, the share is higher during winter than in summer. The household expenditure share on firewood is quite low regardless of location or season due to the free availability of fuel in many households, which is collected from their own forest land. Expenditures on fuels are highly correlated with household income.

8.3 POLICY IMPLICATIONS

The household sector, being a major consumer of energy in the State, has considerable savings potential that needs to be tapped to contribute to reducing energy consumption and mitigating climate change effectively. However, this potential for savings can be beneficial only if supplemented with the development of proper structural policy measures and the implementation of appropriate energy-saving measures. Based on the findings, the following policy suggestions are put forward:

1. It would be economically, socially and environmentally beneficial if households were encouraged to use energy more efficiently by investing in more efficient appliances or engaging in energy conservation actions. For this, households need to take different actions – investing in renewable energy technologies, using more energy-efficient appliances instead of cheap/inefficient ones, changing energy use behavior into energy-saving habits and practices, and be willing to adopt their lifestyles for energy savings to occur.
2. End users should be provided with information on how to optimize their usage of energy and energy-consuming appliances. They also need to be informed of the availability of energy-efficient technologies and the respective energy cost savings, and their positive environmental impacts from proper adoption. This would facilitate reductions in overall energy consumption by encouraging users to make necessary investments and changes in their homes without adversely affecting their lifestyle requirements.
3. The present study identified continual dependence on firewood. Though urban dwellers are not directly associated with managing forest resources, they can contribute to forest conservation by managing their habits. In this context, the possibilities of a shift from firewood to non-conventional sources like solar energy can be explored. Also, an integrated approach needs to be promoted to use wood in an environmentally-friendly manner. New and renewable energies should be further promoted.
4. Due to variations in household energy use in different urban centers, it is advisable to formulate micro-level policies suitable to a particular center. To

achieve maximum effect from intervention strategies, tailored communication and campaigns that specifically address the desires and needs of the individual energy consumer are required.

5. Combining renewable energy and energy efficiency for improving energy sustainability. For example, installing solar photovoltaic or solar hot water systems can be a cost-effective way to generate energy for homes. Also, when the supplier of the renewable system makes recommendations on how to use the energy most efficiently, the generated output could be most beneficial in terms of service to the end users.
6. Education on energy and the importance of efficient energy management and conservation should be included in the curriculum in educational institutions to inculcate the value of sustainable energy behavior in the minds of the younger generation.
7. The government should enact specific plans and measures to improve household energy efficiency for sustainable energy policies. In this context, supply-side policies like improved production efficiency and technical demand-side policies like energy-efficient technologies could be complemented with information and education programmes and economic incentives to target change in household behavior.
8. Government and policymakers must take proper measures to ensure that modern and environment-friendly resources are accessible to all households at affordable costs.
9. Residential areas conducive to energy-efficient lifestyles need to be developed. As new residential areas develop, it is important to consider energy-efficiency standards as development proceeds. Provisions for area development could be tied in closely with urban development provisions and planning.
10. Social interaction through social initiatives and self-organization may be encouraged to promote sustainable energy use in households.
11. The State government may initiate the setting up of an energy research institute that may concentrate on intensive research on various energy dimensions covering technology and socio economic aspects.

8.4 SCOPE FOR FURTHER RESEARCH

The present study has made a reasonable contribution in understanding the household energy consumption behavior in urban Nagaland. However, there is still a vast scope for further research in the continuation of the present study. There are some recommendations with regard to future research. Firstly, this study is limited to the urban area and two districts, i.e., Kohima and Dimapur. For a broader knowledge of household energy consumption of the State, further research may be carried out on the remaining districts, as well as on the rural areas. Secondly, further research may be done on the degree of energy efficiency and intensity of appliance use within the homes. A household survey containing information on these facets would provide valuable insights into whether the possession of energy-efficient appliances and levels of use are associated with certain types of households. Thirdly, the impact of household energy choice and consumption on the environment may be further studied. Effects of household energy consumption on the health of the household members may also be considered. Such studies could assist policymakers in meeting energy and environmental policy objectives.

8.5 CONCLUSION

This humble step in urban energy research tried to explore the consumption aspect of urban energy behavior in Nagaland across geo-climatic and socio economic conditions. The households' attitudes toward energy conservation practices and efficiency were also studied. The study recognizes that the use pattern of urban energy is influenced by the area's geo-climatic and socio economic conditions. Individual characteristics and capabilities, knowledge, habit, and behavior also play a significant influence. A sustainable energy transition that requires individual involvement in making substantial changes in energy demand and behavior is yet to come.

