SES

Social Inclusion and Energy Managment
for Informal Urban Settlements

CASE STUDY
HOUSE HOLD ENERGY MANAGEMENT IN INFORMAL SETTLEMENTS OF ADDIS ABABA

Abnet Gezahegn Berhe, 2019

Funded by the
Erasmus+ Programme
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(2019) Household Energy Management in Informal Settlements of Addis Ababa, case study, prepared in the Social Inclusion and Energy Management for Informal Urban Settlements (SES) project

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ABSTRACT

Keywords:
Informal settlement, Household energy, Sustainable energy management, Energy use pattern, Availability and Affordability

There is a gap in information about the infrastructure adequacy in informal settlements to actually understand the energy provision, use and management. Informal settlements have profound impact on the planning, intervention and expansion of a city. Studying and documenting them is essential to plan effective interventions. Accessibility, both economically and physically, to adequate and reliable energy sources is vital for social and economic development in any country. This is also in line with SDG-7 'to ensure access to affordable, reliable, sustainable and modern energy for all'. The issue of inclusiveness also surfaces when it comes to the availability and affordability of energy. Studies show that the bulk of energy in Ethiopia is still consumed by Households. This study focuses on the energy manage-ment in selected informal settlements of Addis Ababa with an objective to acquire and analyze information on the use pattern, availability and affordability of energy at household levels. In line with the objective, the study also attempts to obtain a broader understanding of the relationship between energy management of households and the social, eco-nomic and environmental characteristics of the settlements. Purposeful systematic selection of four representative case study sites was conducted among different typologies of informal settlements in Addis Ababa. Selam Sefer, Goro and Ayat in the peripheries and Gedam Sefer, in the inner city of Addis Ababa. Mixed data collection techniques were em-ployed including sample survey, in-depth interview of key informants, structured interview on households, mapping, photography, sketching secondary data through literature and contextual review. A total of 520 household survey was conducted. GIS mapping and SPSS were used for the analysis. The analysis outcome is a detailed picture of household energy management in the case study areas. The preliminary findings were further triangulated and validated through a focus group discussion.

Results of the analysis reveal that, with regards to the *energy use patter*n, hydroelectric power is cheaper and available in the case study areas. The households in the informal settlements predominantly use hydroelectric power, a renewa-ble energy sources, for light. More than half of the households also use the same for cooking. Most of the households in the case study areas have access to the main grid hydroelectric power even though the acquisition method is infor-mal in some cases. There is a tendency to acquire an electric meter as a means to secure tenure in the informal settle-ments at the outskirts of the city. Households without any form of tenure documentation also struggle to acquire main grid connection. These households either end up paying extra for rental electricity per light bulb from their neighbors or engage in illegal taping from the main grid. More than 60% of the low – income households cannot afford renewa-ble energy sources and spend more than the energy expenditure threshold, which is 10-15% of the household income. 70% of the households earning decent monthly income, to the contrary, spend less than the energy expenditure threshold. The households in the case study areas exhibit great awareness on the health and environmental benefits of using renewable energy. The substandard infrastructure provision and further informal intervention of the settlers in the case study areas also result in high rates of fire and electricity related accidents. The study recommends to fully exploit the existing social bond and

community structure to create the link between the informal settlers and the local authority. Permanent assurance of renewable energy supply could be achieved by integration of these settlements with the existing infrastructure and further investigation on decentralized energy provision of other renewable sources. ◆

CONTENTS

ABBREVIATIONS

FGD – Focus Group Discussion
GHG – Greenhouse Gas
GWh – Giga Watt Hour
ICES – Integrated Community Energy Systems
IEA – International Energy Agency
kWh – Kilo Watt hour
MW – Mega Watt
NGO – Non-Governmental Organization
WBO – World Bank Overview
WHO – World Health Organization

Definition of local terms
Birr – Ethiopian Currency
Idir – a traditional association established among neighbours or co-workers to raise funds that will be used during emergencies, such as death within these groups and their families
Iqub – a traditional association established by a small group of people in order to provide substantial rotating funding for members in order to improve their lives and living conditions
Kebele – Local government, the smallest administrative unit
Mahber – a traditional association established among neighbours, co-workers, religious or ethnic affiliates to keep in touch regularly
Woreda – Local administrative unit, one level higher than kebele

Note: Unless specified otherwise, the photographs are taken by the author. The analyses results, tables and figures are also prepared by the author and fellow SES team members

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PART 1
INTRODUCTION

The growth in urban populations in the developing world has rapidly overtaken the capacity of national and municipal governments to provide formal housing and servicing to the urban population. As a result, the growth of informal settlements in urban areas of the developing world has been high (Lemaire et. Al., 2016). Informal settlements have profound impact on the planning, in-tervention and expansion of a city. Studying and documenting their characteristics is essential to plan effective interventions. Given the spontaneity and impermanent nature of informal settlements, the social, economic and physical aspects of most settlements are not usually documented. There is a gap in information about the infrastructure adequacy in informal settlements to actually understand the energy provision, use and management. Accessibility, both economically and physically, to adequate and reliable energy sources is vital for social and economic development in any country, it is especially true to the disadvantaged groups of the population. This is also in line with SDG-7 'to ensure access to affordable, reliable, sustainable and modern energy for all'. The issue of inclusiveness also surfaces when it comes to the availability and affordability of energy.

Hydropower electrical energy, in Ethiopia, is mostly used by urban households (Mondale et al., 2018) unlike the rural households that use predominantly biomass energy. This study focuses on the energy management in selected informal settlements of Addis Ababa with an objective to acquire and analyze information on the use pattern, availability and affordability of energy at household levels. In line with the objective, the study also attempts to obtain a broader understanding of the relationship between energy management of households and the social, economic and environmental characteristics of the settlements. The study only focuses on household energy consumption for cooking and light. Given the favourable climate of Addis Ababa, energy for heating or cooling a household is not as critically required, hence is not addressed in this study. Furthermore, the energy footprint of construction materials of the households is not considered since only 'end-use' energy is studied as defined and described under literature review section. Though energy management, in a broader sense, includes energy use pattern, availability, afford-ability and efficiency, this study only concentrates on the use pattern, availability and affordability aspects. Efficiency is out of the scope of this study. Studying and documenting the relationship between energy management of households and the social, economic and environmental characteristics of the informal settlements will narrow the existing gap in information and equip planners, policy makers and energy suppliers with ample information to plan an efficient intervention. ◆

PART 2
LITERATURE REVIEW

This section will define and discuss the identifying features of informal settlements and state the different types of energy in terms of source, application and use. The theoretical background of sustainable energy management will also be discussed including commendable ways of achieving access to renewable energy sources. Finally, the relationship between energy management of households and the social, economic and environmental characteristics of the settlements will be specified.

Definition and Characteristics of Informal settlements: informal settlements are defined by different sources but according to UN Habitat, (2015), informal settlements are residential areas where 1) inhabitants have no security of tenure vis-à-vis the land or dwellings they inhabit, with modalities ranging from squatting to informal rental housing, 2) the neighborhoods usually lack, or are cut off from, basic services and city infrastructure and 3) the housing may not comply with current planning and building regulations, and is often situated in geographically and environmentally hazardous areas. In addition, informal settlements can be a form of real estate speculation for all income levels of urban residents, affluent and poor. Slums are the most deprived and excluded form of informal settlements characterized by poverty and large agglomerations of dilapidated housing often located in the most hazardous urban land. In addition to tenure insecurity, slum dwellers lack formal supply of basic infrastructure and services, public space and green areas, and are constantly exposed to eviction, disease and violence. According to the SDG progress report, 2019, the absolute number of people living in informal settlements in the world, grew to over 1 billion out of which, 238 million belong to sub-Saharan Africa. The growing number of informal settlers is the result of both urbanization and population growth that are outpacing the construction of new affordable homes. Adequate housing is a human right, and the absence of it negatively affects urban equity and inclusion, health and safety, and livelihood opportunities. Availability of services, materials and infrastructure should also be considered in line with adequate housing. All beneficiaries of the right to adequate housing should have sustainable access to natural and common resources, clean drinking water, *energy for cooking, heating and lighting*, sanitation and washing facilities, food storage facilities, refuse disposal, site drainage and emergency services, (IBID).

Different sources portray unpleasant images while describing the characteristics of informal settlements: 'Physical and socio-economic conditions found in informal settlements are generally hazardous to health and tend to exacerbate the severe socio-economic conditions of the urban poor as well as environmental pollution and degradation of the local ecosystems' (Wekesa. et.al, 2011, P238). 'By definition, informal settlements are exposed to numerous hazards and vulnerabilities given the extremely dense population and lack of secured tenure, safe and clean-living environment, and access to the most basic services such as clean water, sanitation and health care' (UN Habitat. World Cities Report 2016, p-262). 'Notably, these are all defined as universal human rights and included in United Nations' Sustainable Development Goals, indicating severe deficiencies in sustainable development' (UN, 2010). On the other hand,

there is a new shift in characterizing and defining informality. Cruz (2012) cited in (d'Alencon, et al., 2018) states that 'The informal is not just an image of precariousness; it is a compendium of practices, a set of functional urban operations that counter and transgress imposed political boundaries and hierarchic economic models. This will lead to new interpretations of housing, infrastructure, property and citizenship, and inspire new modes of intervention in the contemporary city' (d'Alencon, et al., 2018). 'Informality as a concept is increasingly recognized as bridging the duality between formal and informal 'sectors' (i.e. economic, spatial, etc.) and processes (i.e. 'a way of life' (AlSayyad, 2004). The characteristics of informal settlements is a broad subject and could be studied in depth, this study however only zooms on to the most relevant social economic and environmental aspects in relation to the household energy management.

