SES

Social Inclusion and Energy Managment
for Informal Urban Settlements

CASE STUDY
ENERGY MANAGEMENT IN MEKELLE CONDOMINIUM HOUSING, ETHIOPIA

Sara Amare Gebremeskel – 2019
Reviewer: Peter Gotsch (Prof.)

Funded by the
Erasmus+ Programme
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A Case Study on Energy Management as Part of the SES,
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ABSTRACT

In Ethiopia, Condominium housings were introduced by Integrated Housing Development Program (IHDP) in 2005 as a housing solution for low- and middle-income households who were previously living in informal settlements. However, household energy management is becoming one of the challenging factors of affordability in such housing. This study has assessed energy management in condominium housing according to occupants' activities and behaviour, which is the major determining factor of residential buildings' energy consumption. Specifically, it has assessed the current households' fuel dependency, monthly average energy expenditure and perception on green energy. To do so, in addition to the review of secondary sources, the study has adopted an evidence-based case study approach and has conducted household surveys, focus group discussions with the occupants and in-depth interviews with professionals. Accordingly, electricity has been found to be the primary source of energy for cooking, lighting and heating; and charcoal is the secondary source mainly used for making coffee. This contradicts the general dependency share in national Ethiopian energy context, according to which waste and biomass are the country's primary energy sources. That means that living in condominium does not allow the households to use other energy options than electricity even during scarcity. Also, the average monthly expenditure in terms of their socio-economic status is 349 birr in 2018 currency, which takes up to 17.7% share of their income, and is costly when compared with average energy expenses of low income groups in Ethiopia, which ranges at 10%. Residents' acceptance and willingness to use green energy has been found to have a direct relationship to their education level. ◆

Key words: fuel dependency, average energy expenditure, perception on green energy

> " The aim of this paper is to provide an overview of Ahmedabad's development over time, with a focus on the urban poor and marginalised communities and their housing."

CONTENTS

PART 1
INTRODUCTION

In Ethiopia, under section 2 of the Condominium Proclamation No. 370/2003 (MWUD 2007), condominium means "a building for residential or other purpose with five or more separately owned units and common elements, in a high-rise building or in a row of houses, and includes the landholding of the building. Common elements refer to all parts of the condominium except the houses owned individually." Generally, a condominium is a multiple-unit dwelling in which there is separate and distinct ownership of individual units and joint ownership of common areas. The building is managed by the condominium association, either directly or through a professional manager. The owners of the individual units are jointly responsible for the costs of maintaining the building and common areas, but they are individually responsible for the maintenance expenses of their particular units.

The integrated housing development program (IHDP) is the eighth core component of the Plan for Accelerated and Sustained Development to End Poverty (PASDEP). The PASDEP is the second five-year national strategic plan of Ethiopia which got into action by 2005/06. The Integrated Housing Development Program (IHDP) is an urban strategy with an approach of integrating initiatives to address poor housing quality, housing shortages and reduce slum areas in Ethiopia's main cities by 50%. The program was initiated by the Ministry of Works and Urban Development (MWUD) in 2005 with the aim of increasing housing supply for the low-income population, recognizing existing urban slum areas and mitigating their expansion in the future (MWUD, 2007).

IHDP is developed for all slums to be cleared within ten years by introducing condominium housing stocks for the slum dwellers and for Ethiopia to be a middle-income country by 2025 (MWUD, 2007). The IHDP aims at providing affordable housing for those middle- and lower-income households who do not own a house (Ibid). The initial goal of the housing development program, during the four-year program period 2006/7 to 2009/10, was to construct 360,000 condominium units in cities (Ibid). As part of this IHDP program, 3322 total housing units are constructed in 6 Sub cities and transferred to users in Mekelle in 2006 and 2007 (MHDA, 2008).

Related to this aspect of housing for the poor, some international researches have been conducted. SES[1] is one of such researches, but in a holistic approach which integrates students and teachers from Ethiopian universities and professors from European universities. It helps Ethiopian cities to solve problems related to housing poor urban communities by supporting these communities rather than evicting them from their informal settlements. The project introduces a holistic approach in Ethiopian higher education institutions' existing academic programs for future urban developers and energy managers and educates responsible personnel at local authorities. The first aim of the project is to increase the relevance of architecture and planning studies to the community by introducing multidisciplinary topics like social inclusion, sustainable housing, participatory mapping and environmental risk assessment. The project has a holistic approach towards improving poor residents' security in housing and their access to energy needs.

1 Social inclusion and energy management for informal urban settlement. SES is a project funded by the Erasmus+ Programme of the European Union. https://moodle.donau-uni.ac.at/ses/mod/page/view.php?id=145

As part of the SES project'sfocus on sustainable housing and energy management, this study will investigate energy management of condominium housings. Condominium housing is built to be affordable to low- and middle-income households who are currently living in informal settlements. But households' energy consumption and management are becoming one of the challenging factors of affordability in those condominiums. This issue of affordability, a major concern of the energy management challenges, is the focus of this study.

It aims at orienting students of architecture and urban planning with regards to the hidden aspect of energy management in housing, which is the occupants' behavior. For sustainability of housing, the the building as a structure and the occupants' behavior need to be considered, as they are the two major parameters of building energy model (Virote, J. and R. Neves-Silva 2012). Occupants' activities and manners towards energy consumption are the major determining factor of residential building consumptions. A lot of energy is wasted due to occupants' behavior (J. S. Hassan et al. 2014). Designers often assume that occupants will use buildings as designed so they mostly focus on the building as a structure. However, occupants of a building do not always acknowledge designer's effort, instead, they operate the building contrary to its original design. For example; occupants of buildings consider comfort more than energy conservation (Knight I., S., Lasvaux S. 2007). So, this study will equip the students and graduates with knowledge on occupants' behavior and the role in housing quality when they need to design sustainable housing.

1.1 Research Question

This study has assessed energy management in condominium housing according to occupants' activities and behavior, which is the major determining factor of residential buildings' energy consumption. Specifically, it has answered questions regarding the current households' fuel dependency, monthly average energy expenditure and perception on green energy. ◆

PART 2
REVIEW OF LITERATURE

2.1 Introduction

Review of secondary data is done to investigate existing knowledge about the research questions of this study, major topic areas such as housing consumption and energy challenges in Ethiopia, housing consumption and energy management trends, energy policy and strategy, renewable energy sector and the future scenario are reviewed.

2.2 Housing Energy Consumption and Challenges in Ethiopia

In this section, topics related to determinants of household energy consumption, energy mix, energy supply versus demand and energy affordability are discussed.

Determinants of Household Energy Consumption
It is a must to have an overview of the determinant factors of household energy consumption to know where to focus while analyzing the household energy consumption. Therefore, according to Steemers and Yun (2009), building orientation, building services and energy systems (e.g space cooling/heating hot water supply etc.), building operation and maintenance, occupants' activities and behavior and indoor environmental quality are the determinant factors (Steemers and Yun, 2009). Also, a recent research by Kavousian et al. (2013) has identified four major categories of determinants that influence building energy use (Kavousian et al. 2013). They are explained as follows:

i. Weather and Location: Climatic zone and daily outdoor temperature changes according to the weather condition and location of a particular country.

ii. Physical Characteristic of the Building: This factor considers the type of fuel use for water heating as well as the level of insulation used in the building. This determinant takes a very long-term investment when it comes to modification.

iii. Appliance and Electronics Stock: This factor considers air-conditions, refrigerators and computers used in the buildings. This determinant takes a medium to short-term investment when it comes to modification.

iv. Occupancy and Occupant's Behavior towards Energy Consumption: according to the study, energy-efficient buildings are not limited to design and construction alone. Occupant behavior can easily influence consumption. It is very difficult to predict the level of occupants' interaction at an individual level, rather, the use of patterns for a group of occupants and general control-related behavioral trends need to be outlined. Occupants' activities and attitudes towards energy consumption are the major determining factor of residential building consumptions. Some behavioral determining factors are easy and temporary (e.g. setting of thermostats), while other determinants are associated with long-standing effort and impact (e.g., buying energy-efficient appliances) (J. S. Hassana et al. 2014).

In addition, as for the comparative analysis of household energy consumption patterns, a case study of Merkato and Jemo residential areas of Addis Ababa city by Marta Gebreyesus in 2016, identifies different factors that determine the household energy consumption, such as cooking, lighting and heating; development level of the country, economic status of

the household, (socio-economic status as in terms of income and level of education) awareness and settlement of the household. In this study, for the analyses of energy use patterns, household income, family size and housing type are used as factors and relations were established between these factors and energy use patterns. Family size indicates the number of inhabitants in the household and, as of this study findings, the relationship between the energy consumption and family size have positive relation: with family size increases the energy consumption also increases. Monthly income indicates the average monthly income and, as of this study's findings, the relationship between income of the household and energy consumption have positive relation, which means: as monthly income increases the energy consumption also increases. Housing type indicates the type of housing the household is living in and is specific to the status of the housing. The study implies that households who reside in condominium houses use modern energy sources other than that of households who live in kebele houses and other housing units (Gebreyesus, 2016).

Energy Mix

The national energy mix is the snapshot of a country's dependency on each energy source and provides a good indication of a country's energy challenges (IEA, 2012).

According to the International Energy Agency (2016), Ethiopia is one of the least developed countries in the world, whit approximately 34% of its over 100 million inhabitants living below the poverty line. It has one of the lowest rates of access to modern energy services, whereby the energy supply is primarily based on biomass (mainly fuel wood, animal dung, crop residues) with a share of 92.4% of national energy supply. Waste and biomass are the country's primary energy sources, followed by oil (5.7%) and hydropower (1.6%) (IEA 2016). Even in urban areas, half the households rely on traditional biomass (wood, dung and agricultural residues) for cooking, and in rural areas, virtually all do (except for 0.2% who use kerosene, and 1.2% charcoal). While many nations in sub- Saharan Africa face similar challenges, Ethiopia ranks particularly low in terms of energy progress, 62nd out of 64 per the IEA's 2011 Energy Development Index, with an EDI of 0.017 (REEP, 2014).

Energy Supply vs Demand

As of the International Energy Agency (2016), Ethiopia has a final energy consumption of around 40,000 GWh, whereof 92 % is consumed by domestic appliances, 4% by transport sector and 3% by industry. Most of the energy supply thereby is covered by bioenergy, which in case of domestic use is usually stemming from unsustainable sources. The produced electricity of ~ 9000 GWh/ais mainly generated by hydro energy (96%) followed by wind energy (4%), whereof in total 11% gets exported. In contrast, the major share of energy supply for transport is imported in forms of petroleum (IEA, 2014).

Energy Affordability

According to the summery given by Bereket et al. (2002) in their paper 'Affordability of modern fuels and patterns of energy demand in urban Ethiopia' households expend around a tenth of their income on energy. A majority of the population uses biomass energy such as burning wood, crop waste, and animal dung as their primary energy source. The high consumption of biomass energy has resulted in the continuing destruction of forests and woodlands. The expenditure on firewood is the most important (38% of the households' energy budget) followed by electricity (20%) and kerosene (19%). Charcoal accounts for 17% and dung cakes for 5% of the household energy budget. Butane gas and sawdust are the least important. The combined percentage share of firewood, charcoal and dung cakes is 60% implying heavy dependence on biomass fuels. The mean budget share of poor households for energy supply is 10% while that of non-poor is around 7% (but the non-poor expend more in absolute terms). The dependence of households on biomass fuels

significantly decreases with increase in income. The lowest income group expends 70% of its energy budget on biomass fuels but the corresponding figure for the richest is only 42%. The dependence on biomass fuels in urban centers varies widely. The shares of biomass fuels range from 26% (Addis Ababa) to 85% (Gondar). Addis Ababa is the only urban center without heavy dependence on biomass fuels and is on top of the list for all three modern forms of energy. Kerosene seems to be affordable for all urban areas. Electricity is too expensive even for the relatively well to do (Bereket et al. 2002).

Energy Expenditure

In a region where average incomes are low, the importance of the relationship between incomes, energy prices and energy expenditure are starkly evident. Across sub-Saharan Africa, the wealthiest 20% of households account for about half of total residential spending on energy, on average, while the poorest 20% account for around 5% (IEA, 2014). Around 40% of total energy expenditure is on electricity and 25% is on kerosene, but this picture is distorted by the consumption of unpriced solid biomass (Ibid).

In general, as one would expect, the heavy burden of energy expenditures tends to get lighter as households' incomes increase. For instance, energy expenditures in South Africa account for around 3.5% of total income, while in Malawi, where income levels are typically much lower, the share is more than double (NISR, 2012). Large disparities in electricity consumption are also evident: in countries with intermediate levels of income, the wealthiest 20% of households tend to account for around 40% of consumption while, in the extreme case of Malawi, the richest 20% consume more than 80% of the total (Ibid). Urban and rural households are also very different, with urban households typically having higher incomes and better access to electricity services. In Rwanda, for example, more than 40% of urban households report electricity spending, while in rural areas the figure is 4% (Ibid) (IEA, 2014).

2.3 Housing Consumption and Energy Management Trends in Ethiopia

Energy Management

Building Energy Consumption Model

Building Energy Model is a simulation instrument to calculate the energy and thermal load used in either residential or commercial buildings. Building Energy Models are used in retrofitting of the existing structures based on the building architecture and HVAC as well as designing of new buildings. The model can suggest the right construction materials to be used in a building; it also can indicate unique energy-saving methods like advanced window treatment for sun shading as well as renewable energy systems (Zhao, H.-x. and F. Magoulès. 2012). The building as a structure and the occupants of the building are the two parameters that need to be considered while developing a building energy model. The building as structure is represented by the architectural layout, the materials and HVAC equipment used in the building (Virote, J. and R. Neves-Silva, 2012).

Many parameters need to be considered while evaluating the energy performance of a building. This may include the passive solar usage, indoor and outdoor condition, ventilation, thermal characteristic of the building (A. B. H. Kueh; et al. 2011 cited in J. S. Hassan et al. 2014), occupants' behavior with regards to energy usage as well as weather condition of a specified region (Foucquier, A. R., et al. 2013 cited in J. S. Hassan et al. 2014). Also, buildings are usually designed on the assumption that occupants will use it as designed. However, occupants of buildings consider comfort more than energy conservation. Besides that, occupants of a building do not always acknowledge designers effort, instead, they may operate the building contrary to its original design (Knight I., S., Lasvaux S. 2007) It is assumed that more understanding of occupants' behavior related to energy usage supports a more realistic prediction of buildings' energy consumption (J. S. Hassan et al. 2014).

Regarding occupants' behaviour related to energy usage, some interventions are made in Ethiopia in the household sector towards energy demand and supply management (EEA, 2007/08). The box below shows three case studies of interventions which are applied in Ethiopia regarding energy management.

Box 1

Ethiopian case studies on interventions regarding household energy management

Case study 1:
Dissemination of Mirt stove
One of the demand-side management interventions in the household sector has been the dissemination of efficient cooking appliances. In particular, the improved biomass injera stove - locally known as Mirt – has been disseminated by the private sector, governmental and non-governmental organizations. At the end of 2008, an estimated 400,000 stoves have been disseminated throughout the Country. The fuel saving of Mirt stove is 48 percent. The wide scale dissemination of this stove will decrease the demand for firewood, crop residues and animal dung.

Case study 2:
Ethanol use for transport and for cooking
Ethanol is used in cars as additive to gasoline, in flexible fuel (FF) cars or in dedicated ethanol engines. The Government has mandated a 5% gasoline blend starting in October 2008. Ethanol will also substitute for kerosene for cooking on a liter for liter basis. Ethanol is being used both for transport as well as for cooking. Currently, Finchaa Sugar Factory is producing 8 million liters a year. The Government plans to expand capacity of existing sugar factories as well as develop a new factory at Tendaho. Ethanol production was expected to increase to about 62 million litters by 2015. For the gasoline blend 7 to 19 million liters of ethanol was required and the remaining was for domestic and commercial cooking market. Ethanol for cooking was expected to displace about 43 million liters of kerosene in 2015 or about 5 percent of the projected demand.

Case study 3:
Switching to compact fluorescent lamps (CFLs)
One of the potential electricity efficiency measures in buildings is replacement of the incandescent light bulbs with energy saving compact florescent lamps (CFLs). Compared to incandescent lamps of the same luminosity, CFLs require les energy and last longer. CFLs use about 20 percent of the energy equivalent incandescent lamps. Lighting accounts for 25 percent and 20 percent of the demand for electricity by households and the service sectors. Switching from incandescent lighting to CFLs should, therefore, result in significant reduction in peak-hour electricity demand. It was assumed for complete phasing-out of incandescent light bulbs over the period 2011-2016 in the household and service sectors, to save about 20 GWh during the first year and nearly 600 GWh in 2016.

Source: compiled from (EEA, 2007/08)

Drawbacks to Energy Management in Ethiopia

Ethiopia is still at a low level of development of its energy infrastructure and access to energy. Ethiopia is by far less than the average for developing countries when one looks at both the installed capacity per person and per capita consumption for electricity. While 85% of the population of Ethiopia live in rural areas (with less than 1% electricity coverage), electricity supply from the grid is almost entirely concentrated in urban areas (EEA, 2007/08).

Electricity, petroleum and biomass fuels are the major fuels in Ethiopia, and accordingly, the problems and challenges in the energy sector are listed as follows (EEA, 2007/08):

I. Shortage of electricity generation capacity
II. Low level of access to electricity supply
III. Huge financial investment required for the implementation of generation and transmission projects/ programs
IV. Need for better handling of environmental issues encountered in developing electricity supply infrastructure
V. Heavy financial burden resulting from the import of petroleum fuels
VI. Lack of substitutes/supplements for biomass fuels used in households, in the face of decreasing availability of fuel wood
VII. Low level of efficiency of use of energy in all sectors
VIII. Low level of renewable energy development outside large-scale hydropower development
IX. Low level of entrepreneurial capacity in the energy sector
X. Lack of comprehensive energy policy and strategy tuned to the current and impending challenges and opportunities
XI. Lack of a comprehensive development program for the sector

2.4 Renewable Energy Sector Context in Ethiopia

To date in Ethiopia, reasons for negligence to integrate green energy in social housing are: lack of confidence in real benefits; time and budget constraints; inadequate and expensive resources; incorrect perceptions about the amount of energy consumption in social housing; wrong perceptions of real costs of sustainable alternatives; land-use constraints; lack of related skills, research, and knowledge among stakeholders; and fragmentation in the process of design, construction, use and maintenance over the life-cycle of a building (UN-Habitat, 2015). ◆

PART 3
METHODOLOGY

Generally, a exploratory case study approach was found. to be compatible to achieve the study objectives. It is used to diagnose the existing situation with regards to energy consumption and management of households in condominium housing estates in the city of Mekelle, Ethiopia .

3.1 Case Area Selection

The case study is conducted in condominium housing of the sites of Merha Tibeb from Hawelti sub-city, Ayder from Ayder sub-city, QelQel Debri from Hadinet sub-city and Quiha from Quha sub-city. The sites are selected according to their location regarding the east, waste, north, and south orientation of the city so that they can represent majority of the condominium sites in the city.