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Ph.D QUESTIONNAIRE

SECTION A: SOCIO ECONOMIC PROFILE

1. Head of household: a) Husband b) Wife c) Other (specify):
2. Respondent: a) Husband b) Wife c) Other (specify):
3. Please indicate the necessary information in the appropriate space in the table below-

Sl. no.	Age of the people who currently live in the household starting with the head of household	Gender M=male F=female	What is the highest educational qualification obtained? (for age 3 and above only) 1. No schooling 2. Primary 3. High school 4. Higher secondary 5. Undergraduate 6. Post graduate 7. Others (specify)	What is the current status of adults in the household? (age 16 and above only) 1.Student 2. Retired 3. Self-employed 4. Govt. service 5. Private service 6. Unemployed
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

4. Which of these best describe your housing ownership?
   a) Owned b) Rented c) Quarters
5. What is the average monthly income of your household (in Rs.)? ☐

SECTION B: DWELLING CHARACTERISTICS

6. Which of these best describe your home?

   i. Main outer wall material: a) Brick/cement block b) Wood/bamboo c) Stone d) Metal sheets e) Other

   ii. Main roof material: a) Concrete b) Tiles c) Wood d) Metal sheets e) Other

   iii. Main floor material: a) Floor tiles b) Marble slabs c) Cement d) Earth/sand e) Wood planks f) Other

   iv. No. of room (excluding kitchen and bathroom):_____________

SECTION C: HOUSEHOLD ENERGY CONSUMPTION AND EXPENDITURE

C1. Energy Consuming Appliances

7. When do you most use these appliances?

Sl. no.	Appliance	Total no.	Frequency of use 1.Daily 2.No. of days per week 3.No. of times per month	Average hour of operation in a day	Energy Star Rating
i.	Standard TV				
ii.	LCD/LED TV				
iv.	Refrigerator				
v.	Washing machine				
vi.	Room AC				
vii.	Ceiling fan				
viii.	Electric water pump				
ix.	Electric geyser				
x.	CD/VCD/DVD Player				
xi.	Computer (desktop)				
xii.	Laptop				
xiii.	Printer				
xiv.	Rice cooker				
xv.	Phone charger				
xvi.	Electric iron				
xvii.	Electric hair dryer				
xviii.	Microwave oven				
xix.	Electric toaster				
xx.	Immersion rod				
xxi.	Electric kettle				
xxii.	Electric room heater				
xxiii.	Induction cooktop				
xxiv.	Dishwasher				
xxv.	Satellite dish				
xxvi.	Standing fan				
xxvii	Juicer				
xxvii	Mixer/Blender				
xxix.	Other-				

C2. Electricity: Access to Electricity Services

8. Indicate your satisfaction level on the performance of grid electricity

Very Satisfied	Satisfied	Neutral	Not Satisfied	Very Unsatisfied

9. What do you use when you face power failure?

a) Inverter b) Voltage stabilizer c) Generators d) Battery and storage devices

e) Candles f) Others (specify)

10. Please indicate your household's **approximate monthly electricity bill** for summer and winter:

Season	Summer	Winter
Unit (kWh)		
Cost (Rs)		

C3. LPG

11. Do you use LPG in your home?

    a) Yes b) No

12. If 'Yes',

    i) Where do you get your supply of LPG?

    a) LPG distribution station b) LPG distribution truck c) From shop d) From colony supplier e) Other (specify)

    ii) Do you avail LPG subsidy?

    a) Yes b) No

    iii) How often do you fill your LPG cylinder?

    iv) Weekly b) Fortnightly c) Monthly d) Bi-monthly e) Quarterly

    v) Please indicate the size and quantity of LPG cylinders used by your household.

Size (kg)	No. of Cylinder	Cost of Cylinder

C4. Firewood

13. Do you use firewood in your home?

    a) Yes b) No

14. If 'Yes',

    i) Are you aware of the health and environmental impact of the uses of firewood?

    a) Yes b) No

    ii) When alternative fuel is available, why do you still use firewood? (*tick all that apply*)

    a) Habituated b) Cheaper c) Easier to get than other fuel d) Other (specify)

    iii) Where do you get your supply of firewood? (*tick all that apply*)

    a) Nearby agent b) Local market c) Own farm d) Cut from forest for free e) Other (specify)

    iv) Please indicate the total firewood used in the last 3 months (approx.).

Month	1	2	3
Unit (kg or indicate other units being used)			
Cost (if purchased)			

C5. Household Energy Consumption Pattern

15. Please tick where applicable energy type use for the activities stated in the table-

	Purpose of Use					
	Cooking	Lighting	Water heating	Heating	Cooling	Not used at all
Electricity						
LPG						
Firewood						
Kerosene						
Charcoal						

16. Do you use any of these fuels for commercial activities (e.g. snacks for street selling, supply to shops, etc.)?
    a) Yes b) No
17. If 'Yes', specify____________________
18. Has your consumption pattern over the last 5 years changed for each energy source? If so, indicate the reasons given below the table for the change.