Definition of Energy: The term energy is broadly used in different disciplines and contexts. To zoom in to the focus of this study, this section sets out by defining sources of energy, energy services and identifying how they differ according to sector. 'The term "primary energy" means the energy "embodied" in natural resources, such as coal, crude oil, natural gas, uranium, and even falling water, which may be mined, stored, harnessed or collected but not yet converted into other forms of energy (Pachauri et al., 2004). Natural resources of energy, depending on the rate at which they are replaced by the natural processes relative to the rate of human consumption are further categorized in to renewable and non-renewable. 'Non-renewable energy resources are available in limited supplies, usually because they take a long time to replenish. The non-renewable energy resources are: Coal, Nuclear, Oil and Natural gas. Renewable resources, on the other hand, replenish themselves. The five major renewable energy resources are: Solar, Wind, hydro, Biomass, or organic material from plants and animals, Geothermal, which is naturally occurring heat from the earth' (Stark, 2019). Renewable resources of energy do not emit greenhouse gases in energy generation processes, making them the cleanest, most viable solution to prevent environmental degradation. This makes them an essential element in a sustainable energy management system that allows development today without risking that of future generations. 'The term "End-use energy," refers to the energy content of primary energy supplied to the consumer at the point of end-use, such as kerosene, gasoline, or electricity, delivered to homes and factories' (Sovacool, 2011). 'Six basic sectors utilize the end use energy: residential, commercial, agricultural, transport, and industrial needs' (Reister and Devine,1981). Energy, in the context of this study, is the "end-use energy" required to meet the needs of a household particularly for light and cooking purposes. Given the favourable climate of Addis Ababa, energy for heating or cooling a household is not required as much.

Energy management at household level includes the energy use pattern, availability, affordability, and efficiency initiatives. *Energy use pattern*, in the context of this study is the type of energy (renewable and non-renewable) consumed in households. This is used to determine whether the energy consumption in the case study areas is to a certain extent sustainable or not. The physical access to energy is studied in terms of the availability of renewable energy sources in the case study areas. *Availability* in the context of this study refers to a direct connection to the municipal electricity grid and/or the ease of obtaining locally available source of energy in a close vicinity. *Affordability* of energy, considers the households' ability to pay for the required amount of renewable energy for light and cooking uses. Balachandra, on 'Modern Energy Access to All in Rural India' link the terms availability and affordability as the physical and economical aspects of access to energy: 'Conceptually energy access means that modern (renewable) energy services should be physically accessible and available to peo-

ple and should be of acceptable quality, reliable and preferred. Further, it should be affordable in terms of low capital and operating cost in the context of income' (Balachnadra, 2011). (Longe et al., 2018) argue that the percentage of household income spent on energy is one of the indicators of affordability to renewable energy sources. Electricity consumption by households is largely dependent on household income, lifestyle, and appliances owned. Energy expenditure is important, because it is one of the indicators of households' affordability. The energy expenditure threshold is the approved maximum income-dependent amount that a household should spend on energy costs. It is usually set by the government of any nation, and it is 10% to 15% of household income. The affordability of energy used in a household can be calculated using the energy expenditure threshold ranging between 10% to 15% of household income.

The topic of *energy efficiency* is broad and can be studied in depth with regards to the application of efficient industrial processes, transport, utilization of energy efficient building construction materials and efficient household appliances. This study however, only focuses on the level of utilization of renewable energy sources at households in the case study areas to comprehend the impact on health and the environment.

Relationship between energy management of households and the social, economic and environmental characteristics of the settlements: As indicated in the definition of informal settlements earlier in this section, lack of basic services and city infrastructure is one of the identifying features of these settlements. 'Low income dwellers are not able to access most of the formal institutions of society, and lacking a legal address, they are often unable to access social services and renewable energy services. Even when renewable energy services - such as electricity and clean and safe cooking systems - are available, they cannot afford their use' (IEA, 2011). The issue of inclusive development and social justice surfaces while discussing access to energy in terms of availability and affordability to renewable energy sources.

Lemaire et al (2016) argue that the legal status of an informal settlement can be a barrier to any formal municipal authority from attempting to service the settlement. Settlements that exist on land that is already owned by the local authority or by another entity, for example a property developer, often have a tenuous or lacking legal status from the perspective of municipal service authorities. This lack of a formal legal presence can prevent municipal service authorities from engaging with informal settlements due to a lack of a mandate. Due to the difficulties that municipalities often face in providing electricity services or other renewable energy sources to informal communities in developing cities, rates of electricity theft among residents of these communities are often high. These illegal connections can take the form of distributing electricity to several households from one legal connection, or through directly tapping into medium-voltage electricity line to distribute at a local level' (Lemaire et al, 2016).

Kanagwa and Nakata (2008) commendably claim that energy is often considered as a basic human need. Its adequate provision is always a pre - requisite for meeting the human needs. Energy has a great potential to influence the most fundamental components of development. It is highly associated with the socio-economic aspects of development like income, education, health and gender. With regards to education, lighting appliances enables to study at night, moreover, utilization of renewable energy sources results in freeing up from drudgery and creating time for study and also helps narrow the digital divide through information and communication technologies. With regards to income, enterprise development through provisions of renewable energy sources and electrification creates jobs. With regards to the environment, reduction in use of fuelwood prevents deforestation *and the* use of efficient

electric appliances saves energy consumption. With regards to health, using renewable energy sources reduces exposure to hazardous pollutants, moreover, avoiding drudgery such as collecting fuelwood improves health conditions of women and children. (Kanagwa and Nakata, 2008). TERI, (2008) further corroborate the environmental impact of access deprivation to renewable energy sources by stating that: globally, 2.5 billion people meet their primary energy needs through the consumption of biomass. The World Health Organization (WHO) also reports indoor smoke from household air pollution is a serious health risk for some 3 billion people who cook and heat their homes with biomass fuels and coal. Some 3.8 million premature deaths were attributable to household air pollution in 2016 (WHO, 2018). In Ethiopia, over 95% of households continue to rely on biomass fuels for cooking, which results in a high burden on health: air pollution is the largest single environmental risk factor for premature death in Ethiopia, and the deaths attributable to household air pollution are dominated by those due to lower respiratory infections in children. It is however noteworthy to mention that in general, the lifestyle of marginalized informal settlements is relatively energy friendly as compared to other prosperous classes in society. Keeping energy consumption and foot pints under control while attempting to upgrade their living conditions poses a challenge' (WHO, 2018).

Sustainable energy management: 'stable access to energy, especially electricity is considered to be one of the key factors in the development of civilization' (Lemaire, 2010). According to Prandecki, the expression "sustainable energy" is often mistakenly replaced with "renewable energy". The first expression is much wider, as the issue of sustainability applies not only to generate energy, but also its consumption. The utilization of renewable energy sources is therefore considered sustainable. 'Analyzing a balanced approach to energy should be considered not only a problem of sustainability, but also the inclusion of social and environmental needs for economic development' (Prandecki, 2014). H. Rogall cited in (Prandecki, 2014), describes sustainable energy policy in three dimensions: ecological, economic and socio-cultural. In this way, the sustainability criteria adopted are: *The ecological dimension*: including global warming, natural tolerance, consumption of non-renewable resources, overuse of renewable resources, hazards to human health. T*he economic dimension*: the impact on the national economy, meeting the energy needs, short-term security of supply, the relevant prices, preventing concentration and cost-effectiveness of the energy market, the economic dependence on raw material supply and the efficiency and competition for the use by different sectors of the economy (e.g., energy and chemical industry) are included. *The socio-cultural dimension*: social tolerance, permanent assurance of supply, the integration with the existing infrastructure, avoiding participation in global conflicts, security is included.

The three-pillar division of sustainable energy is also provided by G.P. Hammond and C.I. Jones as cited by (Prandecki, 2014), who use slightly different criteria to be met by energy considered to be sustainable. These include: *the environmental pillar*, *the economic pillar* and *the social pillar,* which is more difficult to use measurable criteria. The social pillar can however be measured at least partially, for example, by the level of *involvement of stakeholders*, customer research, mapping preferences, etc. On the other hand, it is also advisable to use ethical assessment of the impact of existing and future energy systems on society and the environment. One aspect of this assessment is also the issue of intergenerational equity in terms of access to sources of energy and the cost of its acquisition.

Social dynamics and community involvement in informal settlements as potentials to ensure access to renewable sources of energy: As the issue of social inclusion surfaces, the study tries to identify how

informal settlers bond or coexist and explores ways of utilizing existing social bonds (if any) and community participation towards achieving access to sustainable or renewable energy sources. Subbiah et.al, (2016) provide valuable insights on utilization of the existing social bond in ensuring access to renewable sources of energy in informal settlements. They advocate customized solutions to each settlement and the involvement of all stakeholders (community, the government and landlords if any) to cater to the particular needs of the community. Identification of the existing community dynamics and power structure from the onset plays an important role in planning and implementing successful interventions. This includes identification of possible monopoly of the energy provision and cost with in the community.

B. P. Koirala, (2017) advocates the application of community micro – grids and integrated community energy systems (ICES). 'These options to energy system integration differ in their objectives and most of them are designed to adapt to an existing blueprint of a centralised energy system. For example, the aim of community micro-grids is to optimize electricity generation and demand for resiliency ICESs offer a comprehensive and integrated approach for local energy system where communities can take complete control of their energy system and capture all the benefits of energy system integration.

Local energy initiatives are becoming a societal movement indicating the growing societal demand for sustainable and 'self-owned' energy with potentially significant impact on the energy system. There is a widespread consensus that if energy systems are to provide more value to the society, different energy sectors and activities at the local level have to be integrated with the engagement of local communities. Such integrated approach impacts different levels of society such as individual households, local communities as well as the society at large. It also means looking at the existing energy infrastructures and available resources in the community and finding the tailored and innovative solutions such as local generation, local exchange, load shifting and energy conservations to meet the local energy demand. Therefore, ICESs include planning, design, implementation, and governance of energy systems at the community level to maximize energy performance while cutting costs and reducing environmental impacts' (B. P. Koirala, 2017). Though Koirala's solution focuses on formal communities, the suggested systems could be discussed as input to non-governmental initiatives and policy measures by governments towards ensuring renewable energy sources in informal settlements.

As suggestion to policy initiatives, (Caputo et al, 2016) compare the energy access status of informal settlements in Latin America and Africa and recommend Latin America's approach which has been more aimed to the legalization of the slum dwellers, providing them energy services like subsidized electricity and LPG for the poorest, thus promoting actions and policies for the development of disadvantaged urban areas.