3.2 Data Sources

Primary Data Sources
The assessment on the existing energy challenges and the existing energy management trends is made based on the users' perception, the professionals' view and the author's investigation.

Secondary Data Sources
Documented data related to the local and international energy overview are used as secondary data sources. The major sources of archival materials are prevalent published materials.

3.3 Sampling and Respondents

The research is carried out with representative householders of the condominium site. It has included different gender, income and occupation groups who had family before and came from different neighborhoods.

3.4 Data Collection Techniques

Questions for the assessment of existing energy challenges and energy management trends were handled in three ways: in-depth interview, focus group discussion and questionnaire. In-depth interview was for the professional respondents, and focus group discussion and questionnaire were for household/dweller respondents.

In-depth Interview
In-depth interview was designed both in semi-structured and un-structured; Extensive interviews were conducted, which encouraged respondents to talk freely and in depth about a topic (Appendix 8.2).

Foucus Group Discussion
The questions for the focus group discussion were designed to extract householders' view of energy usage and management. It was also employed to understand the difference of household energy management in condominium housing with that of other housing (Appendix 8.3). The focus group discussion was held with stakeholders and representatives of the community during a local dissemination workshop.

Figure 1

UoM-SES team in stakeholders discussion

Questionnaire

This case study's questionnaire adressed condominium dwellers and their dependency on each energy source, their level of satisfaction on each energy type they use, their energy consumption and expenditures and their way of management at household level and drawbacks of the existing management trend (Appendix 8.1).

3.5 Data Analysis and Interpretation

The data collected through the in-depth interviews, questionnaires and focus group discussion is analyzed case by case according to the respondents' housing condition, their energy consumption and management and their attitude towards green energy. Then, the analyzed data is interpreted under the category of fuel type dependency, monthly average energy expenditure and their attitude towards green energy according to their socio-economic group. ◆

PART 4
RESULTS AND ANALYSIS

This section includes the result and analysis of the research for the four condominium sites taken according to their location within the city;. Those case study areas are located in four sub-cities, which are: Ayder Condominium site from Ayder sub-city, QelQel Debri Condominium site from Hadinet sub-city, Merha

Figure 2

Location of the designated cae study areas in terms of location within Mekelle

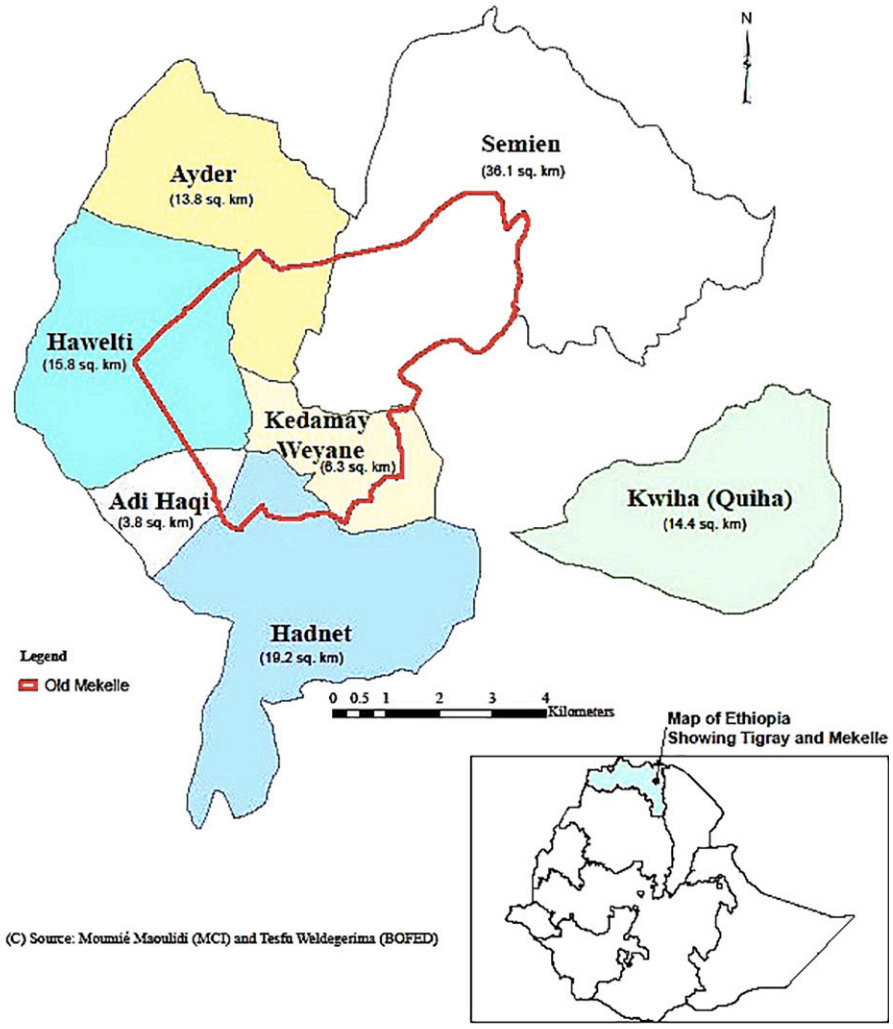


Table 1

Condominium Housing Statistics in Mekelle

TOTAL CONDOMINIUM HOUSING STATISTICS 2007/08									
Sub City	Site	No of Blocks	Studio	No. Bed rooms			Total	Business	Total Residence and business
				1	2	3			
Semen	Endatsaba	2	16	24	16	0	56	6	62
Semen	05 taxi destination	2	0	12	18	4	34	6	40
Semen	05 Senit	2	0	32	16	0	48	12	60
Semen	Mayduba	2	10	31	28	0	69	6	75
Sub total		8	26	99	78	4	207	30	237
Ayder	Old business	7	50	87	64	8	209	20	229
Ayder	Ayder areki factory	4	8	64	28	8	108	22	130
Ayder	Ayder	17	83	136	146	41	406	27	433
Ayder	Old business	2	20	10	0	10	40	0	40
Sub total		30	161	297	238	67	763	69	832
Adi haki	Serawat	13	65	103	58	45	271	32	303
Adi haki	Adihawsi	6	9	68	37	9	123	29	152
Adi haki	Endamaryam	4	16	40	20	12	88	8	96
Sub total		23	90	211	115	66	482	69	551
Hadinet	Kelkel Debri	12	22	120	94	30	266	24	290
Hadinet	Adihawsi	9	62	84	66	15	227	28	255
Hadinet	Maygebel	12	103	130	115	19	367	19	386
Hadinet	Edagabieray	5	24	60	38	9	131	17	148
Hadinet	Kasech	3	14	16	10	10	50	6	56
Sub total		41	225	410	323	83	1041	94	1135
Hawelti	Dejen	2	0	15	24	4	43	4	47
Hawelti	Dedebit microfinance	2	11	16	5	7	39	5	44
Hawelti	Merha Tibeb	9	21	72	65	29	187	24	211
Sub total		13	32	103	94	40	269	33	302
Quiha	Quiha 1	5	23	48	81	8	160	9	169
Quiha	Quiha 2	3	14	31	38	8	91	5	96
Sub total		8	37	79	119	16	251	14	265
TOTAL		123	1142	1265	1934	552	3013	309	3322

As we can see from the above table of condominium housing statistics in Mekelle, condominium sites offer residence as well as business rooms. As this study deals with energy issues for housing consumption, it only targets on those typologies designated for pure residence but also includes those registered for pure residences while informally used for mixed-use purpose. The result and analysis are presented for all the case study areas separately in APENDEX 1: Detailed Results of investigated Condominium sites, page 36. ◆

Source: Data from the Tigray Housing Agency, 2000

PART 5
FINDINGS AND DISCUSSION

Tibeb Condominium site from Haweti sub-city and Quha Condominium site from Quha sub-city.
Occupants' activities and behavior in terms ofenergy consumption is the major determining factor of residential buildings' consumption. A lot of energy goes to waste due to occupants' behavior (J. S. Hassan et al. 2014). The occupants' behavior with regards to energy consumption and management varies according to their socio-economic status. In this study, their energy consumption and management are discussed mainly in relation to their family size, educational level, economic group and occupation group.

5.1 Household Fuel Type Dependency

In this section the dependency of households on a particular fuel type is discussed according to the educational status, occupation group and income group. The four condominium site households' fuel use can be summarized as in the following charts.

Chart 1

Fuel use in terms of educational status of QelQel Debri condominium site households

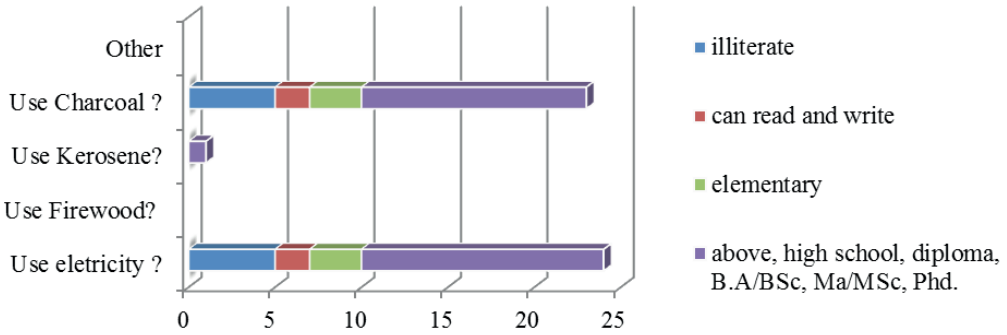


Chart 2

Fuel use in terms of educational status Merha Tibeb condominium site households

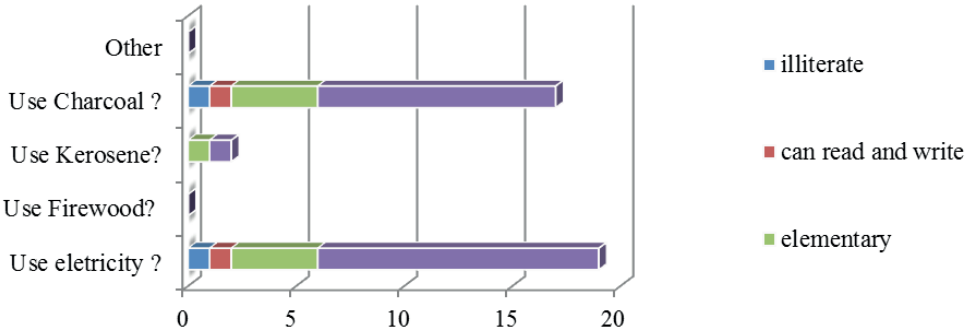


Chart 3

Fuel use in terms of educational status Ayder condominium site households

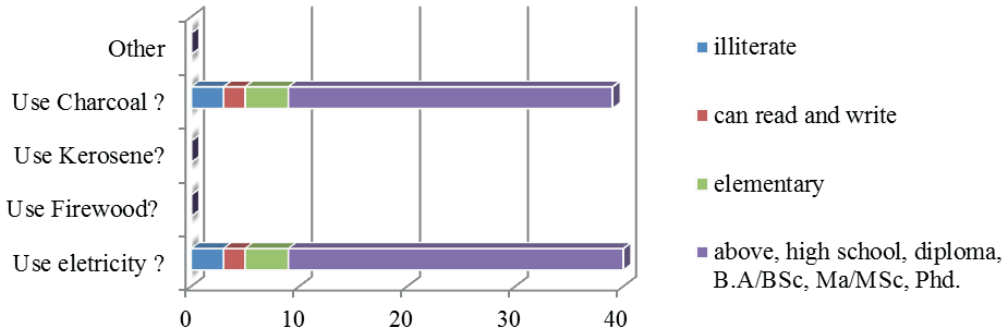
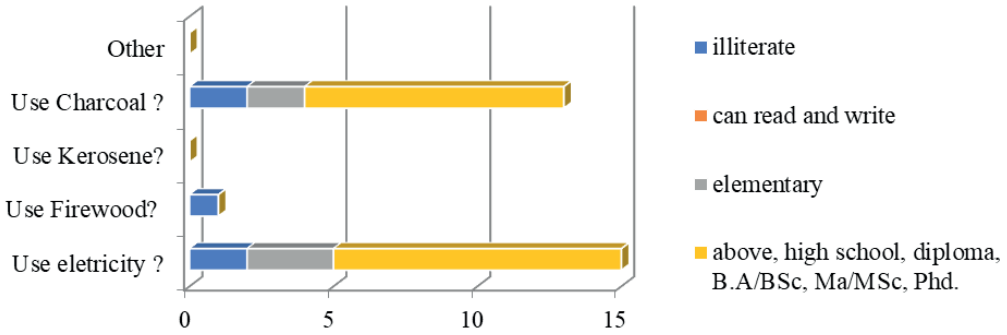


Chart 4

Fuel use in terms of educational status Quiha condominium site households



Regarding educational status of the households in all site, those with educational status of above high school are dominant in number (58% in QelQel Debri, 68.5% in Merha Tibeb, 77% in Ayder and 80% in Quiha) and are major users of electricity (96% for QelQel Debri, 100% for Merha Tibeb, 93% for Ayder and 80% for Quiha) followed by charcoal (4% for QelQel Debri, 7% for Ayder and 20% for Quiha). This indicates that electricity is the primary source of energy for cooking, lighting and heating; and charcoal is the secondary source mainly used for making coffee.

Chart 5

Fuel use in terms of income group of QelQel Debri condominium site households

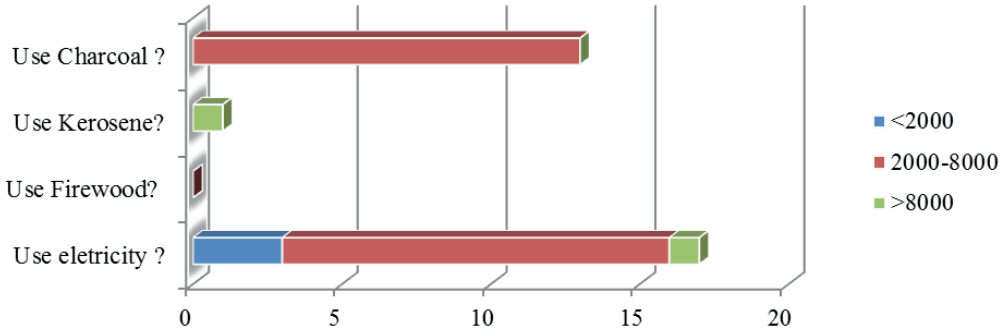


Chart 6

Fuel use in terms of income group of Merha Tibeb condominium site households

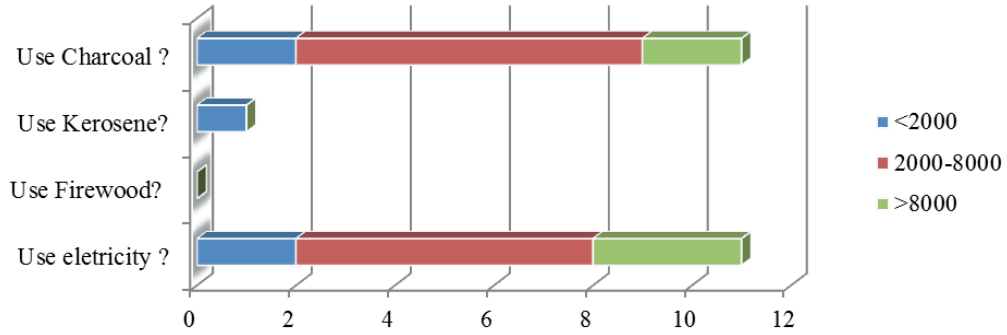


Chart 7

Fuel use in terms of income group of Ayder condominium site households

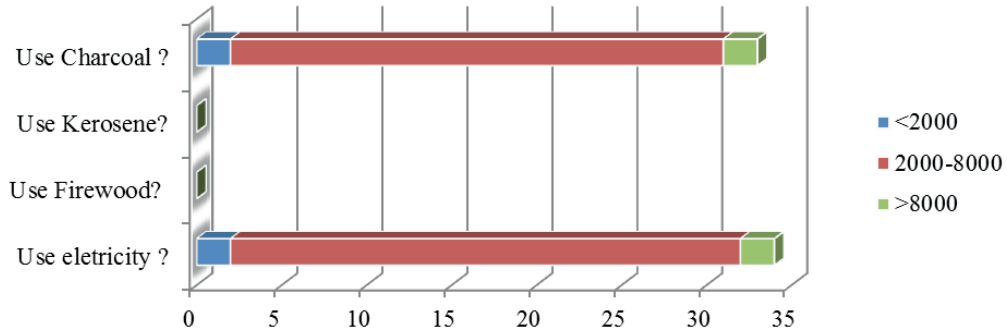
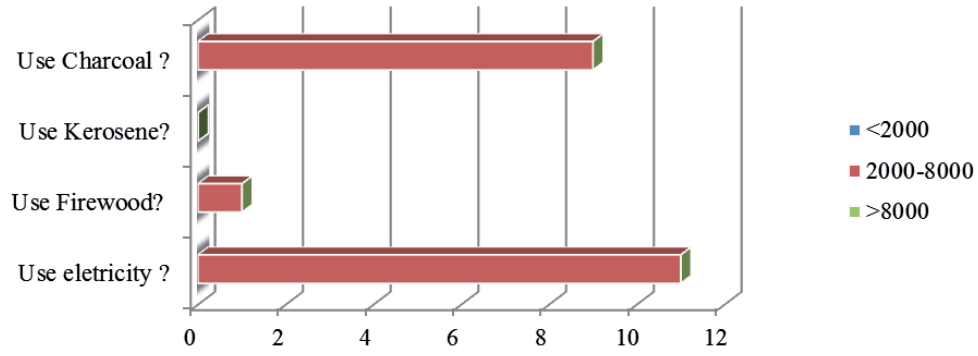


Chart 8

Fuel use in terms of income group of Quiha condominium site households.



In all sites, those with income group of between 2000 up to 8000 Birr are dominant in numbers (58% in QelQel Debri, 42% in Merha Tibeb, 72.5% in Ayder and 73% in Quiha) and are major users of electricity and charcoal (72% for QelQel Debri, 58% for Merha Tibeb, 85% for Ayder and 81% for Quiha).