	Gone up	**Remained the same**	**Gone down**	**Reason(s)***
Electricity				
LPG				
Kerosene				
Firewood				
Charcoal				

***a=increased availability, b=climate change, c=awareness of ways to save energy around the home, d=change in family size, e=changes in household fittings and appliances, f=changing cultural practices, g=changes in costs, h=others (specify)

19. If you use the listed energy for cooking, lighting and heating, how much do they cost?

	Unit use per month	**Unit Cost**
Kerosene		
Charcoal		
Other (other than LPG, electricity, firewood)		

C6. Energy for Cooking/Fuel Use Combination

20. What energy source(s) do you use for cooking? Also specify the reason(s) for using the fuel

Source	**Used daily**	**Few times a week**	**Used for a specific type of food**	**Not at all**	**Reason***
Electricity					
LPG					
Firewood					
Kerosene					
Charcoal					
Other					

*a=easy availability, b=free availability, c=affordability, d=efficient, e=tradition/familiarity, f=cleanliness, g=time saving, h=others

C7. Energy for Lighting

21. Indicate the sources of lighting used within your household

Appliance	Total no.	Average Hours of Operation in a Day	Average No. of Days Used per Week
Incandescent bulb			
Fluorescent tubes			
LED bulbs			
CFL bulbs			
TFL			

SECTION D: AWARENESS AND ATTITUDE ON ENERGY USAGE, ENVIRONMENT AND ENERGY EFFICIENCY

22. Are you aware of standby mode of electrical appliances?
    a) Yes b) No
23. Do you know that an electrical appliance use energy when on standby?
    a) Yes b) No
24. Are you aware that inefficient use of appliances has negative effects on the environment?
    a) Yes b) No
25. Do you know that the use of energy efficient appliances reduces your electricity bill?
    a) Yes b) No
26. Do you talk to your friends or neighbours about the benefits of energy efficiency or related issues?
    a) Yes b) No
27. Please indicate how frequently you personally do the following activity in your home:
    'Leaving on lights when not in use at home'
    a) Always ☐
    b) Often ☐
    c) Sometimes ☐
    d) Hardly ☐
    e) Never ☐
28. Indicate if your household normally practise the following:-
    a) Leaving on lights unnecessarily. Yes/No
    b) Leaving appliances on standby mode. Yes/No
    c) Boiling more water in the kettle than needed. Yes/No
    d) Placing hot food directly in the refrigerator. Yes/No
    e) Heating food immediately out of refrigerator. Yes/No
    f) Using washing machine with less than a full load. Yes/No
    g) Leaving fan on when no one is using it. Yes/No
    h) Prolonging the heating while using water heating system. Yes/No

29. Indicate if you are aware of the listed energy efficiency applications and if you are aware of them, do you adopt them. Also indicate the reasons for adopting and not adopting them.

Sl no.	Application	**Adopt**		**Adopting reason (s)***	**Not adopting reason (s)****
		Yes	**No**		
1	Solar panels				
2	Energy efficient refrigerator				
3	Energy efficient air conditioner				
4	Solar water heater				
5	Energy efficient tube light/Bulbs				
6	Energy efficient washing machine				
7	Solar lamp				

*a= to save energy, b= to save money, c= to save nature, d= time saving, e=others (specify)

**a= non-availability, b= high cost, c= lack of information about the benefits, d= have not felt the need, e=others (specify)

30. How far do you agree with the given statements? Please rate each accordingly –
1=Strongly disagree 2=Disgree 3=Moderately agree 4=Agree 5=Strongly agree

Statement	**Rating**
I only buy appliances with high energy efficiency ratings even if they cost more	
I have a responsibility to save energy by using energy efficient technologies	
I believe if my household adopts some energy-saving practices, it would have a positive effect on the environment	
I primarily pay attention to energy conservation in the house to achieve a reduction in electricity bills	
I do not feel good when energy is consumed unnecessarily in the house	
I want to enjoy life without giving a thought on energy conservation	

31. To what extent would you agree or disagree that the following would help your household to become more energy efficient? Please rate each accordingly –

1=Strongly disagree 2=Disgree 3=Moderately agree 4=Agree 5=Strongly agree

	Rating
More cash incentive	
Education on how to become more energy efficient	
More information on the environmental impact of wasting energy	
Better labeling and information on appliances	
Government campaign that promote household energy sustainability	
Increasing the prices of energy beyond an agreed limit of usage	
Laws that require that products and appliances are environmentally sustainable	