In Summary, energy has a great potential to influence the most fundamental components of development and plays a great role in achieving the sustainable development goals. Informal settlements on the other hand have profound impact on the planning, intervention and expansion of a city. Studying the relationship between energy management of households and the social, economic and environmental characteristics of the informal settlements will equip planners, policy makers and energy suppliers with ample information to plan an efficient intervention. ◆

PART 3
CONTEXTUAL REVIEW

This section sheds light on the informal settlements of Addis Ababa and the energy policy of Ethiopia. The existing energy use pattern of households, availability and affordability of renewable energy sources in the city will also be deliberated.

Addis Ababa, the political capital and the most important commercial and cultural center of Ethiopia, is a primate city and the home of roughly 25% of the total urban population in the country. Land is public property in Ethiopia. All land and housing related policies, strategies, rules and regulations are adopted in light of the basic land ownership right of the public and government in the past thirty years. The informal settlements in Addis Ababa are either in the inner areas or expansion areas of the city. The informal houses in the inner areas of the city have formalized tenure and evolved along the past century from their beginning around the emergence of Addis Ababa as a garrison town. The majority are owned by the government after 1975, and are commonly referred to as the Kebele houses. Almost 70% (Yitbarek, 2009) of the houses in the inner city are Kebele houses that are single storey and made of mud and wood walls, mud floors and iron sheet roofs. The houses at the expansion areas are not as old as the inner city informal houses and almost all are the results of squatter settlements formed by the farming community in the Oromia regional state. There are farmer communities that informally sell a parcel of their land to migrants. While the city keeps increasing its limits these communities become integrated within the city proper. The informal settlers are encouraged to remain squatting due to the continual government history of land titling of the informal settlements. The government has periodically given land tenures to the settlers with a certain amount of land regularization that tries to correct faulty road alignments & standards (City profile, 2017). There are two types of tenure documentation: households with secure tenure own a title deed, while those without title deed hold on to tax receipts paid to local administration for land lease and other services.

Energy situation in Ethiopia: *According* to (IEA, 2019), close to 600 million people are still without access to renewable energy sources and electricity in sub-Saharan Africa. Africa's electrification rate of 45% in 2018 remains very low compared with other parts of the world. The 600 million people still without access to electricity there represents more than two-thirds of the global total. About half of the sub-Saharan African population without access to electricity live in five countries: *Nigeria, DR Congo, Tanzania*, *Uganda and Ethiopia*.

According to the 2010 energy policy of Ethiopia, 94% of Ethiopia's energy consumption is based on biomass energy sources such as fuel wood, charcoal, branches, dung cakes and agricultural residues - the balance is met by commercial energy sources such as electricity and petroleum. 71 million people do not have access to electricity. The policy, ten years ago, highlights the fact that Ethiopia must be boosted before 2025 into a 'middle-income country'. And that development should not only be 'climate-proof' but also CO_2 proof. According to the (WBO, 2018), Ethiopia has a final energy consumption of around 40,000 Giga Watt Hour (GWh), whereof 92 % are 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/a is mainly generated by hydro energy (96 %) followed by wind energy (4 %), whereof in total 11 % get exported. In contrast, the major share of energy supply for transport is imported in forms of petroleum. Ethiopia is endowed with renewable energy sources. These include first of all hydro, but also wind, geothermal, solar as well as biomass. Only a small portion of the potential is harnessed today. Due to its fast-economic growth, the energy demand is increasing enormously. Therefore, it is expected to rise by a rate of 10 -14 % per year till 2037. The Ethiopian government has emphasized the importance of sustainable energy development in different policy documents such as Growth and Transformation Plan, green economy strategy, sustainable energy for all and biomass energy strategy (Ibid). The data on this ten-year-old document however would have some changes. Particularly the statement indicating that '94% of Ethiopia's energy consumption is based on biomass energy sources' has significantly changed.

Recent documents such as (Africa Energy Outlook, 2019) indicate that 'Ethiopia currently has an electricity access rate of 45%, 11% of its population already have access through decentralised solutions. There is a strong government commitment to reach full access before 2030. Around 80% of new connections are cost effectively delivered by grid densification and extension as a large part of the population lives close to the hydropower grid.'

'For several decades, the Ethiopian economy has been largely agriculture-based. The last two decades, however, have witnessed a structural shift away from the agriculture sector towards the service sector while the share of industry remains low. The main source of electricity in the country has been hydropower, with recent additions from thermal and wind sources. But access to electricity is still limited to urban areas, and biomass burning is the main source of energy for rural households. With regards to the environment, livestock accounts for the largest share of the national greenhouse gas (GHG) emissions (54.5 percent). Land use and forest change, including unsustainable harvesting of fuelwood, represent the second largest share (38.46 percent). Petroleum fuels and kerosene, on the other hand, account for a much smaller share of emissions with 4.5 percent and 1.8 percent respectively' (Mengistu et. Al, 2019)

With regards to the *energy use pattern,* as has been indicated by Mondall et. al, (2018), power generation for the electric grid in Ethiopia currently depends almost entirely on hydropower. In urban areas 87% of the population has access to electricity. Electricity is mostly used by urban households and small industries. Per capita electricity consumption was 23 Kilowatt hours (kWh) in 2000 and increased to about 41 kWh by 2008 and 70 kWh by 2014. This level is far below the average level of per capita energy consumption across all African countries (500 kWh per capita). The estimated potential for hydropower is 45 GW, wind is 10 GW, geothermal is 5 GW, and solar irradiation ranges from 4.5 kWh/m^2/ day to 7.5kWh/m^2/day in light of this, the Government of Ethiopia's strategic priorities in the energy sector are: universal electrification access, energy efficiency improvement, decentralized off-grid power generation through the development of renewable energy technologies, and exporting electricity to neighboring countries. In particular, the government is developing large-scale hydroelectric projects with the aim of increasing the supply of renewable energy sources from the present generation capacity of 2000 Megawatt (MW) to 8000e10,000 MW. The Grand Ethiopian Renaissance Dam is under construction and expected to be completed soon. The hydro- power plant would add 6000 MW to meet the government targets of over 8000 MW capacity (Ibid). This also falls in line with the regional framework 'Agenda 2063', according to (Africa Energy Outlook,

2019), Africa's blueprint and master plan which was envisioned in 2013 for transforming the continent into the global powerhouse of the future. Energy-related targets applicable to Ethiopia contained in the framework for the first ten years include increasing access to electricity by at least 50% compared to 2013 levels and increasing the efficiency of household energy use by at least 30% before 2023.

Characteristics of informal settlements: can be studied in-depth and in a broad manner, but in relevance to the objective of this study, and as established under literature review, the social, economic and environmental characteristics of the settlements will be studied from the perspective of the three pillars of sustainable energy management. The *social characteristics* is seen from indicators of social tolerance and permanent assurance of supply. In the context of this study: the social characteristics of the case study areas, will be studied by scrutinising the social dynamics and checking the availability of existing community structure. Prevalence of social ills and violence in the case study areas will also be checked. The *economic characteristics* is zoomed in from the perspective of meeting the energy needs of households and affordability of renewable energy sources. Hence, the economic aspect of the case study areas will be observed from different angles. The economic activities in the settlements, livelihood of the residents, and the monthly income of the respondents will be studied. The *environmental characteristics* is observed from indicators of sustainable access to common resources, extent of consumption of non-renewable resources and consequent hazards to human health. The physical and environmental situation of the case study areas will be checked by inspecting the physical condition of access routes, availability of infrastructure and prevalence and awareness indoor air pollution, natural and man-made hazards.

In summary, the most reliable and renewable energy source in Ethiopia and particularly the urban areas such as Addis Ababa is currently hydroelectric power. According to Addis Ababa city Electric Utility Bureau's planning office, a legal household can get 7 kWh of electric power with a tariff of 2 birr/kWh. Contextual review of this study revealed a gap in documentation of the actual energy scenario of households in informal settlements of Addis Ababa and sets out to document and understand the energy management at household level in the selected case study areas in relation to the characteristics of the settlements. ◆

PART 4
METHODOLOGY

In line with the objective of this study, the method is designed to acquire a complete picture of the energy management of households in informal settlements of Addis Ababa. The method is further used to obtain a broader understanding of the relationship between energy management of households and the social, economic and environmental characteristics of the settlements. This section describes the methodology in detail.

Purposeful systematic selection of four representative case study sites was conducted based on pre- defined criteria (See Study Area Description) and local knowledge. Data was collected through secondary data Review, sample household survey, interview of key informants, field observation and focus group discussion. Prior to data collection, a reconnaissance survey was conducted and maps were updated by analysing existing line maps, aerial photos, satellite Google Images and direct observation. Parcels are given new, unique numbers in a GIS environment. Clustering or stratification of each site was conducted through identifying homogeneity to avoid selection bias (unrepresentative sample). Sample size margin of error was 5% and the confidence level 95%. Simple random sampling of parcels/compounds in each cluster was conducted using randomly generated numbers out of a set of consecutive numbers given to the population (all compounds/parcels) of each cluster. Parcels and samples in each case study area are presented on table 1. Systematic sampling of households in parcels with multiple households was conducted as described on the survey protocol (see Annex -1).

Table 1

Number of Sample Parcels in the Case Study Areas

CASE STUDY AREA	ADDRESS	PARCELS	SAMPLE	PERCENTAGE
Gedam Sefer	Arada sub city, Woreda 5	411	199	49% (Residential & mixed)
Ayat	Yeka city, Woreda 13	137	101	73%
Goro	Bole sub city, Woreda 9	492	216	44%
Selam Sefer	Bole sub city, Woreda 13	470	212	45%

Mixed data collection techniques were employed including sample survey, in-depth interview of key informants, structured interview on households, mapping, photography, sketching secondary data through literature and contextual review. The key informants are composed of experts and local officials. A single questionnaire, commonly developed by all SES team members was used for all case study sites. Structured questions were used to reduce interview time and ensure uniformity of the collected data. A set of instructions were also provided to data collectors to document observations (measuring, sketching, labelling and photography). A pilot survey was conducted and the questionnaire was further developed through the feedback. A total of 520 household surveys were conducted in all four case study areas in March, April and May, 2018.