Chart 9

Fuel use in terms of occupation group of QelQel Debri condominium site households

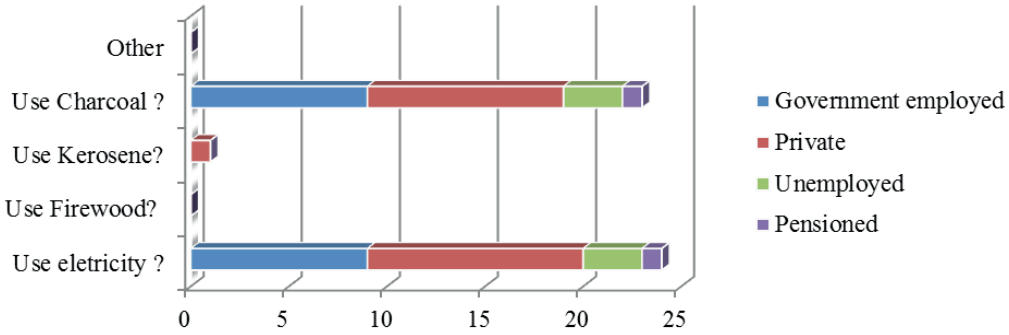


Chart 10

Fuel use in terms of occupation group of Merha Tibeb condominium site households

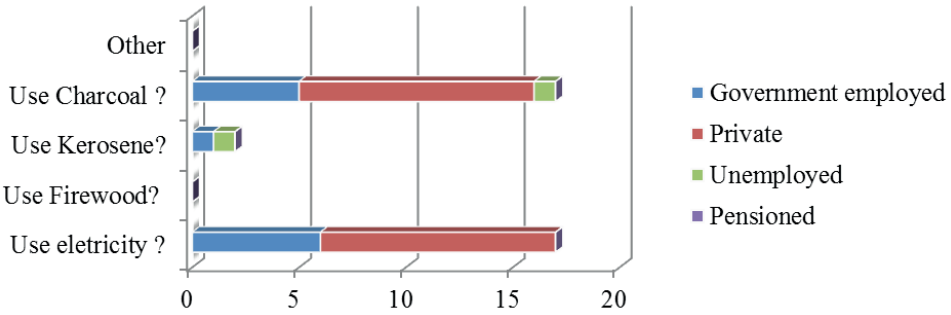


Chart 11

Fuel use in terms of occupation group of Ayder condominium site households

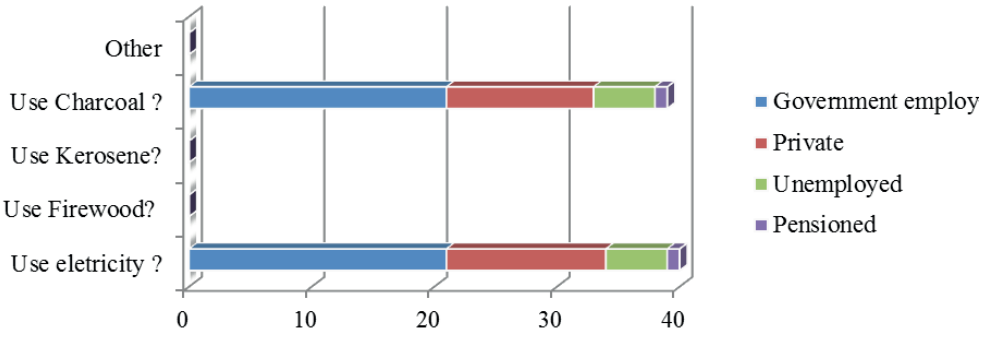


Figure 3

Charcoal use of households

Regarding occupation of households in all site, those private and government employed are dominant in number (49% and 38% in QelQel Debri, 58% and 32% in Merha Tibeb, 35% and 48% in Ayder and 38% and 50% in Quiha), They are major users of electricity and charcoal (42% for QelQel Debri, 58% for Merha Tibeb, 52.5% for Ayder and 40% for Quiha). Electricity and charcoal are the major source of energy for most households.

Therefore, based on the above summary, it can be concluded that electricity and charcoal are the major sources of energy for all of the condominium households. According to the energy context in Ethiopia, the dependency share is 60% on biomass, 20% on electricity, 19% on kerosene and 1% on other types of energy (ES, 2016). The majority of the population uses biomass energy such as burning wood, crop waste, and animal dung as their primary energy source (Ibid). Half the households living in urban areas rely on traditional biomass, and almost all do in rural areas. There is thus a considerable contradiction between the primary data gained from the existing condominium sites in this study as electricity and charcoal are the major source of energy for all households and what is existing in the secondary data. . Living in condominiums does not allow households to use more energy options even when those sources are scarce.

Chart 12

Fuel use in terms of occupation group of Quiha condominium site households

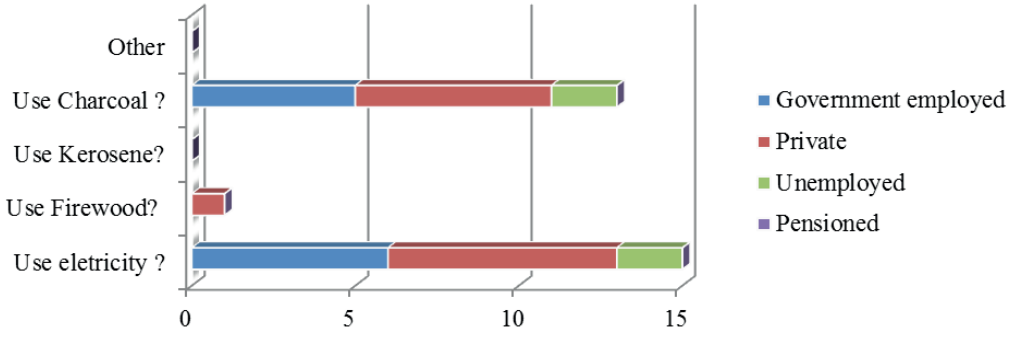


Figure 4

Electricity use of households

5.2 Household Monthly Average Energy Expenditure

The households'average monthly expenditure on energy in Birr (2010E.C) is also analyzed in relation to the educational status , family size, and income group.

Chart 13

Monthly average energy expenditure in Birr (2010E.C) in terms of educational status of QelQel Debri condominium site households

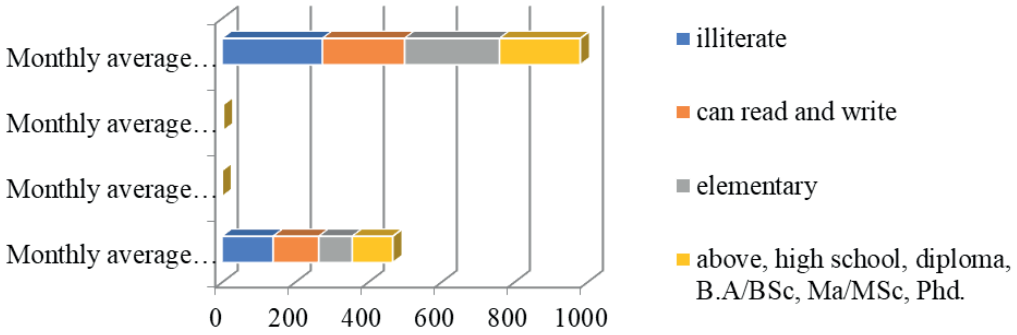


Chart 14

Monthly average energy expenditure in Birr (2010E.C) in terms of educational status of Merha Tibeb condominium site households

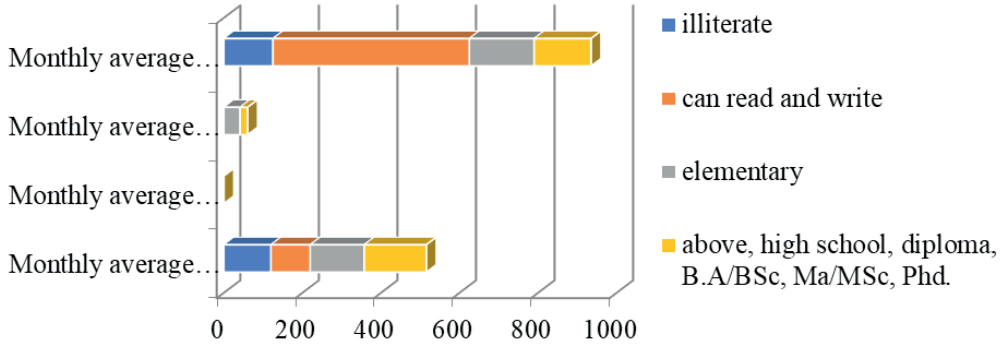


Chart 15

Monthly average energy expenditure in Birr (2010E.C) in terms of educational status of Ayder condominium site households

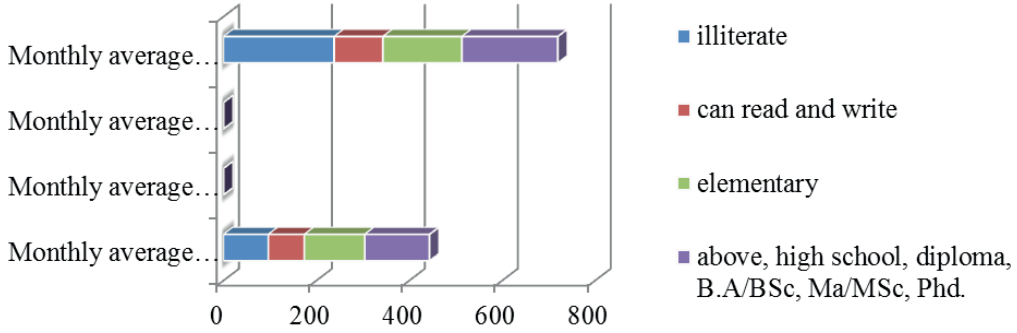
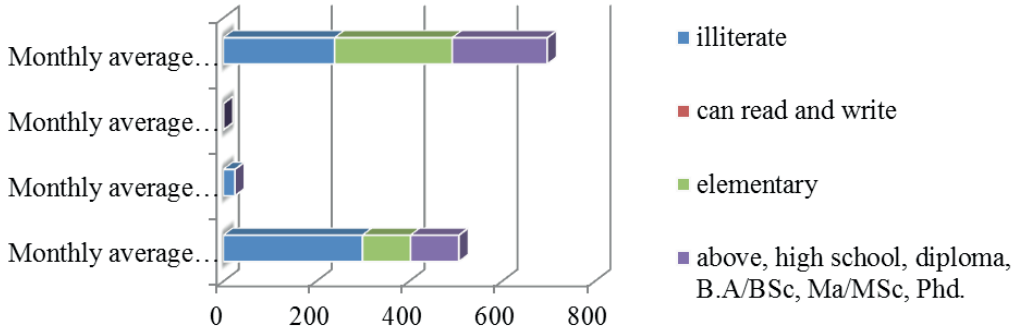


Chart 16

Monthly average energy expenditure in Birr (2010E.C) in terms of educational status of Quiha condominium site households



With regards to households' average monthly expenditure on energy (sum of the electricity and charcoal) it can be seen from the summary that those in the education level of illiterate and those who can read and write have more expenditure for energy with an average of 378 Birr than those in the education level of elementary and above(320 Birr).

Chart 17

Monthly average energy expenditure in Birr (2010 E.C) in terms of family size of QelQel Debri condominium site households

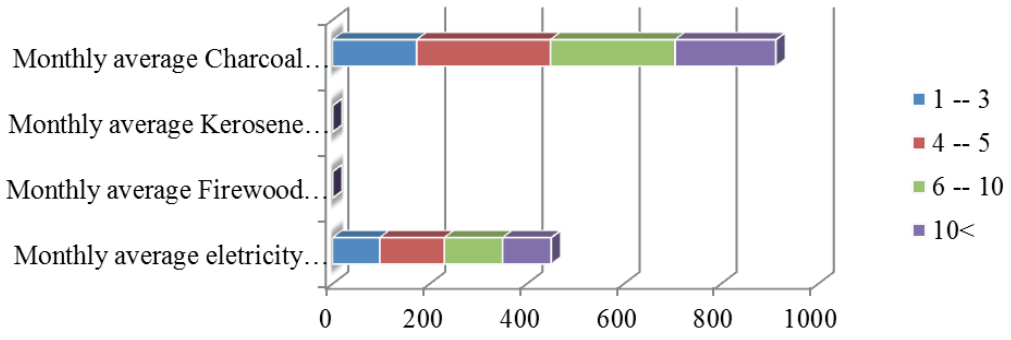


Chart 18

Monthly average energy expenditure in Birr (2010 E.C) in terms of family size of Merha Tibeb condominium site households

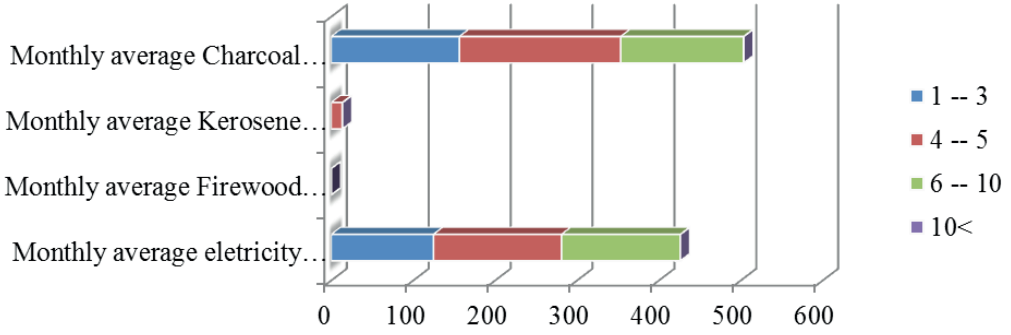


Chart 19

Monthly average energy expenditure in Birr (2010E.C) in terms of family size of Ayder condominium site households

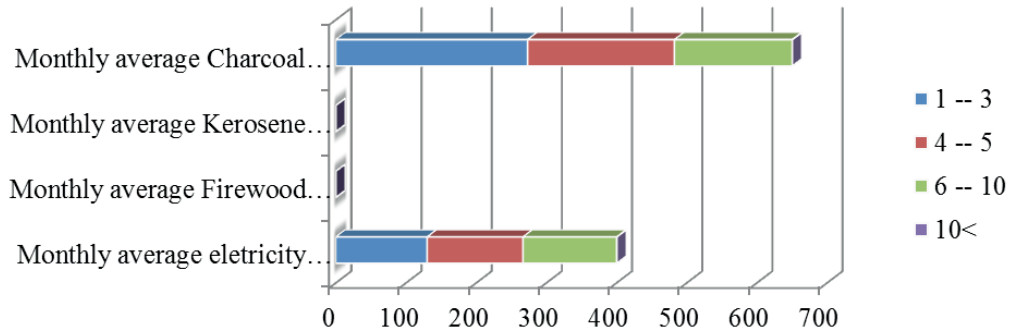
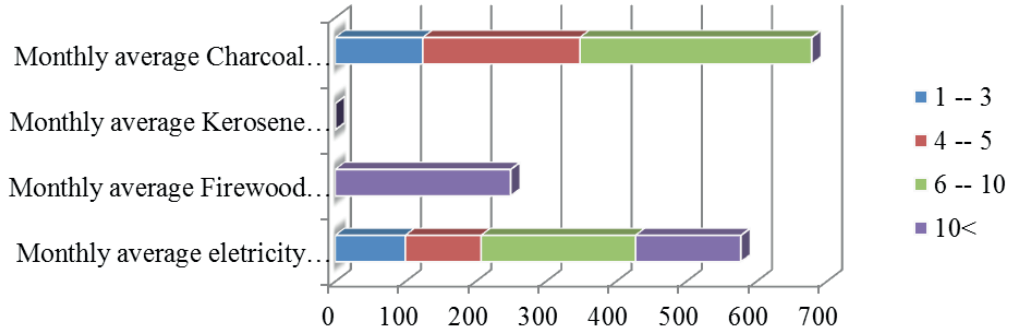


Chart 20

Monthly average energy expenditure in Birr (2010E.C) in terms of family size of Quiha condominium site households



Family size is another determining factor which influence average monthly expenditure on energy. Among the visited households, 32% have 1 to 3 family members, 44% have between 4 and 5 members, 22% comprise of 6 to 10 persons and 3% have above 10 family members. Hardly surprisingly, average monthly expenditure is increasing with an increase in family size.

Chart 21

Monthly average energy expenditure in Birr (2010E.C) in terms of income group of QelQel Debri condominium site households

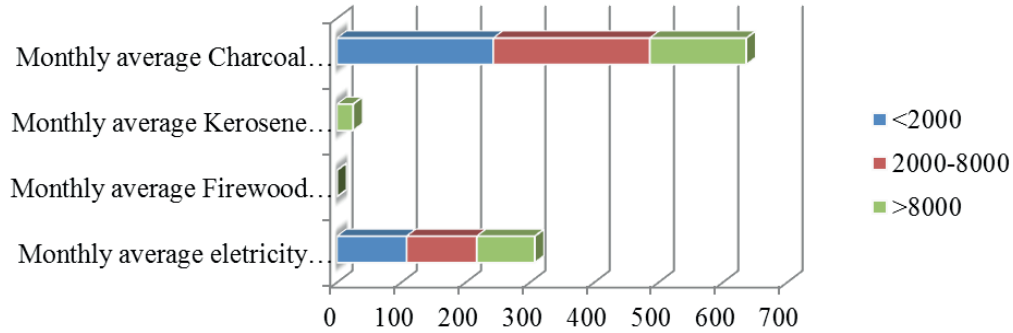


Chart 22

Monthly average energy expenditure in Birr (2010E.C) in terms of income group of Merha Tibeb condominium site households

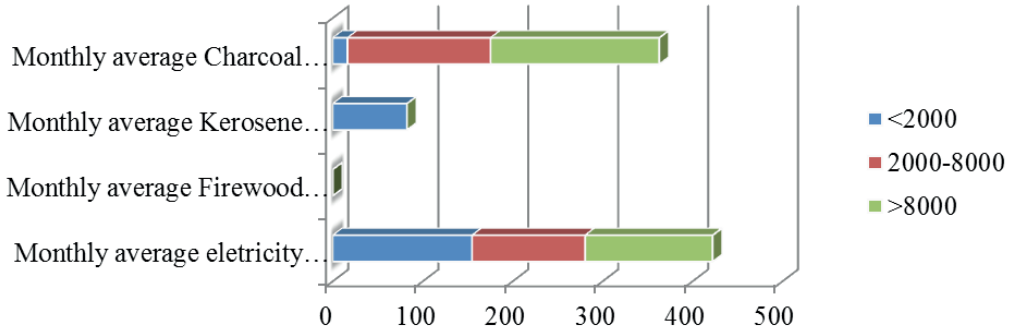


Chart 23

Monthly average energy expenditure in Birr (2010E.C) in terms of income group of Ayder condominium site households

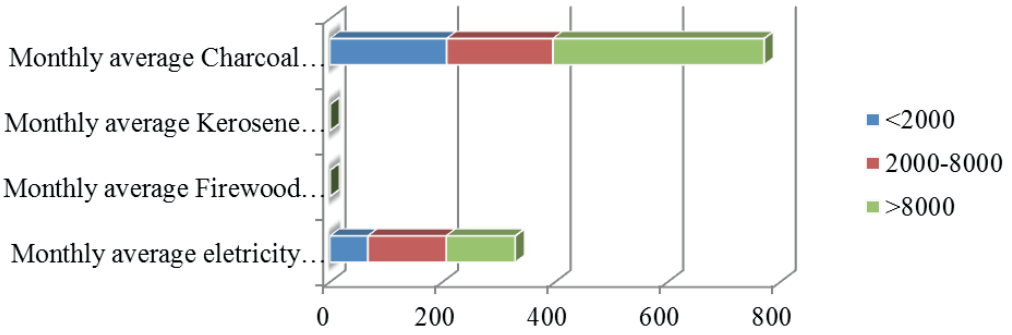
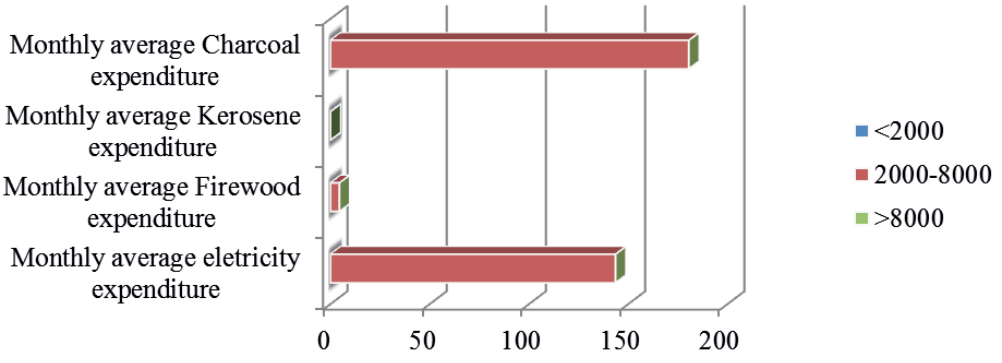


Chart 24

Monthly average energy expenditure in Birr (2010E.C) in terms of income group of Quiha condominium site households



The income group is another determining factor which influence average monthly expenditure on energy. Among the visited households, 9% have an income of less than 2000 Birr, 82% have an income of between 2000 and 8000 Birr and 9% have an income of above 8000 Birr. And those in the income group of less than 2000 Birr have a monthly expenditure of 271 Birr, while those with an average income of between 2000 to 8000 Birr expense 323.5 Birr on average and respondents within the income group of above 8000 Birr pay on average 364 Birr for energy. The average monthly expenditure is increasing when the income level is increasing.

Bereket K., Almaz B. and Elias K. in their paper 'Affordability of Modern Fuels and Patterns of Energy Demand in Urban Ethiopia' state that low-income households expend around a tenth of their income on energy. However, this study has found that the lower and low income households in the investigated condominium sites in Mekelle with less than 2000 Birr monthly income expend 17.5% and above for their energy need while lower-middle-income households with average monthly revenues of 2000 to 8000 Birr expend between 4.4% to 17.5%; and those with above 8000 Birr average income expend less than 4.4% of their income on energy. This can tell us that energy expenditure in condominium housing takes a bigger share of residents' income than it does for those living in other types of housing but the share of energy expenditure in the overall household budget tends to decrease as income increases.

5.3 Household's Attitude with regards to Green Energy

Households' acceptance and willingness to use green energy was assessed in relation to their educational level. It turned out that those who finished high school display good acceptance and willingness whereas those who are illiterate have no idea how to use renewable energy sources and are not willing to accept this approach. But, in general, if some investment is done by the government on green energy for the households, their acceptance and willingness towards green energy can be good. In addition, this study also tells us that there is nothing done so far on green energy by the households. ◆

Chart 25

Acceptance and willingness to invest on green energy of households in terms of educational status in QelQel Debri condominium site

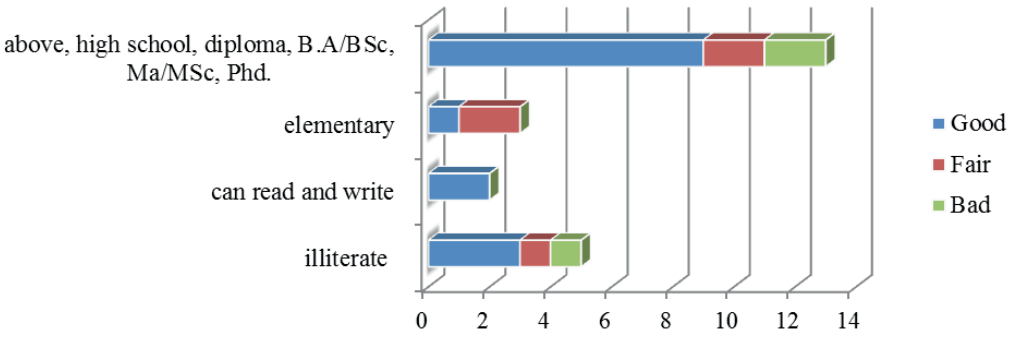


Chart 26

Acceptance and willingness to invest on green energy of households in terms of educational status in Merha Tibeb condominium site

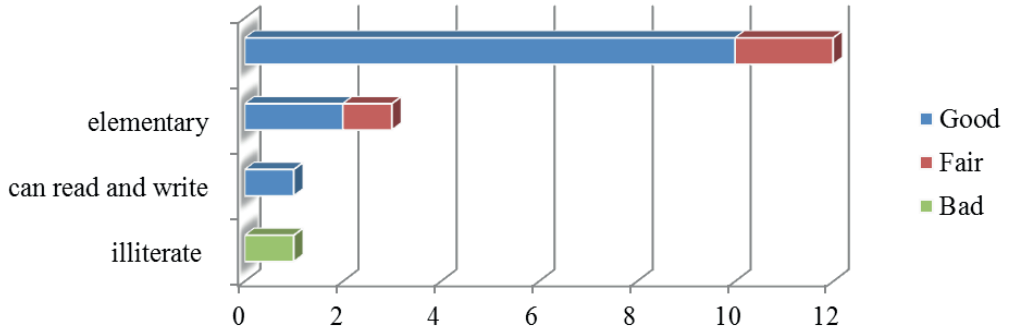


Chart 27

Acceptance and willingness to invest on green energy of households in terms of educational status in Ayder condominium site

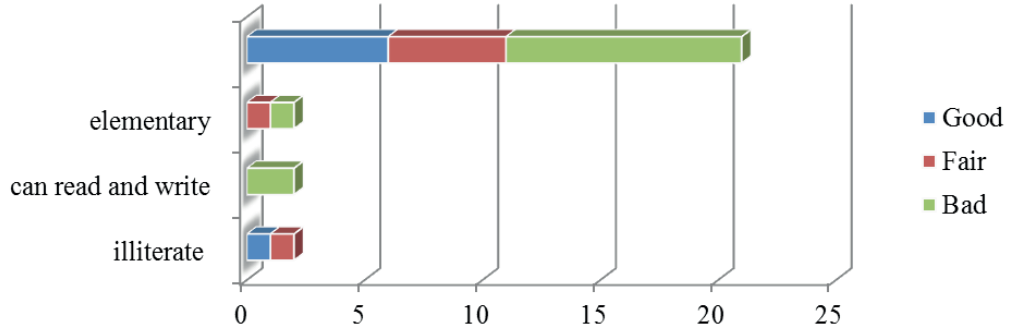
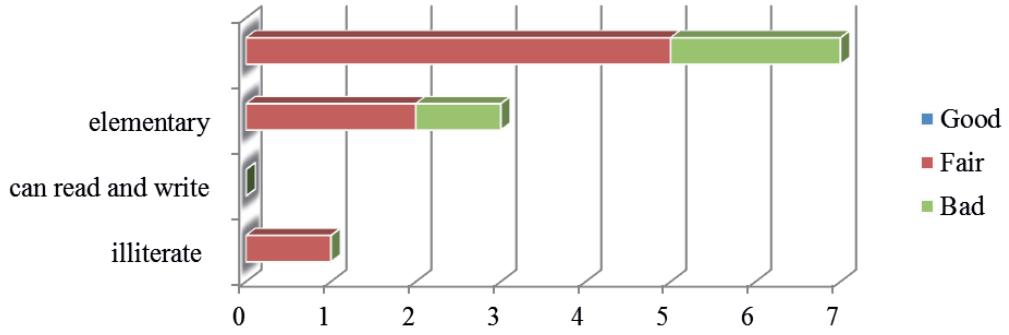


Chart 28

Acceptance and willingness to invest on green energy of households in terms of educational status in Quiha condominium site



PART 6
CONCLUSION AND RECOMENDATIONS

6.1 Conclusion

As per the IHDP target, the low and middle-income people were expected to be the only beneficiaries of the condominium housing. This study has found that the households residing in the interviewed in the Mekelle condominiums almost all belong to the low and lower-middle-income group i.e below 8000 Birr monthly income.

Different works of literature on Ethiopia urban energy demand concluded that the majority of the population uses biomass energy, even in the urban areas. But, this study has found that electricity and charcoal are the major source of energy for all of the investigated condominium households. This implies that living in a condominium house doesn't allow the households to use more energy options even when those sources are scarce.

those households with educational status of "illiterate" and "can read and write" expend more on energy than those of "above elementary level"; Households with 4 and more family members expend more on energy than those below 3; and households with income level of 8000 Birr and above expend more than those below 8000 Birr.

Affordability matters most for the low income residents of the investigated condominiums. The households spend an average 17% of their income on energy, which is more than is paid by those living in other housing types. There is a limitation to access more options of fuel types and power supply is limited due to high competition. In conclusion, for households living in condominium houses it is costly to satisfy their energy demand.

In Ethiopia, some interventions are made in the household sector towards energy demand and supply management, such as: dissemination of Mirt stove, ethanol use for transport and cooking and switching to compact fluorescent lamps. To date, lack of integration of green energy in social housing estates is due to challenges such as: lack of confidence in real benefits; time and budget constraints; inadequate and expensive resources; incorrect perception about the amount of energy consumption in social housing; wrong perception of real costs of sustainable alternatives; land-use constraints; lack of related skills, research, and knowledge among stakeholders; and fragmentation in the process of design, construction, use and maintenance over the life-cycle of a building. According to this study, no initiative has been taken up by the interviewed households towards using green energy, but if some investments were made by the government on green energy for these households, their acceptance and willingness is good.

6.2 Recommendations

Households' energy consumption is influenced by many factors, among them occupants' behavior in energy usage and weather condition of a specified region. The building as a structure is another parameter that needs to be considered while dealing with residential energy consumption and management. This study has investigated the occupants' behavior only. But, the weather condition, the building as structure (the architectural layout, the materials used in building and HVAC equipment used in the condominium housing) shall be studied also to provide an extended conclusion on the energy consumption and management of condominiums.

This study has attempted to compare the affordability of energy to condominium households as compared to other housing categories. To further assess residential energy consumption and management in condominiums, the quality of such buildings' construction in comparison to the other housing needs to be studied. ◆

PART 7
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PART 8
APPENDIX 1: DETAILED RESULTS OF INVESTIGATED CONDOMINIUM SITES

8.1 Case 1: 'QelQel Debri' Condominium Site, Hadinet Subcity

This condominium site is located in Hadinet subcity, the southern part of the city. The site has access through the main road from downtown (Kedamay Weyane Subcity to Debri) and the condominium blocks are clustered in to two separate sites.

According to the data taken from Mekelle housing agency, this site has 12 blocks which in terms of typologies includes 22 studio units, 22 units with-1bed room, 120 with 2bed rooms and 94 with 3bed rooms. The survey conducted with 10% of the total (266 units) is presented and analysed here while excluding 2 questionnaires incomplete according to the study objectives.

Background of Households

The survey was conducted with household heads of different age groups, gender, marital status, household sizes, income, education levels and occupation groups. It was conducted with 14 male and 10 female households heads, who are 1 single, 20 married, 2 divorced and 1 widowed, and who are in the age group of 1 (<25 years), 3 (25-35years), 6 (36-45 years) and 14 (>45 years). There are 6 households with 1-3 family size, 10 with 4-5, 6 with 6-10 and 2 with a size above 10 persons. In terms of monthly income level, 3 of them get less than 2000 birr, 14 of them get between 2000 and 8000 birr, 2 of them above 8000 birr and 5 of them couldn't specify their income level. Among the surveyed households, 6 are illiterate, 1 can read and write, 3 finished elementary education and 14 high school or higher education levels. And in terms of occupation group, 9 respondents are government employees, 11 work as private employees, 3 are unemployed and 1 is pensioned. The data is presented comprehensively in the table below.

Table 2

Background Information of the Households 'QelQel Debri' Condominum Site

Sex Group		Age Group		Marital Status		Household size		Monthly HH income (Birr)		Educational status		Occupational status	
	No HHS	age	No HHS	status	No HHS	size	No HHS	Income	No HHS	status	No HHS	Occ.	No HHS
M	14	< 25 Years	1	single	1	1 - 3	6	< 2000	3	illiterate	6	Government	9
F	10	25 - 35 Years	3	married	20	4 - 5	10	2000 - 8000	14	can read and write	1	private	11
		36 - 45 Years	6	divorced	2	6 - 10	6	> 8001	2	elementary	3	unemployed	3
		> 45 Years	14	widowed	1	10 <	2	I don't know	5	high school-PhD.	14	pensioned	1

Housing Condition

Housing condition is another determinant factor for household energy consumption. In this study, age of block, block height, orientation and area coverage are investigated related to the blocks where the households live. These buildings were found to be 12 years of age and range in height between a minimum of G+3 and a maximum of G+4, oriented to North-East and South-West.

For each specific household, its housing condition, ownership, house typology, existence of window/door openings, house façade orientation, floor location, construction material and in general condition of the housing was assessed. As we can see from the table below, 10 of the 24 investigated units are rented and 12 are private; 12 of them are in good condition and 10 are rated as being in fair condition. When we see the purpose of the houses, all of them are pure residences. Regrading typology of the houses, 2 of the total 24 units are studio houses, 9 comprise of 1-bed room, 9 of two-bedrooms and 3 of 3-bedrooms. 2 are located in ground floor, 7 in first floor, 7 in the second floor, 3 in the third floor and 5 are in fourth floor.

Construction materials such as floor finishes, roofing and ceiling finishes and wall finishes of the housing were also investigated. 10 of the houses have ceramic tile floor finish, 5 have terrazzo tile and 9 have cement screed floor finish. 19 have concrete roofing and 5 have CIS roofing, and about ceiling finish, 2 are with chip wood, 12 gypsums and 10 have other finishes.

Table 3

Housing Condition in 'QelQel Debri' Condominium Site

Ownership		Condition		Purpose of House		House typology		House floor location	
Government		Very good	1	Residential	19	Studio	2	Ground	2
Rent	10	Good	11	Mixed Use		1 Bedroom	7	1st Floor	8
Private	9	Bad	1	Other		2 Bedroom	7	2nd Floor	6
Other/ Specify		Fair	6			3 Bedroom	3	3rd Floor	3
		Under Construction						4th Floor	
		Other							
Construction Material									
House Floor Finish						**House Roof**			
Wood Tiles	Ceramic tile	Terrazo Tile	Cement screed	Marble	Other	CIS	Concrete	Other	
	3	1	14	1		1	18		
House Wall/partition wall					**House Wall finish**			**House Celling finish**	
Masonry	HCB	Boards/Chip Wood/ Fabrics	Brick & Cement	Other	Refined cement finish & painted	Gypsum finish	Other	Gypsum	Other
	16		3		16	3		10	9

If any modification had been undertaken in the house, it was assessed in terms of which part and why it had been modified. 16 of the total 24 households did modify their house, 15 of them in finishing works (wall/facade/ceiling/lighting/fixtures) and 5 of them did make new construction on partition walls. The majority of them have specified that the reason for their modification work was to enhance aesthetics (11 households) and comfortability (7 households) of the house.

Table 4

Modification Status of the Housing

Modification Status	No of respondents	In what part?	No	Reason of Modification	No of respondents
YES	37	**Finishing**	25	Aesthetics	12
		Wall/Façade	18	Functionality	8
		Ceiling/Roof	8	Comfortableness	11
		Balcony/Veranda	1	Other/Specify	
		Lighting/fixtures	6		
		Other/Specify	4		
		New construction	2	Aesthetics	1
		Partition wall/interior	2	Functionality	2
		Façade/exterior wall		Comfortableness	3
		Other/Specify		Other/Specify	
NO	3				

Household Energy Consumption and Management

Hereafter, the surveyed results regarding the households' energy mix, energy consumption and energy management is presented and analyzed.

Energy Mix

Almost all (23) investigated households use electricity and also have stated electricity to be the most secure source of energy; only 1 uses charcoal. All the respondents use electricity for all household purposes such as electric stove, TV and radio, baking and lighting. All interviewed households stated that they have their own meter.

Chart 29

Mostly used energy type for household purposes

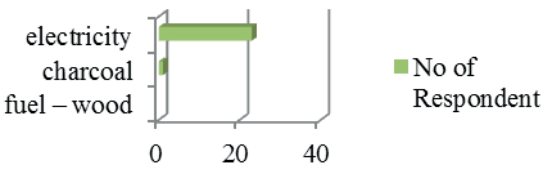
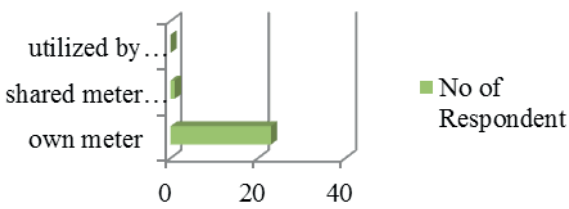


Chart 30

Energy acquisition



Energy usage for specific and major purposes of households like baking, cooking and making coffee was assessed to identify which energy source is mostly used for which purpose. Electricity was found to have the leading role for baking and cooking, while charcoal leads in making coffee.

Chart 31

Energy use for baking

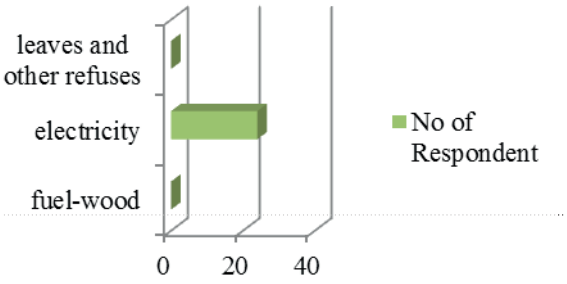


Chart 32

Energy use for cooking

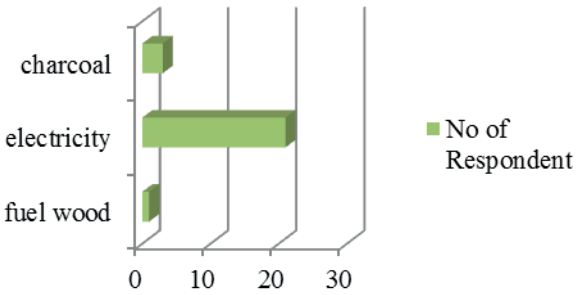
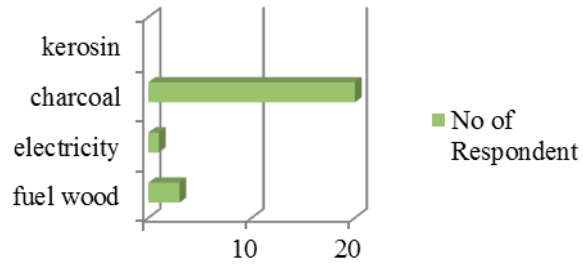


Chart 33

Energy use for making coffee



When asked about reasons behind usage of specific energy types for specific household purposes most respondents explained that they use charcoal for cooking and making coffee because they believe that it offers a better taste. 10 of the respondents also prefer charcoal for quicker cooking.