GIS mapping and SPSS were used for the analysis of the data collected during the surveys and interviews. The former was used for mapping techniques to understand and analyse the spatial configuration, spatial implication and visualization of variations between settlements, while the latter was used to examine relationships between variables, comparison and interpretation, to conduct Intra– and inter–case analysis, paraphrasing and tabulation. The analysis outcome is a detailed picture of the energy management in the case study areas. The preliminary findings were further triangulated and validated through a focus group discussion (FGD) conducted during a stakeholder's workshop. The focus group was composed of: coordinator of the informal settlers, experts and officials from the sub cities and Woredas of the case study areas, Addis Ababa Electric Utility Bureau, Ethiopian Energy Authority, Addis Ababa land development Bureau, Addis Ababa Plan and development commission and Addis Ababa construction permit and control Bureau. ◆

PART 5
STUDY AREA DESCRIPTION

Various types of informal settlements exist in Addis Ababa depending on their location, age, legal status, development pattern and so on. Nevertheless, respective researches have been done in a piecemeal approach with less perspective on comprehensive & comparative pictures. In this study, it was found important to address each type and get an overall undestanding of the informal housing development in the city. Broadly, these settlements are categorized in four mainly considering their location and legal status, which are:

a. Inner-city informally developed kebele house areas
b. Informal settlements both in the inner and in the outskirts of the city on environmentally vulnerable areas (riverside)
c. Informal settlements in outskirts of the city, on acquired farm lands
d. Informal settlements in the outskirts of the city, on environmentally vulnerable areas

Taking the above categories into consideration, for more representative coverage, further criteria such as location in terms of proximity to the inner city & distribution, age, pattern and status (legal) of respective settlements, are considered. Accordingly, four case study sites are identified which are Gedam Sefer, Ayat, Selam Sefer & Goro.

Detail description of the case study sites

1. *Gedam Sefer* is located in Arada Sub-city, Woreda 5 Addis Ababa. It is an old settlement with houses that are legal but informally developed. The site has a total area 30.7ha with a perimeter of 2.6 km. In total, there are 411 parcels with an estimated population size 2,055.
   The new master plan of the city designated the area for a high density mixed development.

Figure 1

Parcellation map of the Gedam Sefer site prepared based on 2003 topographic map

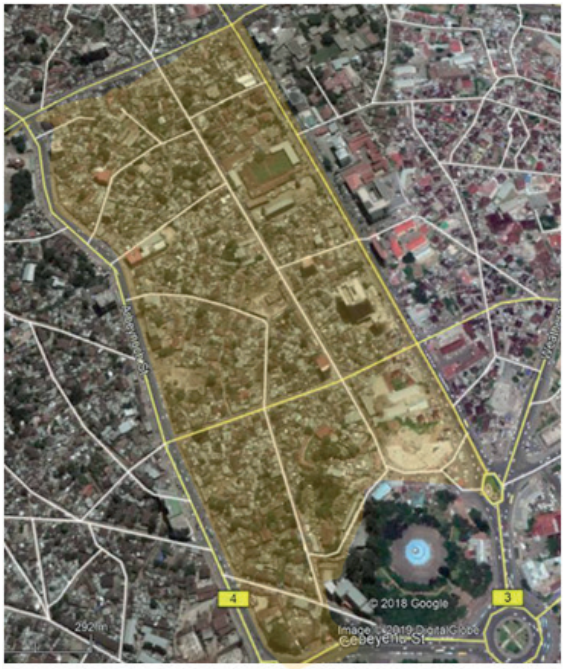


Figure 2

Arada site located on Google

Figure 3

Parcellation map of the Goro site prepared based on the 2003 topographic map

2. *Goro* is located in Bole Sub-city, Woreda 9 Addis Ababa. The site is a recently regularized and legalized informally developed settlement in the outskirts of the city which is located along the bank of a river and partly under high-tension line. It has a total area 26.8 ha with perimeter of 3.56 km. In total there are 492 parcels with an estimated population size 2,460. The settlement is established in the last three decades where its fastest growth is observed only after 2010. The new master plan has designated the area for low density missed residential development.

Figure 4

Goro site located on 2018 Google Image

3. *Selam Sefer* is located in Bole Sub-city, Woreda 13 Addis Ababa. The site is an informal settlement in the outskirts of the city located along a river on a former quarry site which is hazardous & degraded area. It has a total area 23.9ha with a perimeter of 3.27 km. In total there are 470 parcels with an estimated population size 2,350. The settlement is established in the last three decades where its fastest growth is observed only after 2010. The new master plan has designated the area for low density missed residential development.

Figure 5

Parcellation map of the Selam Sefer site prepared based on 2001 topographic map

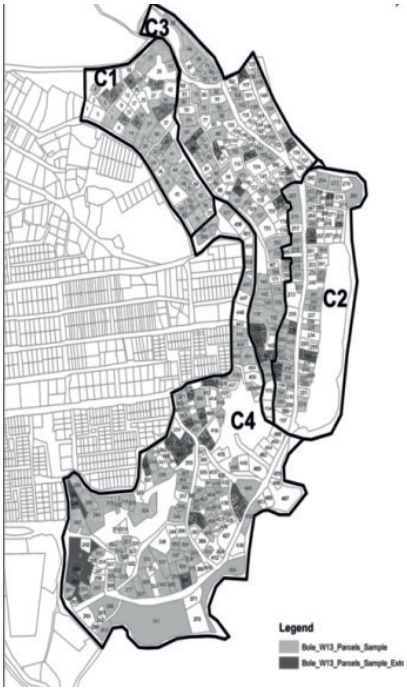


Figure 6

Selam Sefer site located on 2018 Google Image

4. *Ayat* is located in Yeka Sub-city, Woreda 13 Addis Ababa. It is an informal settlement which is acquired farm land in the outskirts of the city. It has a total area 30.7ha & with 2.6 km perimeter. In total there are 79 parcels with an estimated population size 395. Its fastest growth is observed during the last decade. The area was left for green development in the previous master plans of the city, however, the new master plan designated the area for low-density mixed residential area development. ◆

Figure 7

Parcellation map of the Ayat site prepared based on 2003 topographic map

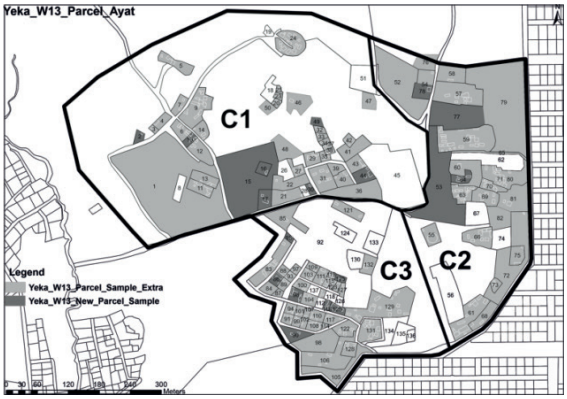


Figure 8

Ayat site loacted on 2018 Google Image

PART 6
FINDINGS AND DISCUSSION

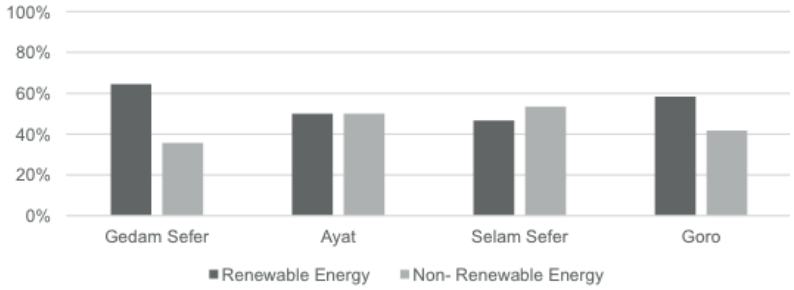
Findings of the collected data are presented in this section as follows: the inter-case analysis result of each indicator on the energy management of households is presented in charts. The intra-case analysis of the same is also provided in maps. Further discussion on implications of the findings in relation to relevant social, economic and environmental characteristics of the settlements is also provided. The social characteristics of the case study areas is reviewed by scrutinising the social dynamics and checking the availability of existing community structure. Prevalence of social ills and violence in the case study areas was also checked. The types of tenure-ownership modality of the households was studied in relation to acquisition of renewable energy sources. The economic aspect of the case study areas was observed from different angles. The economic activities in the settlements, livelihood of the residents, and the monthly income of the respondents was observed. The physical and environmental situation of the case study areas was checked through physical observation and from the opinions of the respondents. Physical access routes were scrutinized, availability of infrastructure was checked and prevalence and awareness of indoor air pollution, natural and man-made hazards in the case study areas were checked.

Household energy management in the case study areas

With regards to the *energy use pattern,* 56 % of the respondents use hydroelectric (renewable source of energy) and 44% use charcoal and firewood (non-renewable source of energy) for cooking as presented in table 2 and figure 9.