Table 5

Reasons given for usage of specific fuel types for specific household purposes

Fuel type	Cooking	Reason	No of Households	Making Coffee	Reason	No of Households
Fuel	Charcoal	For Better taste	12	Charcoal	For Better taste	20
		For its speed	10		For its speed	
		For its price			For its price	
		Other/specify	1		Other/specify	

Energy Consumption and Management

In this section, data on households' consumption in terms of average monthly expenditure and their energy management in terms of alternatives used to replace in case of scarcity or high price of preferred fuel is presented and analyzed.

Before inquiring about households' energy management, questions such as "Since when have you been living in that specific house?", and "Is there any organization/association that deals with energy conservation or management in the condominium buildings?" were asked to understand framework conditions. The relevance of dealing with energy management of condominiums is rated as very high by 12 respondents, as high by 11 and as not being a big deal by 1 respondent. 2 of the respondents indicate that there is an organization/ association that deals with energy conservation or management in their condominium buildings while 22 of the respondent replied that there was none. 7 respondentswere already living in their unit before 2009, 9 of them did so since 2014 and 8 of them since 2017.

Chart 34

Households use electricity for

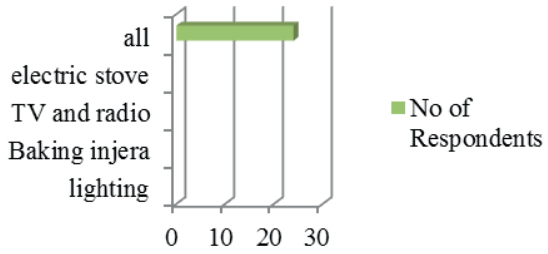
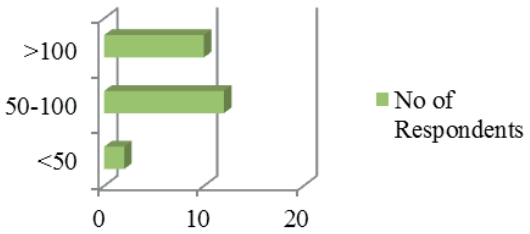


Chart 35

Average monthly expenditure for electricity



All respondents use electricity for all household purposes such as electric stove, TV and radio, baking injera and lighting. Average expenditure for energy ranges below 50 Birr for 2 respondents <, between 50 and 100 Birr for 12 of them and above 100 Birr for10 of them.

Chart 36

Scarcity of electricity

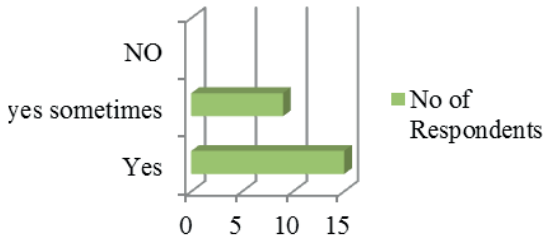
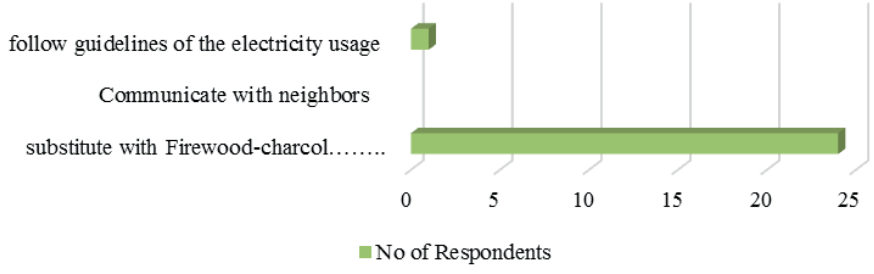


Chart 36

Alternatives used during scarcity of electricity



15 respondents declared that there was a scarcity of electricity in their home, while 9 indicated that this was sometimes the case. 23 of them stated that they use alternative fuel types such as firewood and charcoal during times of scarcity

Chart 38

No of households who use charcoal

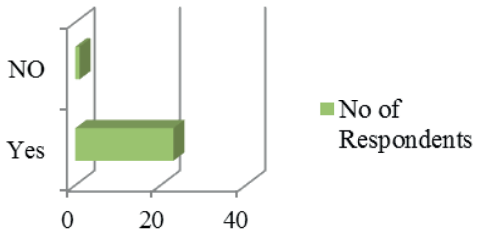
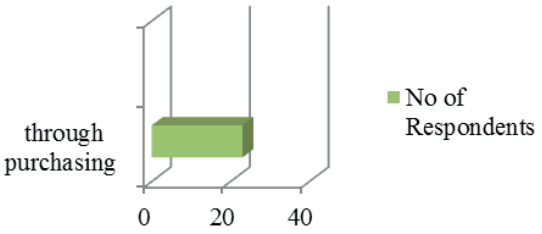


Chart 39

Charcoal acquisition



Almost all of the respondents use charcoal acquired through purchasing as well as the traditional iron charcoal stove. When asked about the amounts purchased at one time 4 respondents indicated that they normally buy for 10 Birr, 2 respondents use to buy for 20 Birr, while 6 respondents frequently purchase in the range of 120 to 200 Birr and 11 for 400 to 500 Birr. 10 of the respondents use charcoal regularly, 11 of them occasionally and 1 of them only in the time of holidays.

Chart 40

No of households who use charcoal

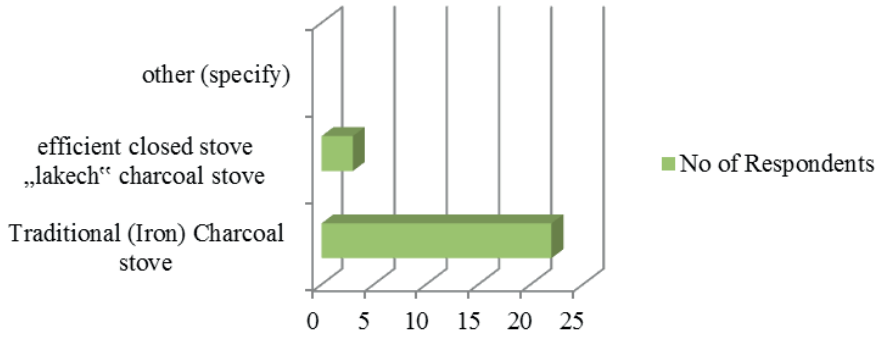


Chart 41

Buy charcoal at a time birr

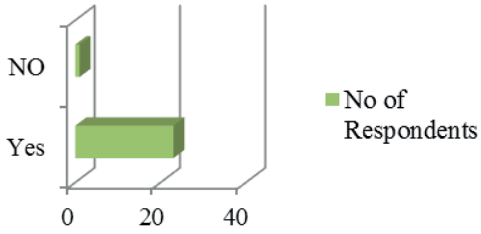
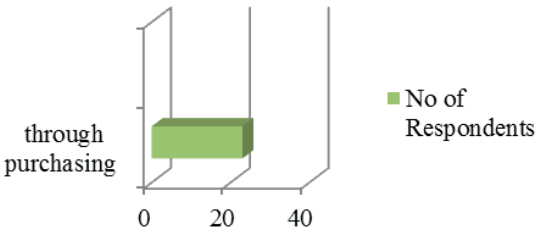


Chart 42

Use charcoal when



The average expenditure of the households for charcoal is less than 200 Birr for 6 households, between 200 and 400 Birr for 16 households and 400 to 600 Birr for 1 household. In case of high price for charcoal, 13 respondents store for the time of scarcity.

Chart 43

Average monthly expenditure for charcoal/ Birr

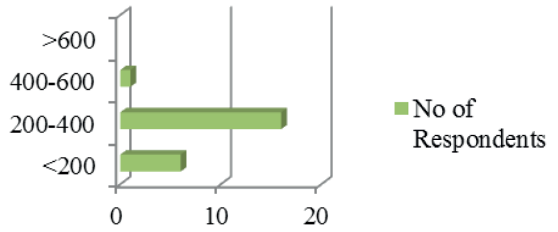
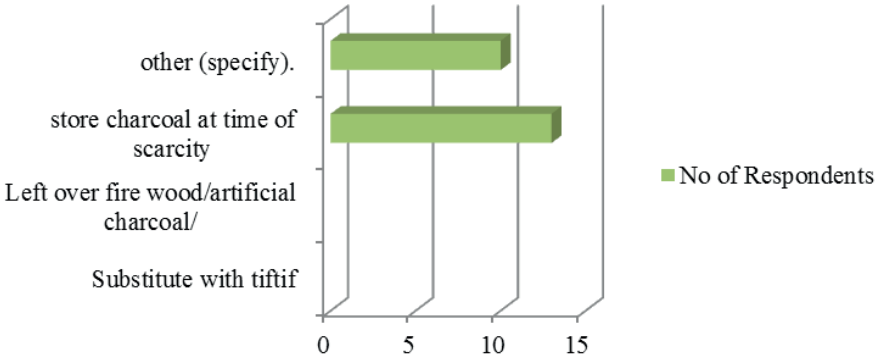


Chart 44

Alternatives if charcoal price is high

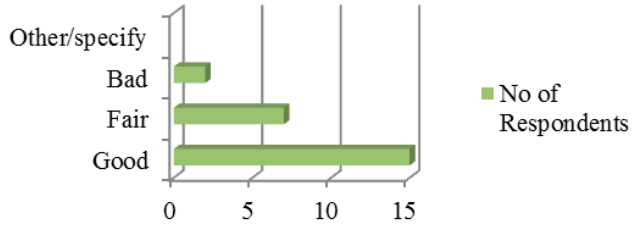


Household Attitudes with regards to Green Energy

The researcher has tried to investigate attitudes of households towards green energy, that is to understand if there are inclinations towards using renwable energy. And according to the investigation, 12 of the households have good acceptance, 11 have fair acceptance and 1 respondent has not accepted the idea of introducing green energy. Respondents were also asked if they had done anything on green energy so far, but none of them had.

Chart 45

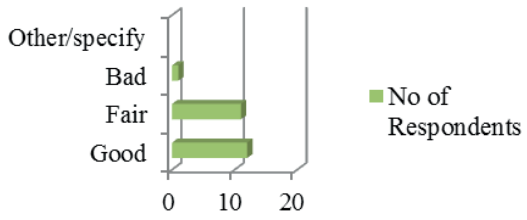
Acceptance to green energy



To understand habits/behavior of households with regards to energy consumption for heating/cooling of their home, questions related to thermal conditions of their house, their cooling mechanisms during hot and their warming mechanisms during cold periods were asked.

Chart 46

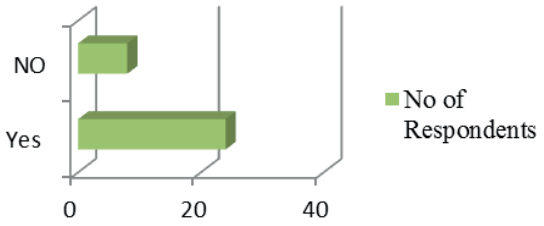
House thermal condition



Out of 24 respondents, 12 rated the thermal condition of their house as being good, 11 rated it as fair and 1 has rated it as bad. All have stated that the thermal condition within their house changes with seasons.

Chart 47

Does your house's thermal condition depend upon season?



Regarding cooling and warming mechanisms, 22 of the 24 respondents indicated to use window/door openings to cool their house during the hot season and 16 of the 24 respondents use charcoal to warm their house during the cold season. ◆

Chart 48

Cooling mechanisms during hot

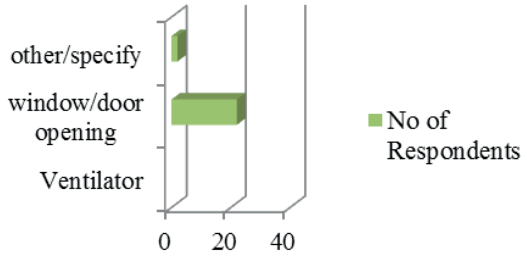
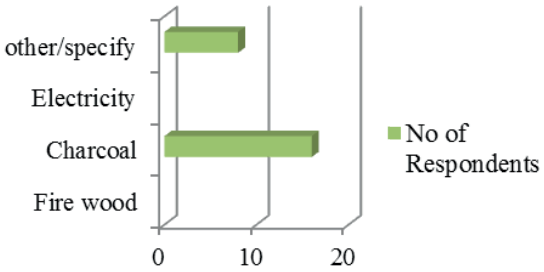


Chart 49

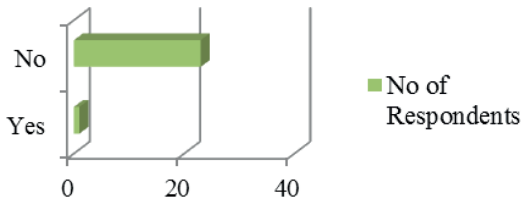
Heating mechanisms during cold



23 of the 24 respondents declared that no training had been given to the households regarding green energy.

Chart 50

Training given about green energy



8.2 Case 2: 'Merha Tibeb' Condominium Site

This condominium site is located in Hawelti sub-city, the southern part of the city. The condominium blocks are arranged in one row. According to the data taken from Mekelle housing agency, this site has 9 blocks, which include 21 studios, 72 units with 1bed room, 65 units with 2-bed rooms and 29 units with 3-bed rooms. The survey conducted with 10% of the total is presented and analyzed hereunder.

Background of Households

The survey was conducted with household heads of different age groups, gender, marital status, household sizes, income, educational levels and occupation groups. It was conducted with 9 male and 10 female households heads, of whom 2 are single, 14 married, 1 is divorced and 2 are widowed. 9 respondents are between 25 to 35 years of age, 5 are between 36 and 45 years old and 5 are above45 years. There are 5 households with 1 to 3 family members, 12 with 4 to 5 and 2 with 6 to 10. 2 of them get less than 2000 Birr as average monthly income, 8 range between 2000 and 8000 Birr, 3 above 8000 Birr and 6 couldn't specify their income level. 1 respondent is illiterate, 1 can read and write, 4 of them finished elementary education and 13 of them are with high school and above educational level. 6 respondents are government employees, 11 work as private employees and 2 are unemployed. The data is presented comprehensively in the table below.

Table 6

Background information of the households

Sex Group		Age Group		Marital Status		Household size		Monthly income (Birr)		Educational status		Occupational status	
	No HHs		No HHs		No HHs		No HHs		No HHs		No HHs		No HHs
M	9	< 25 Years	0	single	2	1 - 3	5	< 2000	2	illiterate	1	Government	6
F	10	25 - 35 Years	9	married	14	4 - 5	12	2000 -8000	8	can read and write	1	private	11
		36 - 45 Years	5	divorced	1	6 - 10	2	> 8001	3	elementary	4	unemployed	2
		> 45 Years	5	widowed	2	10 <	0	I don't know	6	high school-PhD.	13	pensioned	0

Housing Conditions

Housing conditions are another determinant factor for households' energy consumption. In this study, age of block, block height, orientation and area coverage are investigated related to the blocks where the households are living. These blocks are 12 years old and range from minimum of G+3 and to maximum of G+4 in height, oriented to North-South.

Regarding the specific households housing condition, ownership, the purpose of the house, house typology, existence of window/door openings, house façade orientation, floor location, construction material and in general condition of the housing was assessed. As we can see from the table below, 10 of the 19 respondents are renters and 9 are private owners. 1 Respondent reported very good conditions, 11 declared housing condition to be good, 1 reported bad conditions and 6 rated conditions as being fair. All investigated units were used for residence only. 2 of the total 19 units are studio houses, 7 have 1-bed room, 7 have two bedrooms and 3 have 3-bed rooms, 2 are located in ground floor, 8 in the first floor, 6 in the second floor and 3 in the third floor.

3 of the houses have ceramic tile floor finish, 1 has terrazzo tiles, 14 have cement screed floor finish and 1 has marble floor finish. 18 have concrete roofing and 1 has CIS roofing, and as for ceiling finish, 10 display gypsums and 9 have other finishes. With regards to wall/partition wall construction material, 16 units comprise of HCB and 3 are equipped with gypsum finish.

Table 7

Housing condition in 'Merha Tibeb' Condominium Site

Ownership		Condition		Purpose of House		House typology		House floor location	
Government		Very good	5	Residential	24	Studio	2	Ground	2
Rent	10	Good	12	Mixed Use		1 Bedroom	9	1st Floor	7
Private	14	Bad		Other		2 Bedroom	9	2nd Floor	7
Other/ Specify		Fair	7			3 Bedroom	3	3rd Floor	3
		Under Construction						4th Floor	5
		Other							
Construction Material									
House Floor Finish						**House Roof**			
Wood Tiles	Ceramic tile	Terrazo Tile	Cement screed	Marble	Other	CIS	Concrete	Other	
	3	1	14	1		4	19	1	
House Wall/partition wall					**House Wall finish**			**House Celling finish**	
Masonry	HCB	Boards/Chip Wood/ Fabrics	Brick & Cement	Other	Refined cement finish & painted	Gypsum finish	Other	Gypsum	Other
	13		11		15	9		12	10

If there is any modification done in the house it is assessed in terms of the modification done and why. 16 of all 24 households did modify their house, 15 of them in finishing works (wall/facade/ceiling/lighting/ fixtures) and 5 of them built new partition walls. The majority of residents specified that the reason for their modification work is to enhance aesthetics (11 households) and comfortability (7 households) of their unit.

Table 8

Modification Status of the Housing

Modification Status	No of respondents	In what part?	No	Reason of Modification	No of respondents
YES	14	**Finishing**	13	Aesthetics	8
		Wall/Façade	4	Functionality	1
		Ceiling/Roof	5	Comfortableness	4
		Balcony/Veranda		Other/Specify	
		Lighting/fixtures			
		Other/Specify	4		
		New construction	4	Aesthetics	
		Partition wall/interior	3	Functionality	
		Façade/exterior wall	1	Comfortableness	4
		Other/Specify		Other/Specify	
NO	5				

Household Energy Consumption and Management

Under this topic, the survey questions regarding the households' energy mix, energy consumption and energy management are presented and analyzed.

Energy Mix

Which energy source do they use mostly for household purposes is investigated and according to their response all of them use electricity and also have stated electricity as the most secured source of energy. All the respondents use electricity for all household purposes such as electric stove, Tv and radio, baking and lighting. About the acquisition, again they stated that they have their meter. This investigation was done to identify in which fuel type the households are mostly dependent.

Chart 51

Mostly used energy type for household purposes

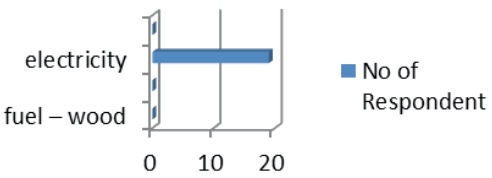
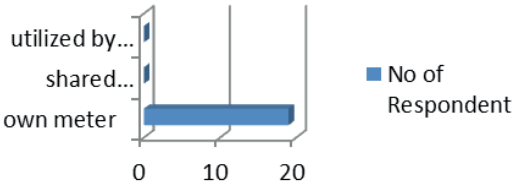


Chart 52

Electricity energy acquisition



Energy use for specific and major purposes of households like baking, cooking and making coffee is also assessed to identify which energy type is mostly used for which purpose. Accordingly, electricity has the leading role for baking and cooking, while charcoal has the leading role in making coffee.

Chart 53

Energy use for baking

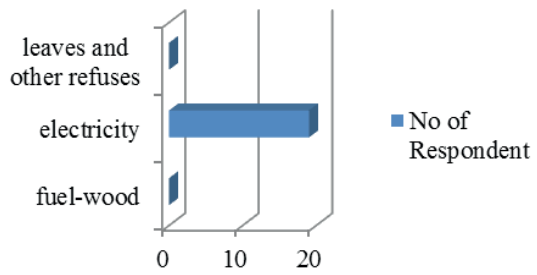


Chart 54

Energy use for cooking

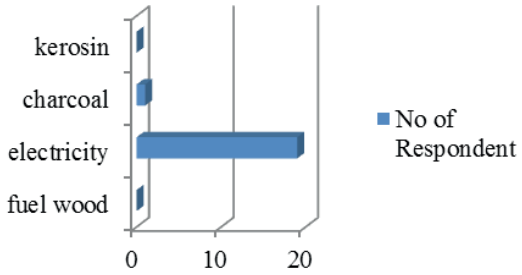
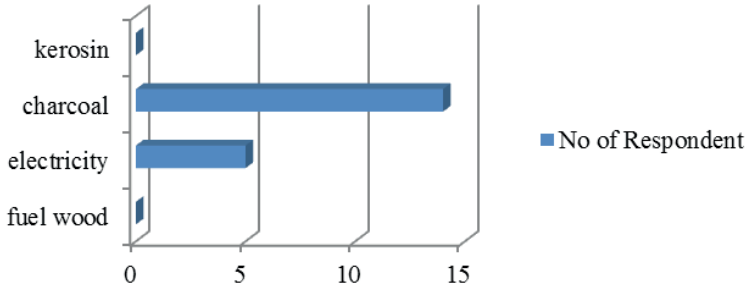


Chart 55

Energy use for making coffe



The reason behind use of specific energy type for specific household purpose is investigated, and as we can see from the below table, most of the respondents use charcoal for cooking and making coffee because they believe that it offers a better taste. 2 of the respondents also have stated to prefer charcoal for its speed in the cooking process.

Table 9

The reason behind use of specific fuel type for specific household purpose

Fuel type	Cooking	Reason	No of Households	Making Coffee	Reason	No of Households
Fuel	Charcoal	For Better taste	2	Charcoal	For Better taste	9
		For its speed	0		For its speed	4
		For its price			For its price	1
		Other/specify	0		Other/specify	

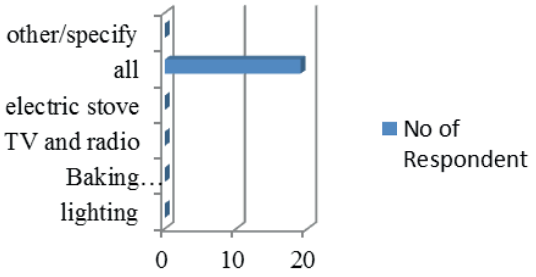
Energy Consumption and Management

In this section, the data on households consumption in terms of average monthly expenditure and their energy management in terms of alternatives used to replace in case of scarcity or high price of the fuel prefered is presented and analyzed.

Ahead of the question about their energy management, questions such as since when they have been living in that specific house, the relevance of dealing with energy management and if there is any organization/association that deals with energy conservation or management in the condominium buildings were asked in order to understand the depth and relevance of their responses. The relevance of dealing with energy management of condominiums is rated as very relevant by 4, relevant by 12 and not a big deal by 3. None of the respondents responded 'yes' to the question if there is any organization/association that deals with energy conservation or management in the condominium buildings. According to to the questionsince when they have been living in that specific house, 10 of them responded before 2009, 8 of them said since 2014 and 8 of them since 2017.

Chart 56

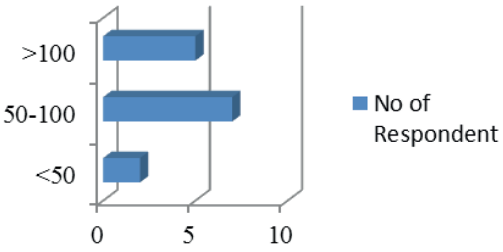
Households use electricity for



All of the respondents use electricity for all household purposes such as for electric stove, TV and radio, baking and lighting. When we see the average expenditure of the households, 2 of them responded

Chart 57

Average monthly expenditure for electricity



<50 Birr, 12 of them responded from 50 to 100 Birr and 10 of them responded that their average expenditure surpasses 100 Birr.

Chart 58

Scarcity of electricity

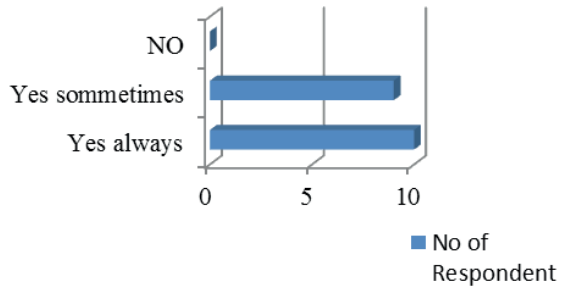
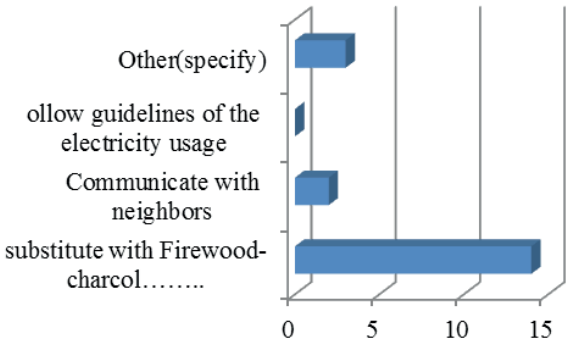


Chart 59

Alternatives used during scarcity of electricity



To the question 'is there scarcity of electricity?', 10 of respondents replied "yes always" and 9 of them replied "yes sometimes". When they were asked about the alternatives they are useing during scarcity of electricity, 14 of them stated that they use alternative fuel types such as firewood-charcoal and 2 of them prefer to communicate with neighbors.

Chart 60

No of households who use charcoal

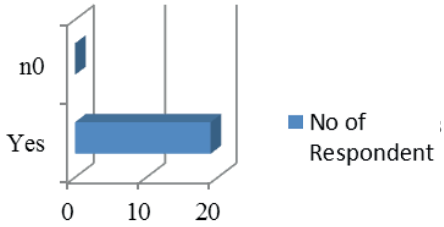
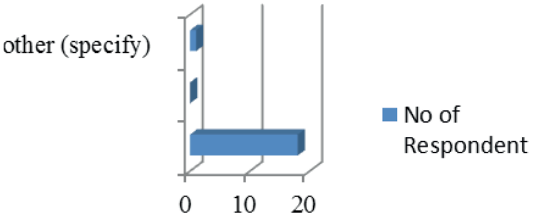


Chart 61

Charcoal acquisition



Almost all of the respondent households use charcoal acquired through purchasing. Almost all of them use the traditional (Iron) charcoal stove. And when they were asked a question 'what amounts do you buy at a time?' 2 of them stated that they would normally purchase for 10 Birr, 4 for 20 Birr, 9 for 120 to 200 Birr and 4 for 400 to 500 Birr. 6 of the respondents use charcoal regularly, 12 of them occasionally and 1 of them during times of holiday.

Chart 62

Type of stove for charcoal

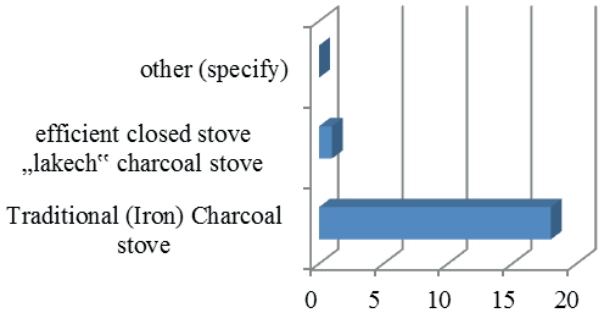


Chart 63

Buy charcoal at a time [Birr]

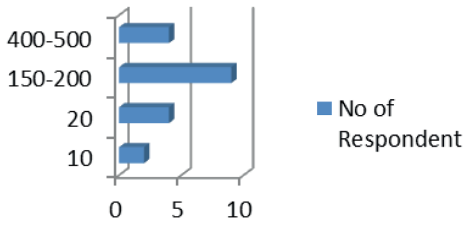
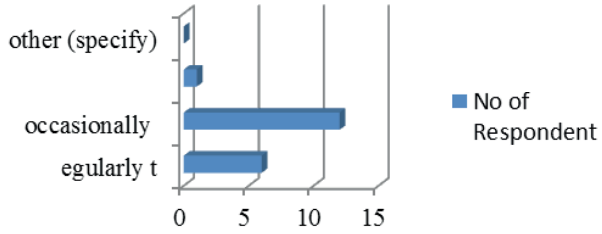


Chart 64

Use charcoal when ….



The average expenditure of the households for charcoal is less than 200 Birr for 8 households, 200 to 400 Birr for 9 households, 400 to 600 Birr for 2 households. In case of high-price for charcoal, 12 of the respondents store for the time of scarcity and the rest gave other answers.

Chart 65

Average monthly expenditure for charcoal [Birr]

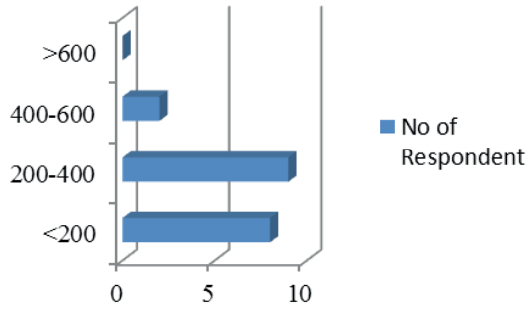
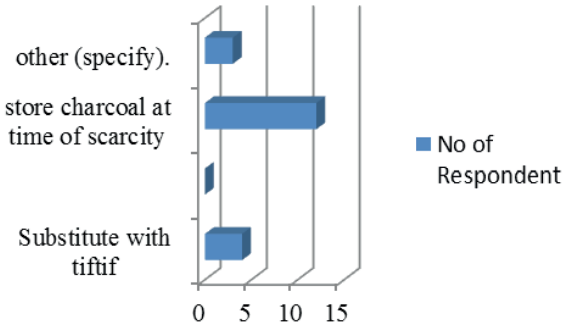


Chart 66

Alternatives if charcoal price is high

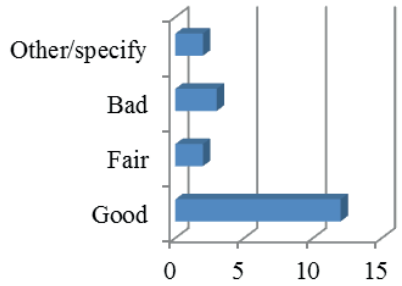


Household Attitude with regards to Green Energy

The researcher has tried to investigate the perceptions of households towards green energy, that is to understand if there are inclinations towards it. According to the respondents, 12 of the households are rated as 'good', 2 rated 'fair' while 3 respondents do not agree with the idea of introducing green energy. There was also a question forwarded for the respondents if there is anything done so far on green energy, 2 of them have accepted this idea.

Chart 65

Acceptance of green energy



To understand habits of the households with regards to energy consumption for heating/cooling of their home, questions related to thermal condition of their house, if seasonal, their cooling mechanism during hot and their warming mechanism during cold were asked. Out of 19 respondents, 6 rated the thermal conditions of their house as good, 10 rated it as fair and 3 as bad. 14 of the respondents have stated that thermal conditions in their house depends upon season.

Chart 68

House thermal condition

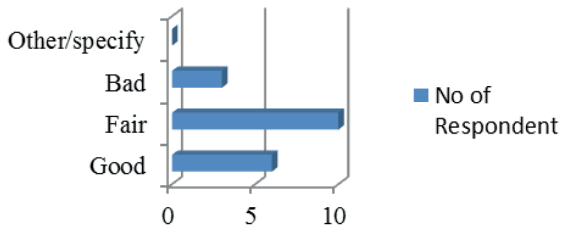
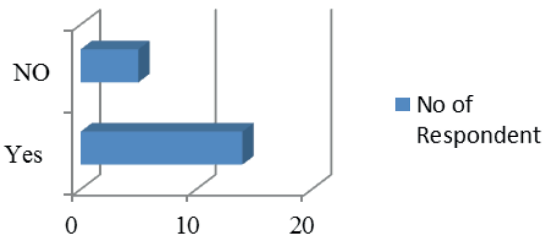


Chart 69

Does your house's thermal condition depend upon season?



For those respondents who stated that thermal conditions in their house depend upon season, questions regarding their cooling and warming/ heating mechanisms were asked. According to their response, all of the respondents use window/door openings to cool their house during hot season and 14 0f the 19 respondents use charcoal to warm their house during cold season.

Chart 70

Cooling mechanisms during hot

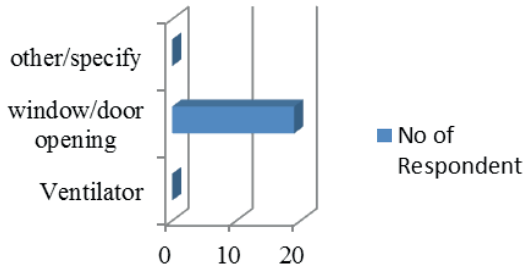
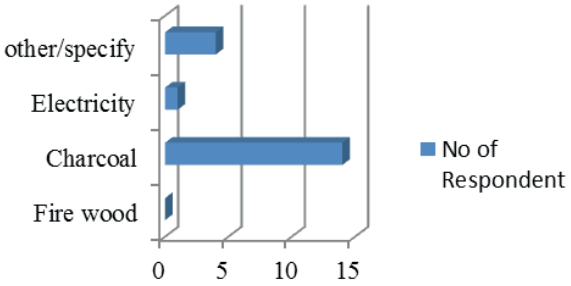


Chart 71

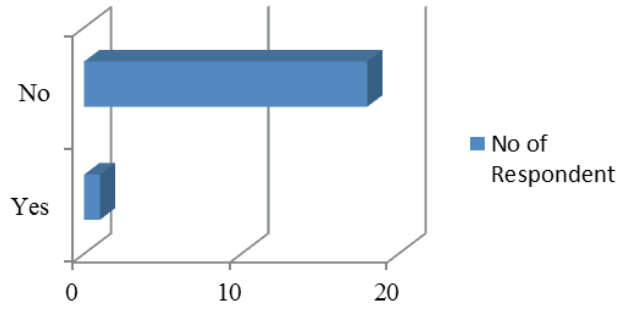
Heating mechanisms during cold



This research has explore if any training had been given to the households regarding green energy, to understand the know-how of the households and if there is need for training. 18 of the 19 respondents replied that they had not previously received any training on green energy. ◆

Chart 72

Training given about green energy



8.3 Case 3: 'Ayder' Condominium Site

This condominium site is located in Ayder sub-city, the southern part of the city. According to the data taken from Mekelle housing agency, this site has 12 blocks clustered which in terms of typologies as follows: 22 studios, 22 1-bed room units, 120 2-bed room units and 94 3-bed room units. The survey conducted with 10% of the all residents (266 number of units) is presented and analyzed hereunder excluding 2 incomplete questionnaires according to the study objectives.

Background of Households

When we see the household information of the site, the survey was conducted with household headed housing units of different age group, gender, marital status, household size, income, educational level and occupation groups. It is conducted with 15 male and 25 female household headed housing units, who are 6 single, 31 married, 1 divorced and 2 widowed. These are in the age group of 3 (<25 years), 12 (25-35 years), 13 (36-45 years) and 12 (>45 years). There are14 households with 1-3 family size, 16 with 4-5 and 10 with 6-10. In terms of monthly income, 3 of them get less than 2000 birr, 29 of them get between 2000 and 8000 birr, 1 of them above 8000 birr and 7 of them couldn't specify their income level. Among the surveyed households, 3 of them are illiterate, 2 can read and write, 4 of them are at elementary school level and 31 of them are with high school and above educational level. In terms of occupation, 19 of them are government employees, 14 of them are private employees, 6 of them are unemployed and 1 is pensioned. The data is presented comprehensively in the table below.

Table 10

Background information of the households

Sex Group		Age Group		Marital Status		Household size		Monthly income (Birr)		Educational status		Occupational status	
	No HHs		No HHs		No HHs		No HHs		No HHs		No HHs		No HHs
M	15	< 25 Years	3	single	6	1 - 3	14	< 2000	3	illiterate	3	Government	19
F	25	25 - 35 Years	12	married	31	4 - 5	16	2000 - 8000	29	can read and write	2	private	14
		36 - 45 Years	13	divorced	1	6 - 10	10	> 8001	1	elementary	4	unemployed	6
		> 45 Years	12	widowed	2	10 <	0	I don't know	7	high school-PhD.	31	pensioned	1

Housing Condition

Blocks in this condominium are 12 years old, they comprise at minimum of G+3 and at maximum of G+4 in height. The specific households housing condition, ownership, usage of the unit and typology, existence of window/door openings, house façade orientation, floor location, construction material and the general condition of the housing were assessed.

7 of the 40 units are rented and 15 are privately owned. 15 of them are in good physical condition and 7 are rated as fair. When we see the usage of the units, all of them are purely used as residences. 6 of the total 14 units are studios, 14 are 1-bed room units, 15 are two-bedroom units and 4 units comprise of 3-bed rooms, 7 are located in the ground floor, 11 in first floor, 11 in second floor, 6 in the third floor and 1 is in the fourth floor.

Construction materials are presented below.

Table 11

Housing Condition in Ayder Condominium Site

Ownership		Condition		Purpose of House		House typology		House floor location	
Government	5	Very good	3	Residential	40	Studio	6	Ground	7
Rent	7	Good	19	Mixed Use		1 Bedroom	14	1st Floor	11
Private	15	Bad	7	Other		2 Bedroom	15	2nd Floor	11
Other/ Specify		Fair	9			3 Bedroom	4	3rd Floor	6
		Under Construction						4th Floor	1
		Other							
Construction Material									
House Floor Finish						**House Roof**			
Wood Tiles	Ceramic tile	Terrazo Tile	Cement screed	Marble	Other	CIS	Concrete	Other	
	13	3	21			3	32		
House Wall/partition wall					**House Wall finish**			**House Celling finish**	
Masonry	HCB	Boards/Chip Wood/ Fabrics	Brick & Cement	Other	Refined cement finish & painted	Gypsum finish	Other	Gypsum	Other
	33				31	3		6	34

Any modification done in the house was assessed. 37 of the total 39 households had modified their house, 25 of them in finishing works (wall/facade/ceiling/ lighting/fixtures) and 2 constructed new partition walls. The majority of residents have specified that the reason for their modification work was to enhance aesthetics (12 households) and comfort-ableness (11households).