Table 2

Source of energy for cooking: indicated for each cases study area, top and average of the four areas



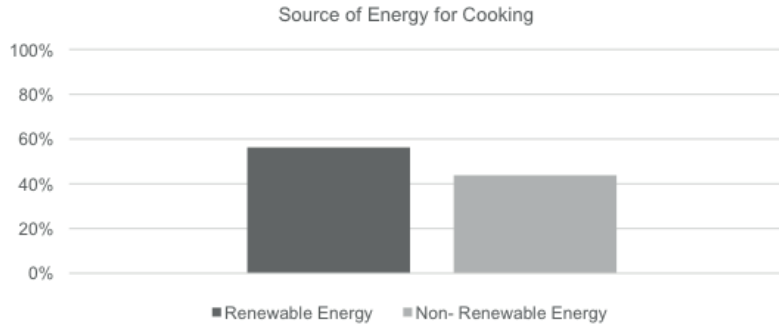


Figure 9a

Map distribution of renewable energy use for cooking - Gedam sefer, Goro, Selam Sefer and Ayat

Figure 9b

Map distribution of renewable energy use for cooking - Gedam sefer, Goro, Selam Sefer and Ayat

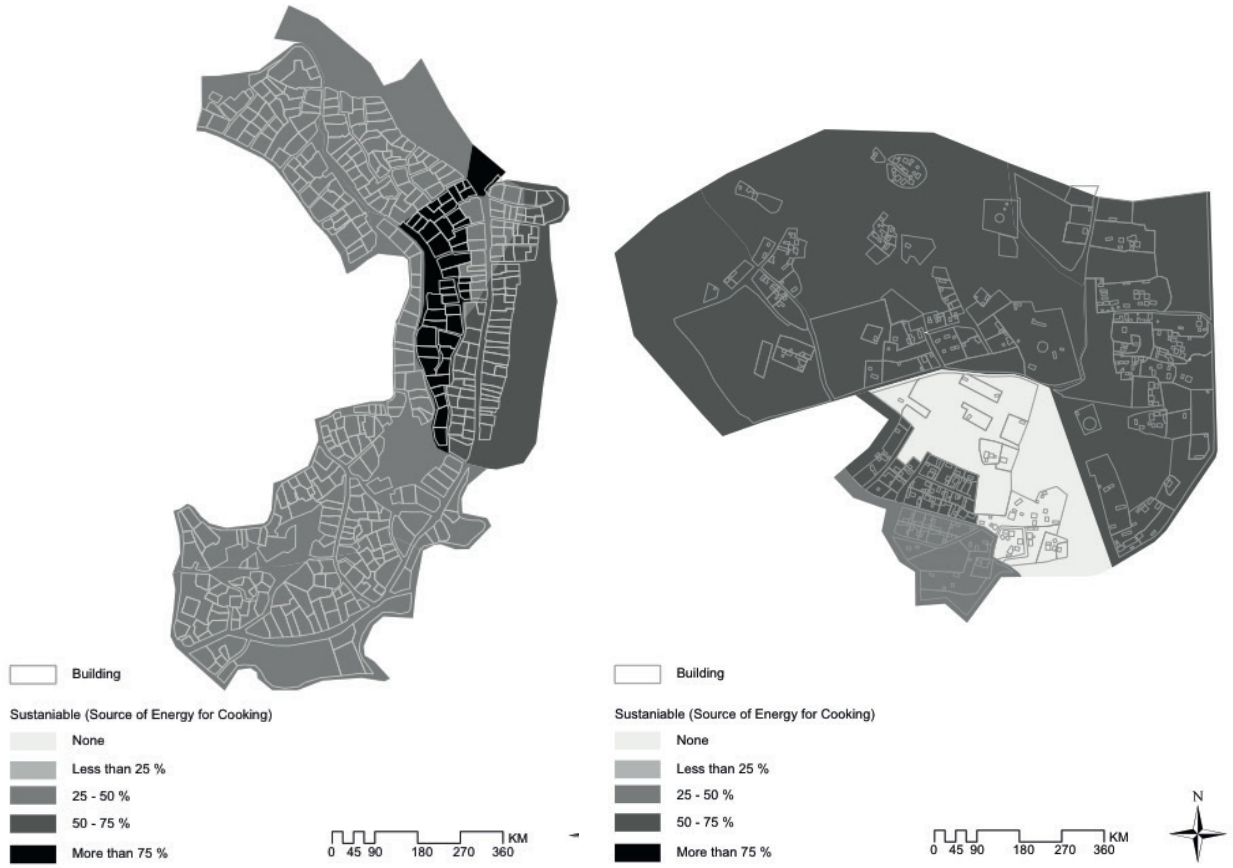


Figure 10 a

Map distribution of renewable (sustainable) energy use for light - Gedam Sefer, Goro, Selam Sefer and Ayat

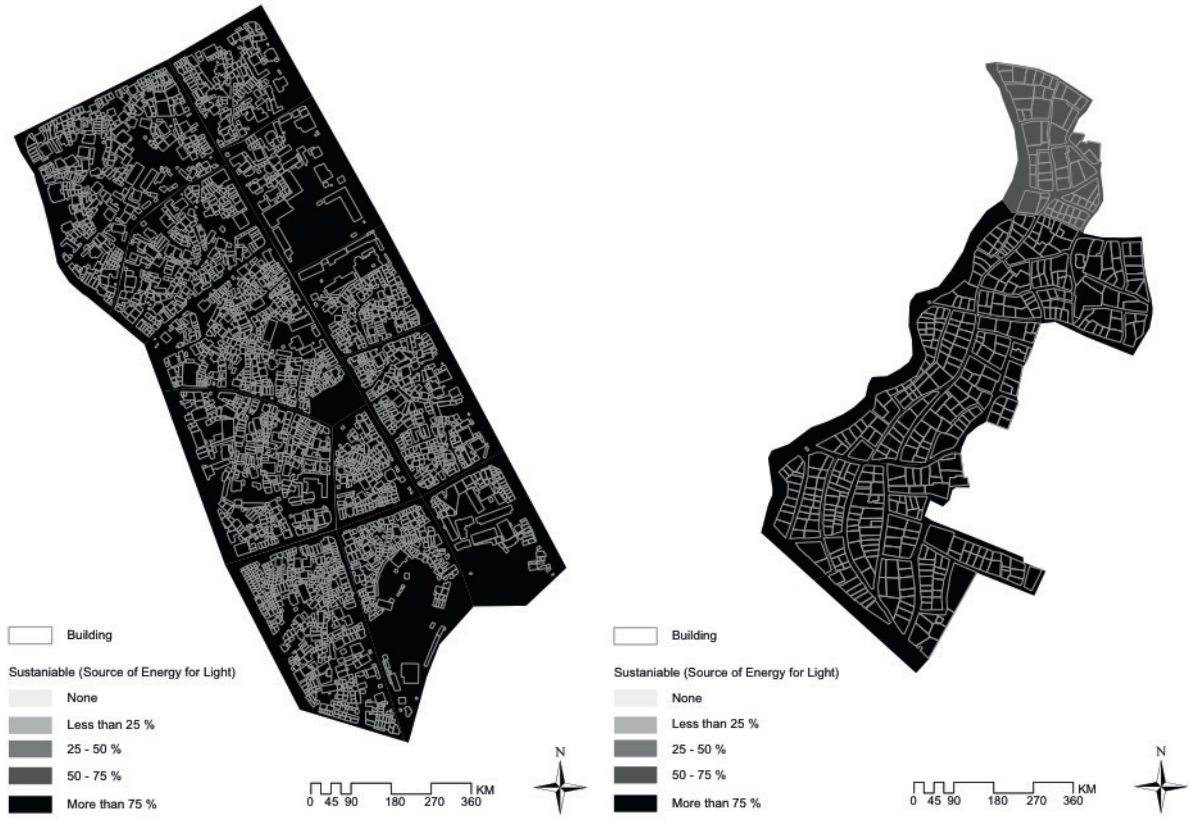


Figure 10 b

Map distribution of renewable (sustainable) energy use for light - Gedam Sefer, Goro, Selam Sefer and Ayat

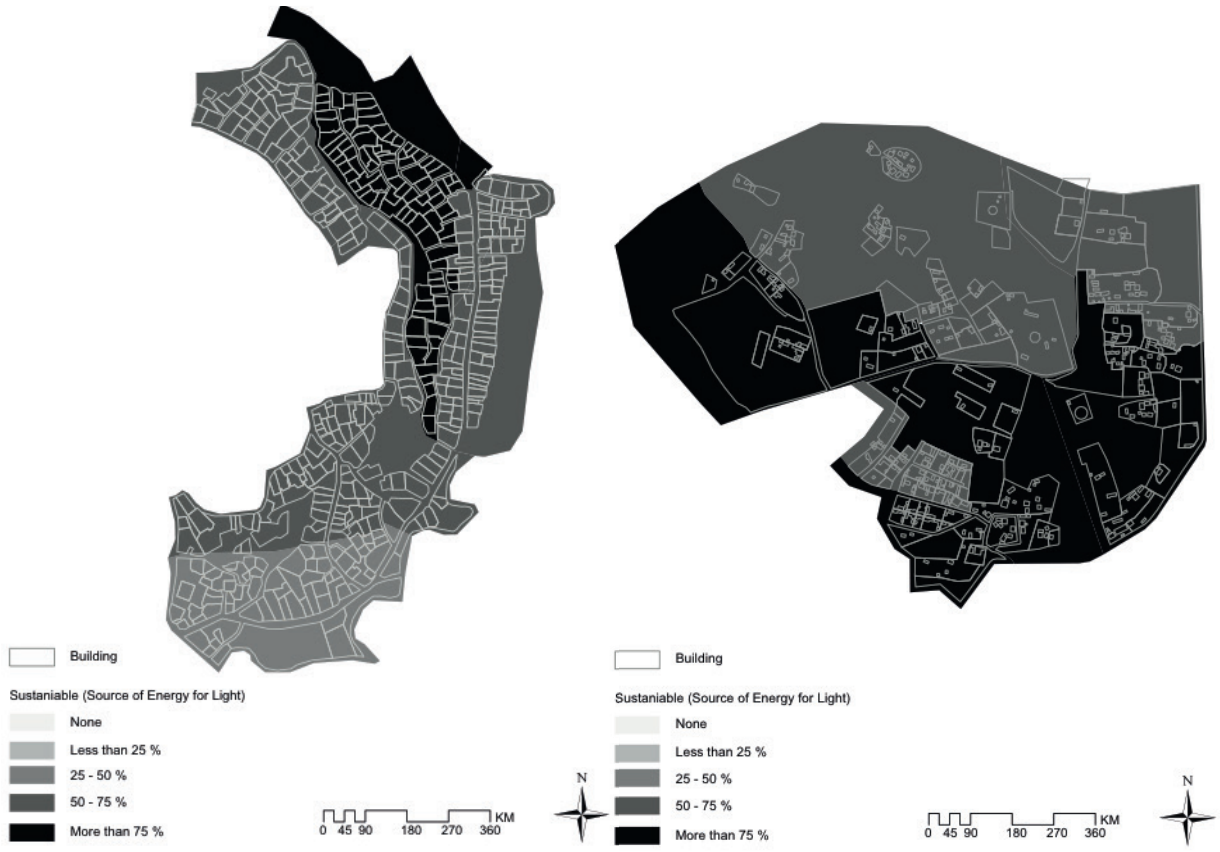
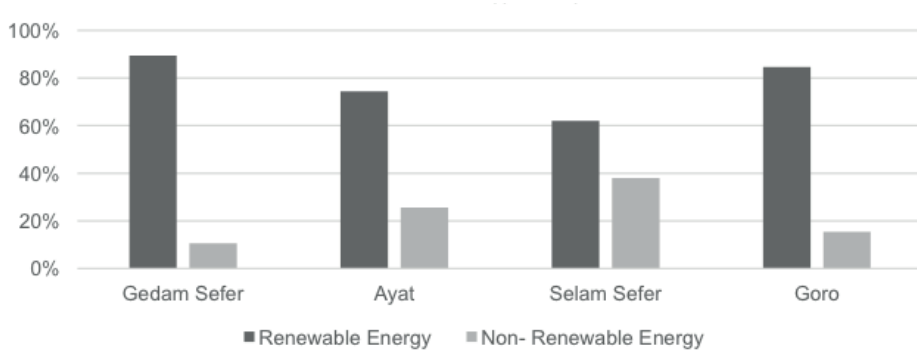
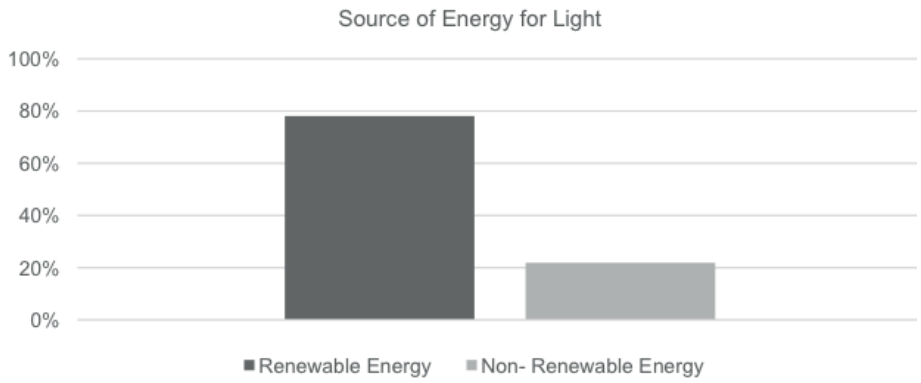


Table 3

Source of energy for light: indicated for each cases study area, top and average of the four areas, below





78 % of the respondents use hydroelectric power for lighting followed by candle users that account only to 12% of the total respondents, as presented in table 3 and figure 10.

Contrary to the characteristics and definition of informal settlements in literature, renewable energy source is utilized to a higher degree for light. More than half of the respondents also use the same for cooking.

With regards to physical *access or availability of renewable energy source*, similar to the formal housing in Addis Ababa, 89% of the respondents are connected to main grid hydroelectric power and own electric meters, while only 11% of the households are not. As presented in detail in table 4, 97% of the respondents from Gedam sefer, in the inner city, are connected to the main grid taking the lead with this regard, followed by 90% in Ayat, an acquired farm land in the outskirts of the city and 89% in Goro, a recently regularized and legalized settlement in the outskirts of the city. The case study area with the least - 74% respondents that are connected to the main grid is Selam Sefer located in a hazardous and degraded area in the outskirts of the city. It's interesting to understand how the newly formed settlement in Ayat has more grid connection than that of the regularized settlement in Goro. It's worth looking into the driving forces at play in acquiring main grid electric meters.

Respondents on all case study areas indicated that, the number of households that acquired the main grid legally are 91% as compared to those that

acquired the electric meters informally 9%. See table 5. However, this data is further elaborated during the FGD. According to the newly proposed 'Electricity Customer Service Policy and Procedure' at the Addis Ababa Electric Utility Bureau, informal residents in the case study areas are not allowed to own electric meter. The document indicates that a household is entitled to electric meter if they have title deed (proof of ownership of the house) or if they acquire a Woreda permit, a support letter proving that they own the house with parcel number and that they are permanent residents. This however, only applies to domestic use and was intended to address the original/ local settlers of the area. According to the FGD respondents, this is the loophole in the legal electric meter acquisition. Not only original settlers, but also informal settlers acquire support letter from the respective Woreda. Those that are still unable to acquire their own electric meters either buy electricity from neighbors or else acquire connection from the main grid informally. Figure 11 shows how households share electricity from neighbors and even directly tap in to the main grid line using substandard poles and wires.

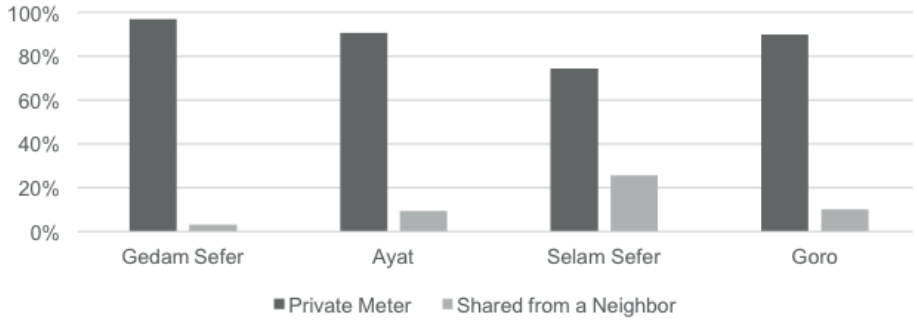
Figure 11

Households sharing electricity form neighbors and informally from the main grid

One interesting fact is that the Addis Ababa Electric Utility Bureau takes in to account the informal settlers' power demand during periodic energy audits. Energy audit and forecast is done using the measurement on grid and not on individual electric meters. The informal settlers' power demand is included on the planning process indirectly, though it is not official. The Bureau also conducted a study and found out that the capacity of the power supply in Addis Ababa is actually underutilized. The informal settlers are considered as 'potential customers'. In conclusion, informal settlers obtain power services from the main grid in one way or another. Substations are located at the peripheries of Addis Ababa on the west, east, north and south ends. Physical access to the main electric power grid is available, however, the informal settlers are not permitted to use them. Hence, densification of potential customers is required regardless of their informality.

Table 4

Availability of renewable energy source, access to main grid hydroelectric power: indicated for each cases study area, top and average of the four areas, below



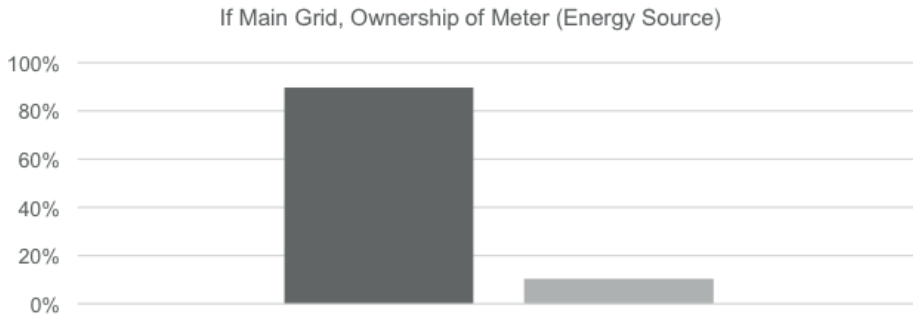


Table 5

Formal versus informal acquisition of electric Meter

		Direct Formal Request	Indirect Though Informal Means
Site	Gedam Sefer	95.4%	4.6%
	Ayat	95.9%	4.1%
	Selam Sefer	78.1%	21.9%
	Goro	92.6%	7.4%
	Total	91.0%	9.0%

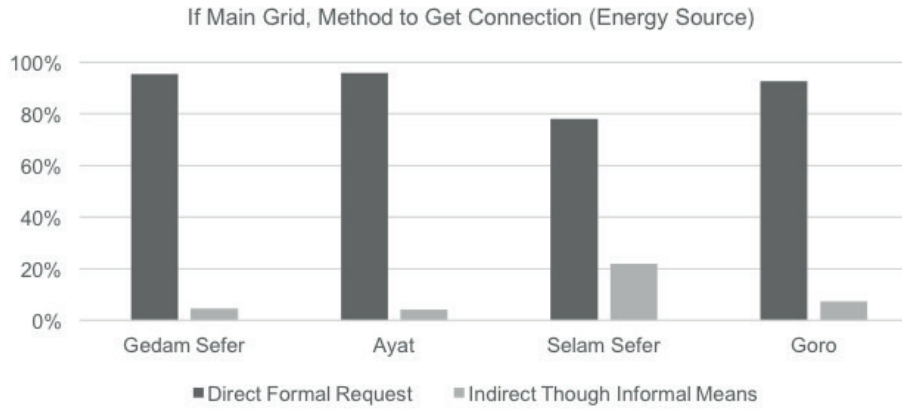
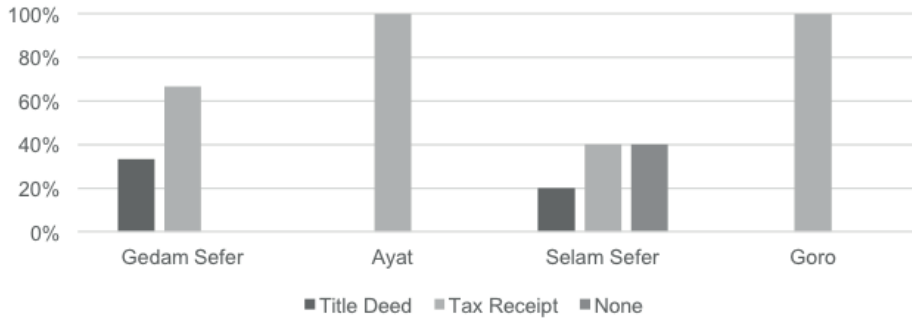
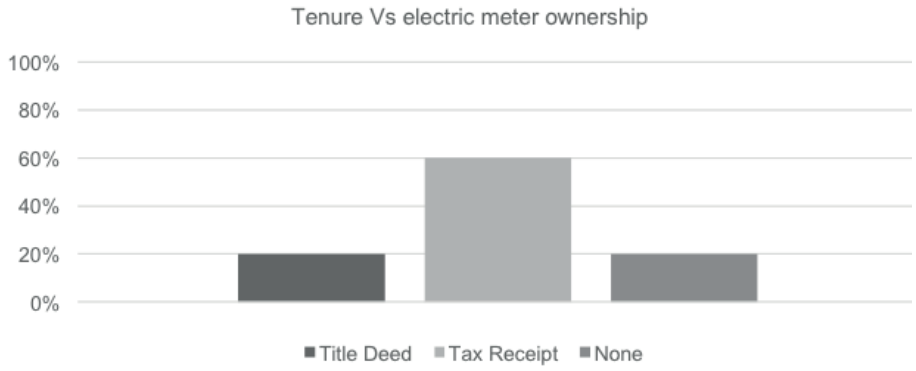