Table 12

Modification status of the housing

Modification Status	No of respondents	In what part?	No	Reason of Modification	No of respondents
YES	37	**Finishing**	25	Aesthetics	12
		Wall/Façade	18	Functionality	8
		Ceiling/Roof	8	Comfortableness	11
		Balcony/Veranda	1	Other/Specify	
		Lighting/fixtures	6		
		Other/Specify	4		
		New construction	2	Aesthetics	1
		Partition wall/interior	2	Functionality	2
		Façade/exterior wall		Comfortableness	3
		Other/Specify		Other/Specify	
NO	3				

Household Energy Consumption and Management

In this chapter, the surveyed questions regarding the households' energy mix, energy consumption and energy management are presented and analyzed.

Energy Mix

Which energy source do residents use mostly for household purposes is investigated and according to their response almost all (39) use electricity and also have identified electricity as the most secure source of energy, only 1 uses charcoal. All the respondents use electricity for all household purposes such as electric stove, TV and radio, baking and lighting. About their acquisition of electricity supply, respondents stated that they have their meter. This investigation was done to identify on which fuel type the households are mostly dependent.

Chart 73

Mostly used energy type for household purposes

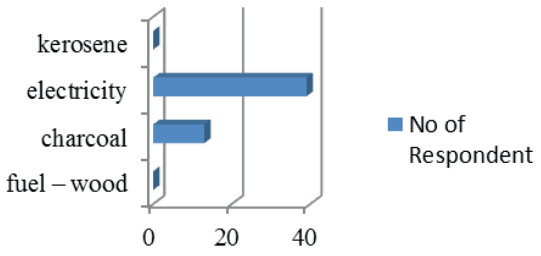
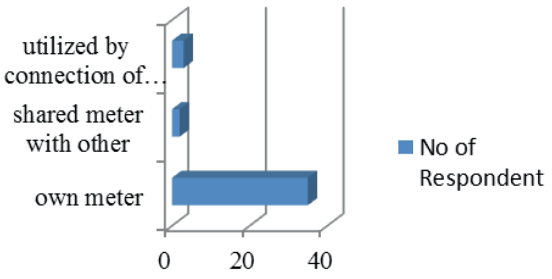


Chart 74

Energy acquisition



Energy use for specific and major purposes of households like baking, cooking and making coffee was also assessed to identify which energy type is mostly used for which purpose. E electricity was found to have the leading role for baking and cooking, while charcoal has the leading role in making coffee.

Chart 75

Energy use for baking

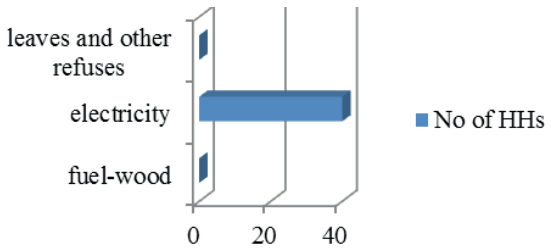


Chart 76

Energy use for cooking

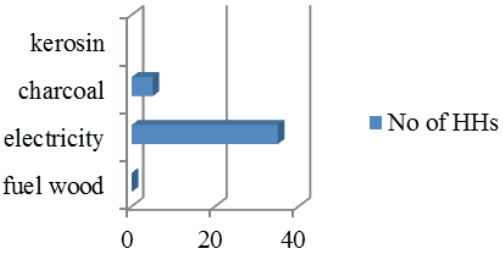
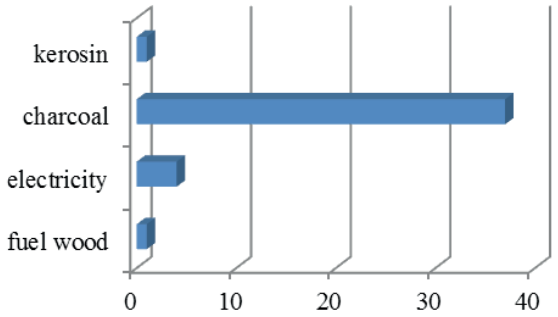


Chart 77

Energy use for making coffee



The reason behind use of specific energy types for specific household purposes was investigated, and as we can see from the table below, most of the respondents use charcoal for cooking and making coffee because they believe that it offers a better taste. 10 of the respondents also have stated to prefer charcoal for its speed in the cooking process.

Table 13

The reason for using specific fuel types for specific household purposes

Fuel type	Cooking	Reason	No of Households	Making Coffee	Reason	No of Households
Fuel	Charcoal	For Better taste		Charcoal	For Better taste	22
		For its speed			For its speed	5
		For its price			For its price	2
		Other/specify			Other/specify	4

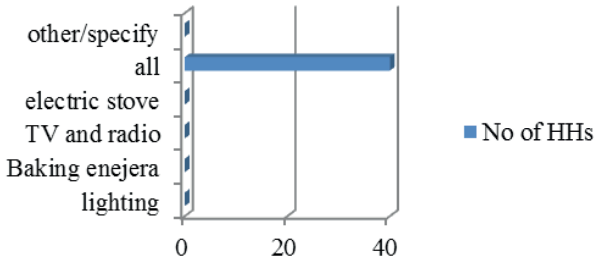
Energy consumption and management

In this section, the data on households' consumption in terms of average monthly expenditure and their energy management in terms of alternatives used to replace in case of scarcity or high price of the preferred fuel is presented and analyzed.

Prior to the question about their energy management, questions such as "Since when have you been living in that specific house?", the relevance of dealing with energy management and if there is any organization/association that deals with energy conservation or management in the condominium buildings were asked. The relevance of energy management of condominiums is rated as very high by 6, high by 31 and not high by 3. 3 of the respondents replied "yes" when asked if there is any organization/association that deals with energy conservation or management in the condominium buildings while 34 of the respondent have replied "no". 20 of the respondents started living in their unit before 2009, 16 are living there since 2014 and 4 since 2017.

Chart 78

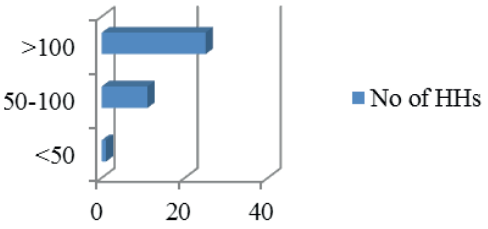
Households use electricity for



All of the interviewed residents use electricity for all household purposes such as electric stove, TV and radio, baking and lighting. Average expenditure

Chart 79

Average monthly expenditure for electricity



ranges below 50 Birr for 1 of them, 11 pay 50 to 100 Birr and 25 expense more than 100 Birr on average.

Chart 80

Scarcity of electricity

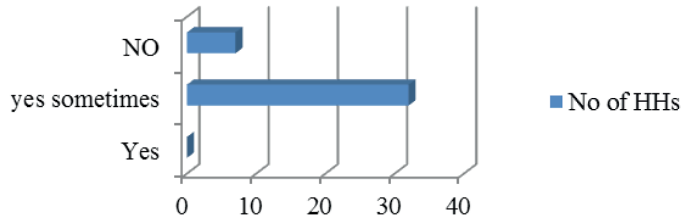
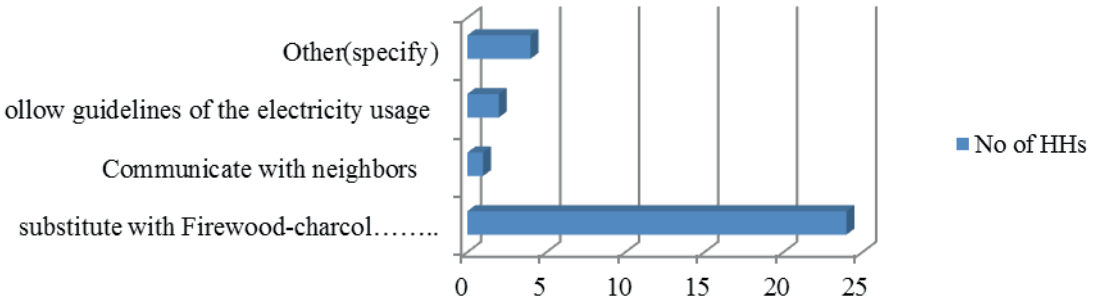


Chart 81

Alternatives used during scarcity of electricity



To the question "Is there scarcity of electricity?" 32 residents replied "Yes sometimes". And where they were asked about the alternatives they use during times of scarcity, 24 respondents stated that they use alternative fuel types such as firewood-charcoal and 2 of them prefer to follow guidelines of the electricity usage.

Chart 82

No of households who use charcoal

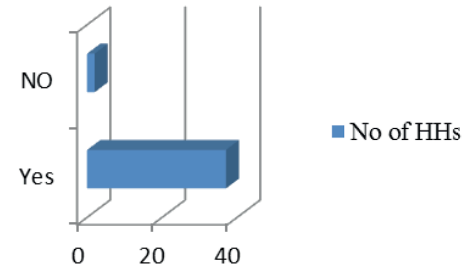
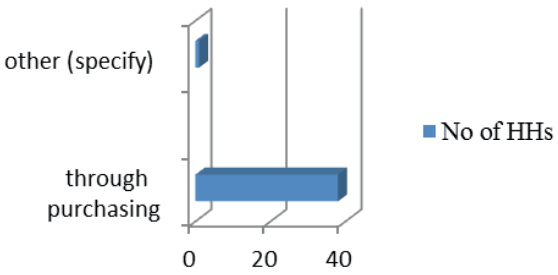


Chart 83

Charcoal acquisition



Almost all of the respondent households use charcoal acquired through purchasing. Almost all of them use the traditional (Iron) charcoal stove. And when they were asked how much they normally purchase, 2 indicated that they do so for 10 Birr, 2 for 20 Birr, 26 for 120 to 200 Birr and 9 for 400 to 500 Birr. 9 of the respondents use charcoal regularly and 26 of them occasionally.

Chart 84

Type of stove for charcoal

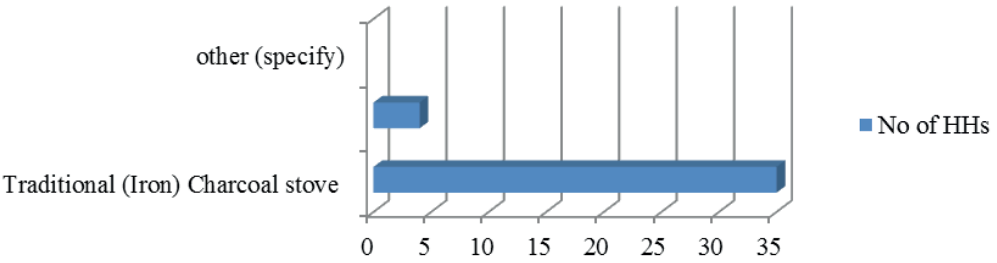
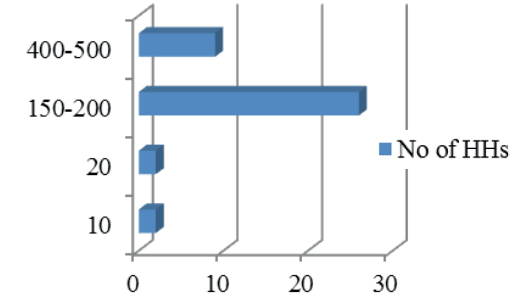


Chart 85

Buy charcoal at a time [Birr]



The average expenditure of the households for charcoal is less than 200 Birr for 20 households, between 200 to 400birr for 16 households, 400 to 600 Birr for 3 households. In case of high-price for charcoal, 10 of them store for times of scarcity.

Chart 86

Use Charcoal when…?

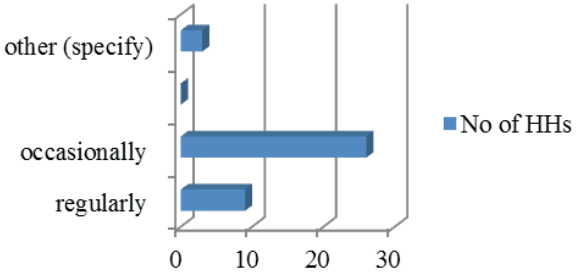
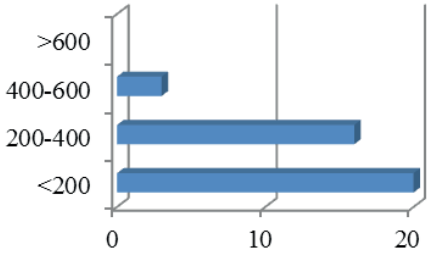


Chart 87

Average monthly expenditure for charcoal [Birr]



Household Attitude with regards to Green Energy

The researcher has tried to investigate the attitudes of households with regards to green energy. The respondents' level of acceptance of green energy was found to be rated as 'good' for 7 of the households, as 'fair' for 10 and 15 do not agree with the idea of introducing green energy. Respondents were also asked if anything had been done so far with regards to green energy in their building, but none of them reflected.

Chart 88

Alternatives if charcoal price is high

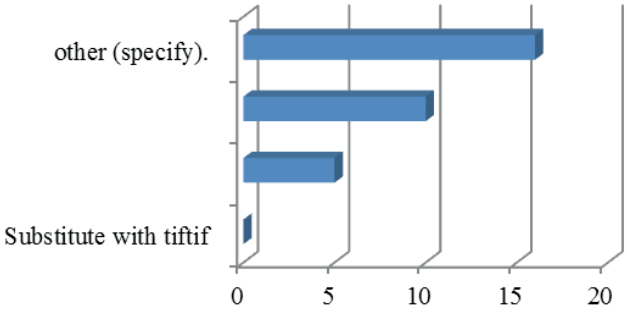
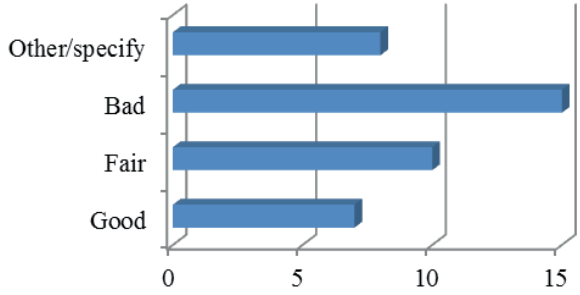


Chart 89

Acceptance of green energy



To understand habits of the households on energy consumption for heating/cooling, questions related to thermal condition of their house, their cooling mechanisms during hot and their heating mechanisms during cold were investigated.

Out of 40 respondents, 11 consider the thermal conditions of their house to be good, 26 rated these as fair and 9 rated them as bad. Nearly all have stated that thermal conditions in their house depend upon season.

Chart 90

House thermal condition

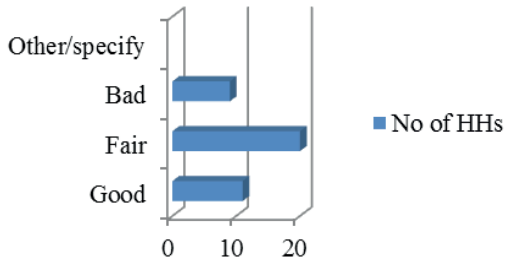
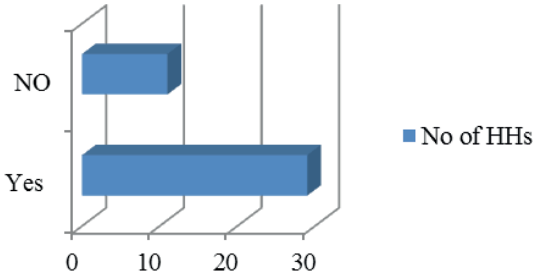


Chart 91

Does your house's thermal condition depend upon season?



For those respondents who stated that their home's thermal conditions depend upon season, questions regarding their cooling and warming mechanisms were asked. And according to their response, 38 of the 40 respondents use window/door openings to cool their unit during the hot season and 19 of the 40 respondents use charcoal to warm their house during the cold season.

Chart 92

Cooling mechanisms during hot

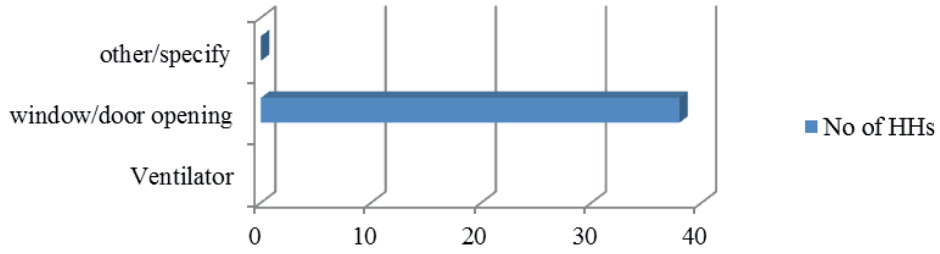
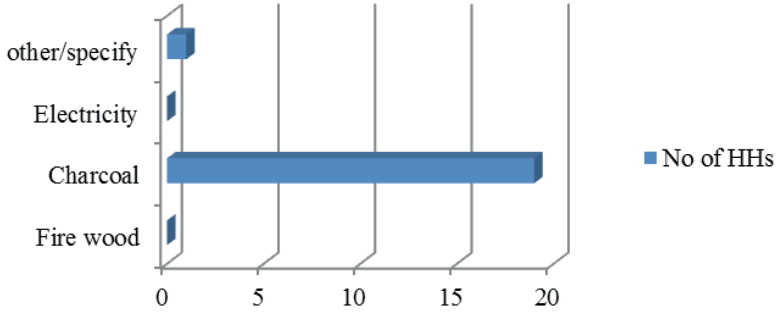


Chart 93

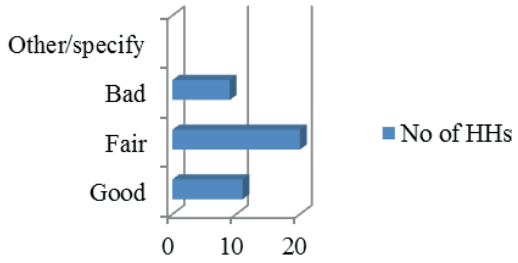
Heating mechanisms during cold



This research has tried to know if any training had been given to households regarding green energy, to understand their know-how and to know if there is any inclination towards it, However, all of the respondents indicated that they were not provided with any training regarding the appliance of green energy. ◆

Chart 94

Training given about green energy



8.4 Case 4: 'Quiha' Condominium Site, Quiha Sub city

This condominium site is located in Quiha sub-city, in the Eastern part of Mekelle. The site is near Magarment Factory and the condominium blocks are spatially clustered. According to the data taken from Mekelle housing agency, this site has 5 blocks which includes 23 studios, 48 1-bed room units, 81 2-bed rooms units and 8 3-bed rooms units. The survey conducted with 10% out of a total of 160 households is presented and analyzed here.

Table 14

Background information of the households

Sex Group		Age Group		Marital Status		Household size		Monthly income (Birr)		Educational status		Occupational status	
	No HHs		No HHs		No HHs		No HHs		No HHs		No HHs		No HHs
M	9	< 25 Years	0	single	2	1 - 3	7	< 2000	0	illiterate	2	Government	8
F	7	25 - 35 Years	5	married	14	4 - 5	5	2000 - 8000	11	can read and write	0	private	6
		36 - 45 Years	10	divorced	0	6 - 10	3	> 8001	1	elementary	3	unemployed	2
		> 45 Years	1	widowed	0	10 <	1	I don't know	4	high school-PhD.	11	pensioned	0

Housing Condition

Building blocks in this condominium are 12 years old, ranging from a minimum of G+3 to a maximum of G+4 in height, oriented to North East and South West.