Table 6

Electricity acquired through informal means on different tenure types: indicated for each cases study area, top and average of the four areas, below



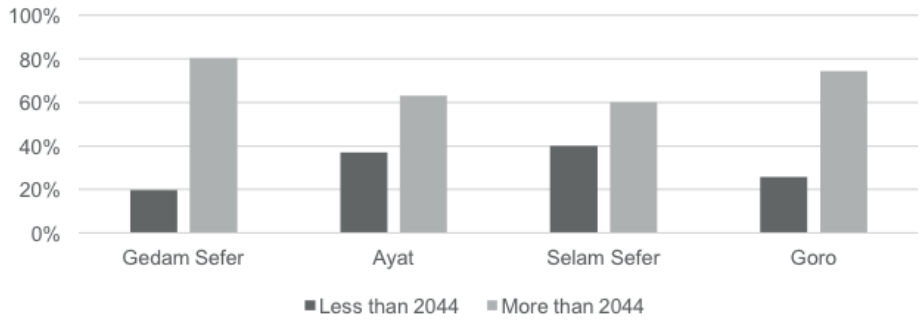


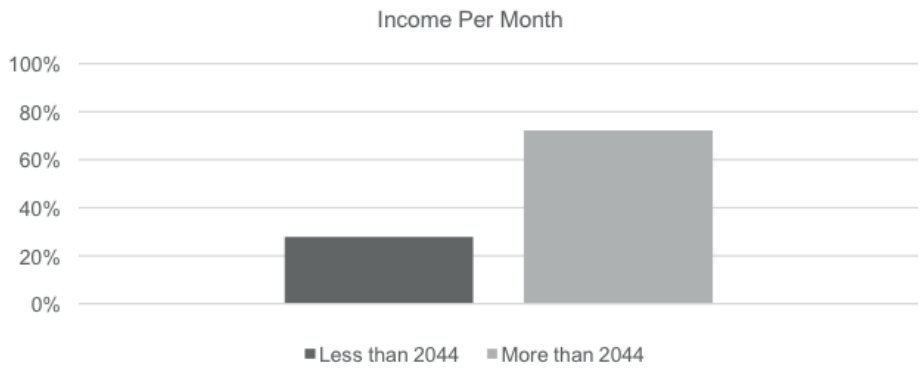
The *tenure*, property documentation type in the case study areas fall in to three main categories: 48% of the respondents have title deed, 31% only have tax receipts and 21% do not have any proof of ownership. Based on the key informant interviews with Woreda officials and experts, there is a tendency to acquire an electric meter as a means to secure tenure in the informal settlements at the outskirts of the city. This is also demonstrated in detail in Table 6. Out of the households that have acquired electric meters through informal means, the majority – 80% do not have title deed yet. This is mainly seen at Goro and Ayat case study areas where 100% of households without title deed acquired electric meter through informal means. There are even informal houses that are repeatedly demolished by the Woredas and the main challenge was placement of the electric meters salvaged from the demolished houses.

Diverse economic activities were observed in the cases study areas. The households along major access roads are mixed uses, housing - commercial activities such as kiosks, small scale metal and carpentry production areas and grinding mills. Livelihood of the respondents vary from daily labor at construction sites to civil servants. With regards to *affordability of renewable energy*, the study reveals that 28% of the respondents earn less than 2,044 birr per month while the remaining 72% earn more than this. 2,044 birr is the monthly income calculated from the current per capita income of Ethiopia, which is 790 United states dollars converted to birr using the current exchange rate. See table 7.

Table 7

Income per month: indicated for each cases study area, top and average of the four areas, below





Affordability of energy is calculated using the energy expenditure threshold, which is the maximum income-dependent amount that a household should spend on energy cost ranging from 10-15% of the household income. The affordability is calculated in two income categories: households earning less than 2,044 birr per month and those earning more. As depicted in table 8: 60% of the households with lower income spend more than 15% of their earnings on energy expenditure. 70% of the households earning monthly income of more than 2,044 actually spend less than 10% of their income on energy expenditure. Households with relatively lower income in the case study areas struggle to afford energy.

Table 8

Energy expenditure as percentage of household income

		Less than 2044 Energy per Income			More than 2044 Energy per Income		
		Less than 10%	10 - 15%	More than 15%	Less than 10%	10 - 15%	More than 15%
Site	Gedam Sefer	15.4%	3.8%	80.8%	64.3%	14.8%	20.9%
	Ayat	13.3%	40.0%	46.7%	69.0%	24.1%	6.9%
	Selam Sefer	21.9%	28.1%	50.0%	68.8%	12.5%	18.8%
	Goro	16.0%	24.0%	60.0%	81.1%	9.5%	9.5%
	Total	17.3%	22.4%	60.2%	70.3%	13.9%	15.8%

Households that own their own electric meter sell out electricity as a source of income. According to the FGD respondents, A single household sells electricity for 25 birr per single bulb or light point per month, this is very expensive in comparison to the normal tariff which is only 2 (1.94) birr.

With regards to *environmental factors*, 66% of the respondents have increased the use of hydroelectric main grid power for cooking and light since they moved in the area. With regards to awareness of indoor air quality in relation to the utilization of non-renewable sources of energy, 42% of the respondents preferred this renewable energy source since its affordable, 16% preferred the positive impact on health and 9% preferred the convenience. 53% and 34% of the households have shifted from using firewood and charcoal respectively due to health hazards showing more awareness and demand for renewable energy source. The major cause of fire in the case study areas is cooking fire hazard (38%) followed by faulty electricity connections (25%). Respondents in the case study area also indicated that electricity related accidents are common as depicted in table 9. Most causes of electrocution are related to the mismanagement and tapering of the main power grid lines.

Table 9

List of causes for electrocution

		Pole Collapse	Transformer Problem	Faulty Wiring	Faulty Appliance	Lack of Proper Setback	Electric Lines Falling
Site	Gedam Sefer	27.5%	24.2%	17.6%	12.1%	3.3%	15.4%
	Ayat	55.6%	0.0%	22.2%	0.0%	0.0%	22.2%
	Selam Sefer	18.2%	9.1%	4.5%	29.5%	13.6%	25.0%
	Goro	0.0%	57.1%	7.1%	21.4%	0.0%	14.3%
	Total	24.0%	21.5%	13.3%	17.1%	5.7%	18.4%

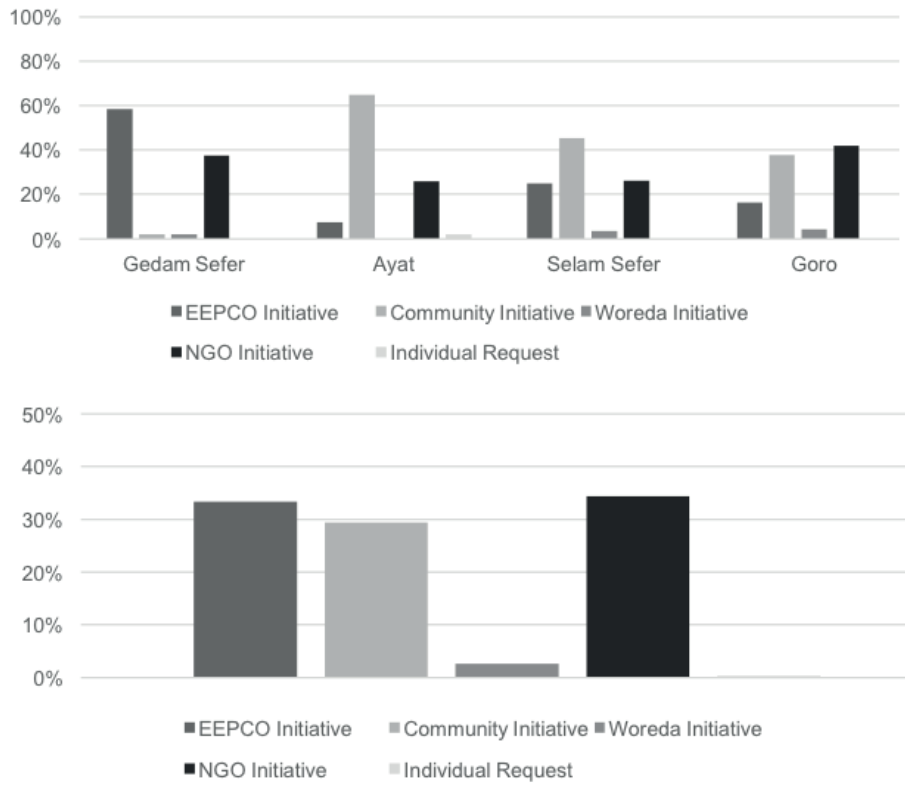
The physical/ environmental condition of the case study areas is actually dilapidated in the existing settlement at the inner-city and under developed in the new ones at the periphery. Access to the settlements and within the settlements is also a problem. More than 40 % of the respondents characterized the access roads as inaccessible.

Social dynamics and community involvement: the respondents in the case study area clearly indicated that there is a strong community structure. The inner-city case study area prevails with this regard but the remaining case study areas also possess community structure. The respondents confirmed their involvement in traditional social structures such as Mahiber, Iqub and Idir. With regards to *the social dynamics*: respondents indicated that, there is low crime rate in terms of homicide, robbery and theft. Social ills, such as addiction, begging, juvenile delinquency, prostitution and sexual assault are also infrequent in the case study areas. This data is further corroborated by the Woreda officials during the key informant interview. They even indicated that the crime and social ills occurrences are even lower than the formal neighborhoods in the Woredas and sub cities of the case study areas. This finding demonstrates that the informal settlers are law abiding citizens with acute housing shortage.

With regards to *achieving access to renewable energy for all:* looking closely at the actual initiation of the main grid connection in the case study area revealed that, the lion share of electric meter acquisition to the households was initiated by Non-Governmental Organizations (NGOs), followed by the government and community, showing high potential of social bond and community involvement. See Table 10.

Table 10

Initiative to acquire Electricity, renewable energy source: indicated for each cases study area, top and average of the four areas, below



The respondents put the need to acquire better infrastructure provision including reliable, affordable and renewable energy on the top of their list of aspirations and expectations from the neighborhood. Acquisition of legal title deed and better housing conditions were also aspired by the respondents. The respondents furthermore revealed that the increase in main grid hydroelectric power connection in the settlements, over the course of their stay, improved their neighborhoods in many aspects as detailed in table 11. Security is enhanced, residents have better health conditions thanks to cleaner cooking methods, the household incomes increased due to better small-scale business opportunities, and the land use was changed from purely residential to mixed use, incorporating more economic activities. ◆

Table 11

Impact of increase in main grid hydroelectric power connection

		Increased Income	Better Health	Better Security	Change of Land Use
Site	Gedam Sefer	23.9%	21.8%	54.3%	0.0%
	Ayat	42.1%	21.0%	21.0%	15.8%
	Selam Sefer	27.9%	27.1%	34.9%	10.1%
	Goro	23.4%	36.6%	40.0%	0.0%
	Total	27.7%	26.8%	38.4%	7.1%

PART 6
CONCLUSION AND RECOMMENDATION

Interesting facts were revealed with regards to the social characteristics of the case study areas, supporting the new shift in the definition of informality, as presented on literature review. Informal settlements in the case study areas are not dangerous, crime infested nor are they full of social ills. In fact, the residents are law abiding citizens as presented on the findings and verified on the FGD and key informants interview. There is strong social bond and healthy social dynamics in the case study areas. With regards to the economic aspect, the residents in the case study areas are composed of all income levels of urban residents, affluent and poor. Comparing the income of the respondents to the per capita income of Ethiopia revealed that more than 70% of the households earn more. Some actually do well economically, it is the acute shortage of housing that has drove them to informally acquire houses. The physical/ environmental condition of the case study areas is actually dilapidated in the existing settlement at the inner-city and under developed in the new ones at the periphery. Access to the settlements and within the settlements is also a problem. More than 40 % of the respondents characterized the access roads as inaccessible.

Energy management at household level: with regards to the *energy use pattern*, hydroelectric power appears to be cheaper and available in the case study areas. The households in the informal settlements predominantly use renewable energy source for light. More than half of the households also use the same for cooking. Most of the households in the case study area have access to renewable energy source even though the acquisition method is informal in some cases as discussed in the data presentation section. The infrastructure development, particularly main grid hydroelectric power is situated in close proximity. Substations of the main grid are located in close vicinity to the case study areas, the legal acquisition modality however, is the main challenge. Households, without any form of tenure documentation, struggle to acquire a main grid hydroelectric power connection. Residents of the case study areas, that are illegible to acquire access to main grid hydropower, have taken it upon themselves to informally do so. These households either end up paying extra for rental electricity per light bulb from their neighbors or engage in illegal taping from the main grid in their effort to acquire a renewable energy source. Access to the main grid hydroelectric power also plays a significant role in ensuring tenure security as seen in case study areas in the outskirts of Addis Ababa.

More than 60% of the low – income households cannot *afford renewable energy* and spend more than the energy expenditure threshold. Almost 70% of the households earning decent monthly income, to the contrary, spend less than the energy expenditure threshold. The households in the case study areas exhibit great awareness on the health and *environmental* benefits of using renewable energy. The substandard infrastructure provision and further informal intervention of the settlers in the case study areas also result in high rates of fire and electricity related accidents.

With regards to achieving access to renewable energy for all: looking closely at the actual initia-tion of the main grid connection in the case study area revealed that, the lion share of electric meter acquisition to

the households was initiated by Non-Governmental Organizations (NGOs), followed by the government and community, showing high potential of the existing social bond and community involvement.

As seen in the case study areas, the community will come up with their own solution (sustainable or not) to acquire access to energy sources, the local government should take the initiative to guide them towards the utilization of renewable energy sources. 'Informality is growing in a con-text of increasing inequity, and in many places becoming the norm. However, despite decades of studies and interventions, 'recognizing informality' is still a key issue. Relating informality to the concept of non-permanence and self-help solutions excludes informal settlement households from being treated according to the standards that apply to the rest of the population, which could dan-gerously mislead and gravely impede the local political will trying to get a grip on urbanization challenges in informal areas. The issue of the process of recognition by the state and by local governments therefore remains central' (d'Alencon, et al., 2018). The Addis Ababa city admin-istration should take the lead in housing and infrastructure provision through a shift to self-help, community involvement and controlled development. This can be achieved by encouraging the formal sector to be more inclusive instead of depriving the settlers of their basic right to tenure and infrastructure including energy. The study recommends to fully exploit the existing social bond and community structure to create the link between the informal settlers and the local au-thority. Permanent assurance of supply could be achieved by integration of these settlements with the existing infrastructure and further investigation of decentralized energy provision of other renewable sources by the Addis Ababa Electric Utility Bureau. This would benefit the govern-ment in two folds: avoid misuse of energy and achieve sustainable energy and environmental protection initiatives by promoting the utilization of renewable energy sources. ◆

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ANNEXES

Survey protocol

Introduction Note (የቃለመጠይቅ መግቢያ)

- ስሜ _____ ይባላል።
- በአዲስ አበባ ዩኒቨርስቲ፣ የኢትዮጵያ አርክቴክቸር፣ ህንጻ ግንባታ እና ከተማ ልማት ኢንስቲትዩት (EiABC) ተማሪ ነኝ።
- ኢንስቲትዩታችን፣ በአዲስ አበባ ከተማ የሚኖሩ ሰዎች አኗኗርና አሰፋፈር ላይ ጥናት እያደረገ ሲሆን፣ ለዚህ ጥናት የሚሆን መጠይቆች ተዘጋጅተዋል።
- ጥናቱም ሀገራዊ ፋይዳ እዲኖረው ሲባል ለተዘጋጁት ጥያቄዎች አስፈላጊውን መልስ ሁሉ እንድትሰጡኝ በአክብሮት እየጠየኩ፣ ቃለ መጠይቁ ለጥናት አገልግሎት ብቻ እንደሚውል አረጋግጣለሁ።

SES–EiABC Sample Survey Protocol

1. Two of the interviewers/students may join together during the interview of any of the households assigned for each of them; however, each of the two students will be fully responsible for the compounds assigned specifically for him/her and the completion of the work within the given time.
2. If a questionnaire is submitted not filled properly or not fully completed, a new household shall be assigned for the student to replace it.
3. Before starting the interview, please check and confirm the actual existence of all the sample parcels/compounds assigned for you, as they are shown on the given map.
4. Please select one of the sample compounds assigned for you, introduce yourself, and identify the number (how many) and tenure situation (owner or renter) of the household(s) in the compound.

   (This information shall be included in the site plan drawing of the parcel.)
5. If you find only one household in the parcel, please introduce yourself according to given Amharic "Introduction Note (የቃለመጠይቅ መግቢያ)" and ask for the willingness of the household head (HH) to participate in the survey.
6. If you find more than one household in the parcel, please select the household living in a house where its main-entrance is found first as you move in the courtyard counterclockwise starting from the gate (to your right-side from the gate as you enter the compound); then, please introduce yourself according to given Amharic "Introduction Note (የቃለመጠይቅ መግቢያ)" and ask for the willingness of the HH to participate in the survey.
7. If the HH is willing to be interviewed, please proceed with the interview using the given structured questionnaire.
8. If the HH is unavailable for interview at the time of your visit, please try to find out the convenient time for him/her to be interviewed and proceed to the next compound assigned to you.

   Please make sure to go back to the skipped household at the agreed time to complete the survey.
9. If the HH is still unavailable after your three visits or is unwilling to be interviewed (participate in the survey), please inform the situation to your instructor(s) as soon as possible.
10. If the respondent HH is unwilling to respond to a specific question, please write "999" next to the question.

    (In such cases, please make sure that the household's response is based on understanding the intended meaning of the question)
11. If a question is not applicable for the specific respondent, please write "222" next to the question.
12. If a question in a table is not applicable for the specific respondent, please use "–" in the given space.

    No space should be left open in the table.
13. If the respondents include more than one of the given options in the tables, please write all the selected options in the given space by using "/" between the selected options.
14. The tenure condition of at least 20% of the households you interview are expected to be either owners or renters (from private owners or government). In the event of either of the two are not included in the samples you interviewed after you finished about half of the total number of compounds assigned for you, please focus on finding the missing tenure type in the remaining compounds assigned for you.

    If you find more than one household of the missing tenure type in any of the remaining compounds, please select the household living in a house where its main-entrance is found first as you move in the courtyard counterclockwise starting from the gate (to your right-side from the gate as you enter the compound).
15. Please submit the completed questionnaire to your instructors at the end of each day of survey.
16. Please make sure to have your **EiABC student identification (ID) card** with you during the survey.

THANK YOU!