As we can see from the table below, 11 of the 16 respondents are renters and 5 are private homeowners. 10 units are in good condition, 5 are rated as fair and one is under construction. 15 units are purely used as residences and one is mixed-use. The 16 investigated units comprise of 2 studios, 5 are 1-bed room units, 7 have two-bedrooms and 1 comprises of 3-bed rooms. 2 units are located on ground floor, 3 in first floor, 5 in the second floor and 3 in the third floor.

Floor finishes, roofings and ceiling finishes and wall finishes of the units are depicted below.

Table 15

Housing condition in Quiha Condominium Site

Ownership		Condition		Purpose of House		House typology		House floor location	
Government		Very good		Residential	15	Studio	2	Ground	2
Rent	11	Good	10	Mixed Use	1	1 Bedroom	5	1st Floor	3
Private	5	Bad		Other		2 Bedroom	7	2nd Floor	5
Other/ Specify		Fair	5			3 Bedroom	1	3rd Floor	3
		Under Construction	1					4th Floor	
		Other							
Construction Material									
House Floor Finish						**House Roof**			
Wood Tiles	Ceramic tile	Terrazo Tile	Cement screed	Marble	Other	CIS	Concrete	Other	
	6	1	7			2	11		
House Wall/partition wall					**House Wall finish**			**House Celling finish**	
Masonry	HCB	Boards/Chip Wood/ Fabrics	Brick & Cement	Other	Refined cement finish & painted	Gypsum finish	Other	Gypsum	Other
	16				16			2	8

9 of the 16 households had modified their house in different parts, 7 of them in finishing works (wall/ facade/ceiling/lighting/fixtures) and 2 constructed new partition walls. The majority of them have specified that the reason for their modification work is to enhance aesthetics (4 households) and comfort (2 households) of the unit.

Table 16

Modification status of the housing

Modification Status	No of respondents	In what part?	No	Reason of Modification	No of respondents
YES	9	**Finishing**	7	Aesthetics	4
		Wall/Façade	5	Functionality	
		Ceiling/Roof	1	Comfortableness	2
		Balcony/Veranda		Other/Specify	
		Lighting/fixtures	1		
		Other/Specify	2		
		New construction	2	Aesthetics	
		Partition wall/interior	2	Functionality	
		Façade/exterior wall		Comfortableness	2
		Other/Specify		Other/Specify	
NO	7				

Household Energy Consumption and Management
Under this topic, the surveyed questions regarding the households energy mix, energy consumption and energy management is presented and analyzed.

Energy Mix
Almost all respondents (15) use electricity and also have stated electricity to be the most secure source of energy. All the respondents use electricity for all household purposes such as electric stove, TV and radio, baking and lighting. They stated that they have their own meter. This investigation was done in order to identify on which fuel type the households are mostly dependent.

Chart 95

Mostly used energy type for household purposes

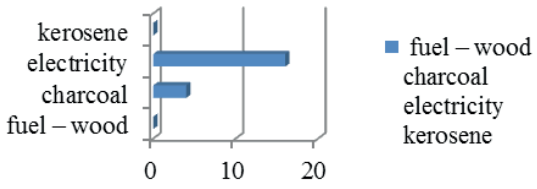
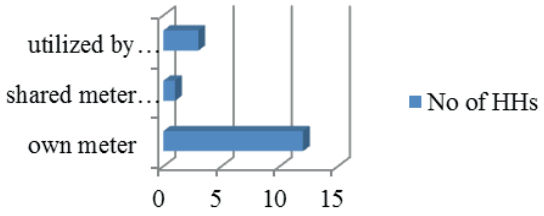


Chart 96

Energy acquisition



Energy use for specific and major purposes of households like baking, cooking and making coffee is also assessed to identify which energy type is mostly used for which purpose. Accordingly, electricity has the leading role for baking and cooking, while charcoal has the leading role in making coffee

Chart 97

Energy use for baking

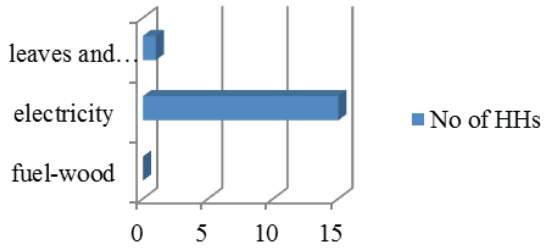
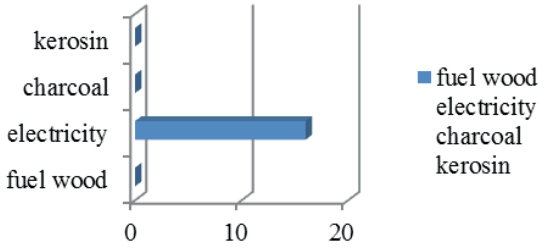


Chart 98

Energy use for cooking



The reason behind use of specific energy type for specific household purpose is investigated, and as we can see from the table below, most of the residents use charcoal for making coffee because they believe that it offers a better taste than other energy supplies.

Chart 99

Energy use for making coffee

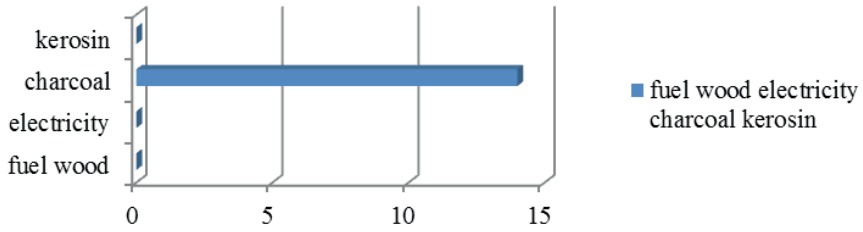


Table 16

Modification status of the housing

Fuel type	Cooking	Reason	No of Households	Making Coffee	Reason	No of Households
Fuel	Charcoal	For Better taste	12	Charcoal	For Better taste	5
		For its speed	10		For its speed	2
		For its price			For its price	1
		Other/specify	1		Other/specify	4

Energy Consumption and Management

In this section, the data on households´ consumption in terms of average monthly expenditure and their energy management in terms of alternatives used to replace in case of scarcity or high price of the preferred fuel is presented and analyzed.

Residents were asked since when they have been living in that specific house, as well as how they rate the relevance of dealing with energy management and if there is any organization/association that deals with energy conservation or management in the condominium buildings. The relevance of dealing with energy management of condominiums is rated as high by 15 respondents and not as not being a big deal by 1 respondent. 5 respondents live in their respective unit since before 2009, 9 since 2014 and 2 since 2017.

Chart 100

Households use electricity for

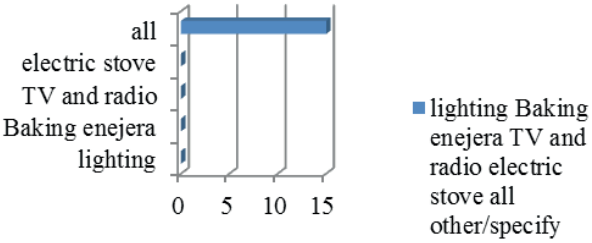
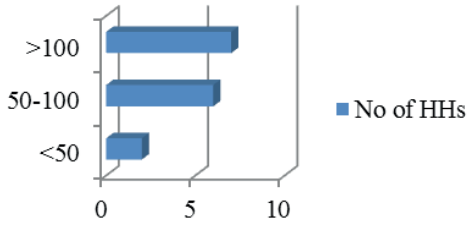


Chart 101

Average monthly expenditure for electricity



All respondents use electricity for all household purposes such as electric stove, TV and radio, baking and for lighting. 2 households spend less than 50 Birr, 6 between 50 and 100 Birr and 7 expense more than 100 Birr.

Chart 102

Scarcity of electricity

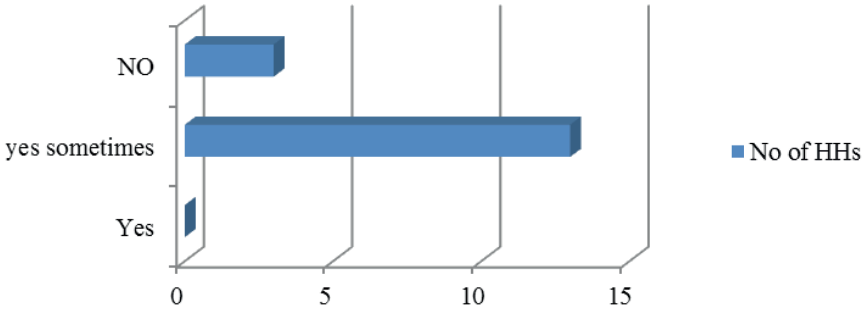
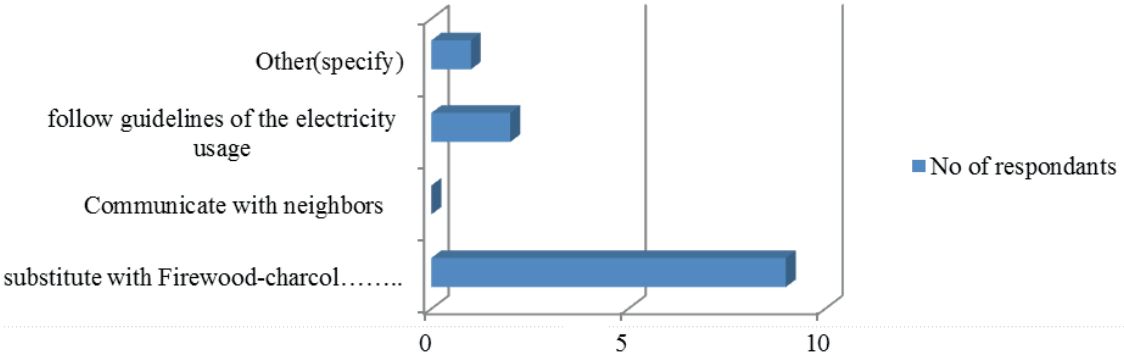


Chart 103

Alternatives used during scarcity of electricity



3 of the respondents indicated they did not experience periods of electricity scarcity, while 13 did so sometimes. When asked about alternatives during scarcity, 9 stated that they use alternative fuel types such as firewood-charcoal and 2 prefer to follow guidelines of the electricity usage.

Chart 104

No of households who use charcoal

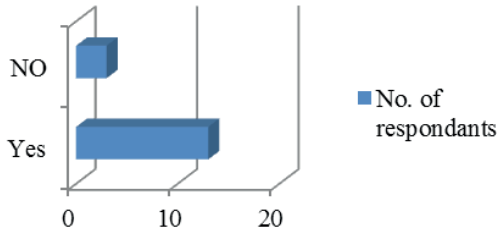
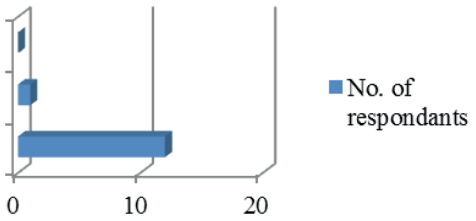


Chart 105

Charcoal acquisition



Almost all of the respondent households use charcoal acquired through purchasing. Almost all of them use the traditional (Iron) charcoal stove. And when they have to aquire charcoal, 4 normally do so for approximately 150 to 200 Birr at once while and 9 purchase for 400 to 500 Birr. 3 of the respondents use charcoal regular and 5 do so only occasionally.

Chart 106

Type of stove for charcoal

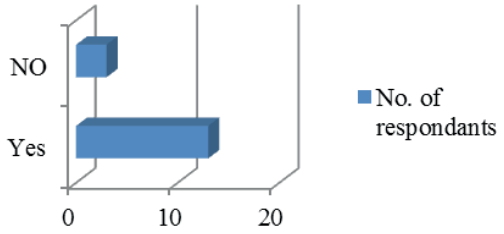


Chart 107

Buy charcoal at a time [Birr]

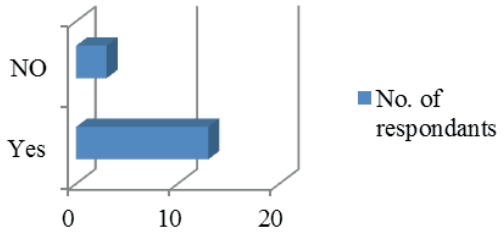
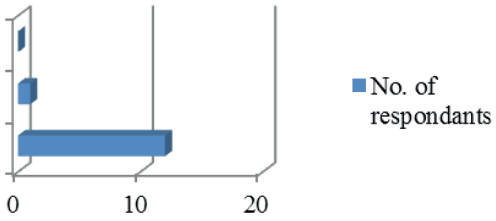


Chart 108

Use Charcoal when….



The average expenditure of the households for charcoal is less than 200 Birr for 2 households, between 200 to 400 Birr for 7 households and between 400 to 600 Birr for 2 households. In case of high-price for charcoal, 6 interviewed households store for the time of scarcity but the rest does not do this.

Chart 109

Average monthly expenditure for charcoal [Birr]

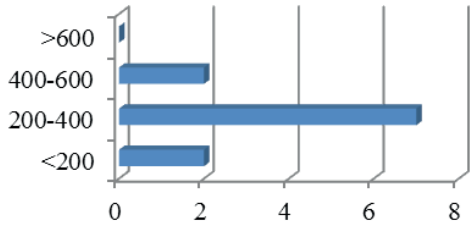
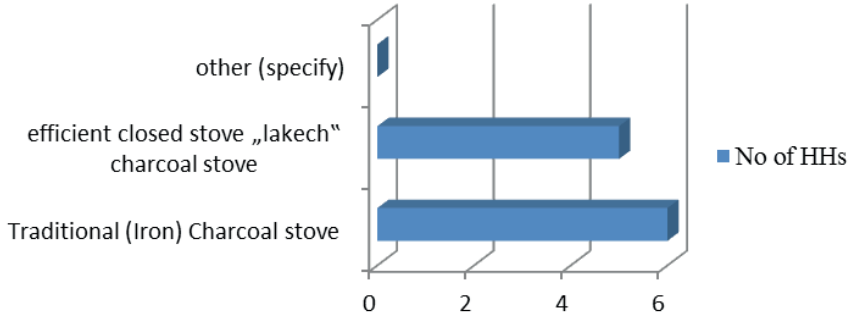


Chart 110

Alternatives if charcoal price is high

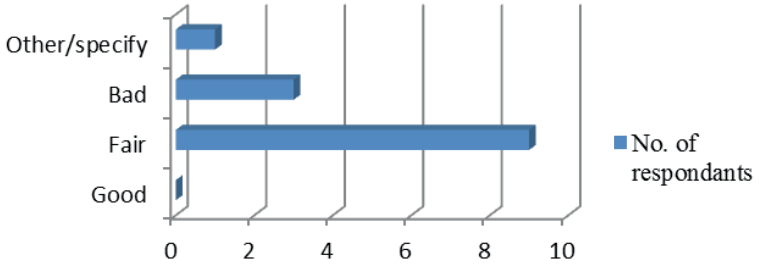


Household Perceptions with regards to Green Energy

The researcher has tried to investigate the perceptions of households with regards to green energy that is to understand if there are inclinations towards it. According to the results, 12 of the households rated their attitude in terms of acceptance of green energy as being 'good', 11 rated this to be 'fair' and 1 respondent dismissed the idea of introducing green energy. All respondents indicated that so far nothing had been done regarding introduction of green energy in their condominium.

Chart 111

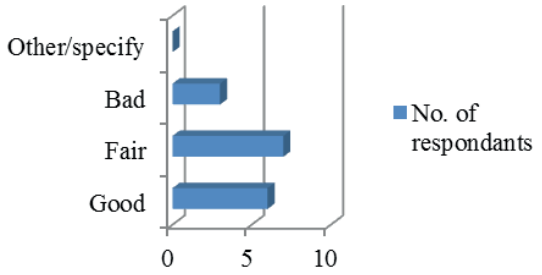
Attitude towards green energy



To understand habits of the households with regards to energy consumption for heating/cooling of their home, questions related to thermal condition of their house, their cooling mechanisms during hot and their warming mechanisms during cold were asked.

Chart 112

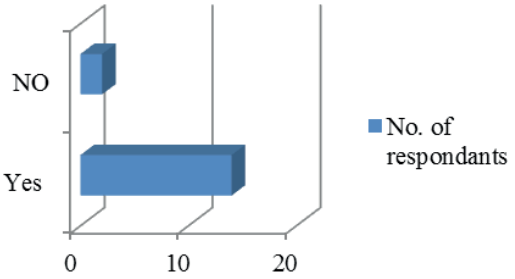
House thermal condition



Out of 16 respondents, 6 answered that the thermal condition of their house is good, 7 of them rated it as fair and 3 has rated it as bad. 14 have stated that thermal condition of their house depends upon the season and 3 respondents stated that it does not do so.

Chart 113

House thermal condition seasonal



13 of the 16 respondents use window/door openings to cool their house during the hot season and

11 use charcoal to warm their house during the cold season.

Chart 114

Cooling mechanisms during hot

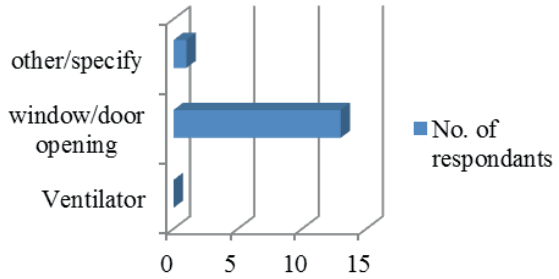


Chart 115

Heating mechanisms during cold

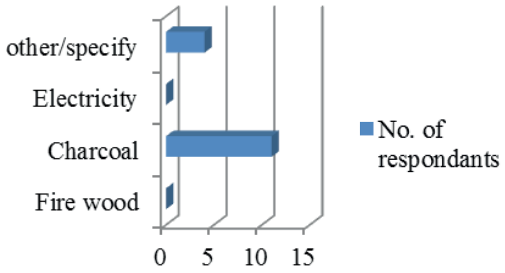
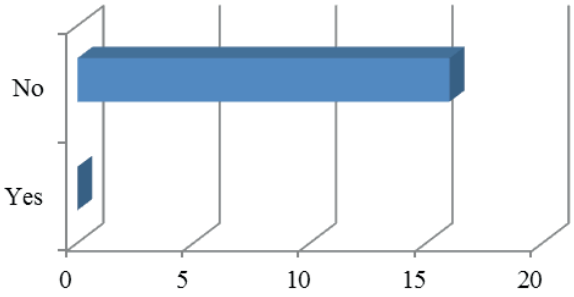


Chart 116

Training given about green energy



This research has tried to know if there is any training given to the households regarding green energy, to understand the know-how of the households and if there are inclinations towards it, but all the respondents replied "no". ◆