

## **Determinants of Energy Choice for Domestic Use in Informal Settlements of Addis Ababa**

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**Abstract:** This paper analyzed the determinants of energy choice for domestic use in informal settlements of Addis Ababa based on the data generated from 450 households in Yeka Sub-city, Woreda 12. The descriptive analysis of data showed that household heads from 30-60 years of age, education above grade 4, suitability of the dwelling place to the urban plan, number of years lived in the area, availability and reliability of energy sources, and food consumption behaviors significantly affected households access to electricity. Households that lived more than 9 years, families with higher levels of income, employed on permanent basis, living in a good shelter and large number of rooms has better access to electricity while land title and size owned, electric tariffs and proximity to electric line have no relationships with households' electric-use status.

**Keywords:** Determinants, Domestic Use, Informal Settlement, Electricity Use, Addis Ababa

### **Déterminants du choix de l'énergie à usage domestique dans les quartiers informels d'Addis-Abeba**

**Sommaire :** Cet article a analysé les déterminants du choix de l'énergie pour l'usage domestique dans les quartiers informels d'Addis-Abeba en se basant sur les données générées par 450 ménages dans la zone Yeka, Woreda 12. L'analyse descriptive des données a montré que les chefs de ménage âgés de 30 à 60 ans, l'éducation supérieure à la quatrième année, l'adéquation du lieu d'habitation avec le plan d'urbanisme, le nombre d'années vécues dans la zone, la disponibilité et la fiabilité des sources d'énergie et les comportements en matière de consommation alimentaire affectaient de manière significative l'accès des ménages à l'électricité. Les ménages ayant vécu plus de 9 ans, les familles ayant des niveaux de revenus plus élevés, ayant un emploi permanent, vivant dans un bon abri et disposant d'un grand nombre de pièces ont un meilleur accès à l'électricité, tandis que les titres et la taille des terrains possédés, les tarifs de l'électricité et la proximité de la ligne électrique n'ont pas de relation avec le statut d'utilisation de l'électricité des ménages.

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## Introduction

To understand the factors that determine households' energy choice and consumption levels is key to apply either developmental fuel switching hypothesis or integrate multiple energy sources (Agizew 2017; Ateba et al. 2018; Soltani et al. 2019). The energy ladder hypothesis which is an extension of consumers' economic theory contends that as income increases, households substitute lower level energy sources (like biomass and kerosene) by higher level energy sources (like LPG and electricity). On the other hand, due to shortages of modern energy sources and prior energy consumption habits, households use both sources from the lower and upper levels in the energy ladder with the concept of fuel stacking. High cost of modern appliances and the different reasons for choosing energy sources in different locations also force consumers to use multiple energy sources (Bisu et al. 2016; Muller & Yanb 2018).

Energy choice and consumption behaviors are also influenced by households' socio-economic factors, the availability and price of energy sources, the prevailing weather condition, home ownership, size, type and condition (Danlami et al. 2015; Olugbire et al. 2016; Butera et al. 2019; Soltani et al. 2019). However, all factors are not equally important in explaining households' fuel consumption behaviors (Danlami et al. 2015; Amoah 2019). For example, wealthy households headed by people with higher levels of education are less likely to use fire wood, kerosene and Liquefied Petroleum Gas (LPG); and consume more electricity and solar energy (Gebreegziabher et al. 2012; Lay et al. 2013; Baiyegunh & Hassan 2014; Soltani et al. 2019). The total energy expenditures and the number of fuels used also increases with the increase in income (Alemu & Köhlin 2008; Fantu et al. 2015; Agizew 2017).

Unreliable electricity supply, prohibitive energy prices, and cooking practices guide households' energy consumption decision (Ateba et al. 2018). Increased use of electric power in turn leads to progressive tariffs increments by electricity suppliers (Soltani et al. 2019). Households living in traditional houses are also less likely to choose natural gas and electricity (Baiyegunh & Hassan 2014; Ifegbesana et al. 2016). Instead they heavily rely on plant and crop residues, animal dung, firewood and charcoal (Muller & Yanb 2018). The gap between supply and demand for biomass is growing and the proportion of income spent on energy is increasing (Getachew et al. 2018). The socioeconomic variables affecting households' energy consumption patterns and the availability and price of biomass also vary based on spatial and temporal differences (Ayele & Demel 2018).

Although electricity is essential for various purposes like for lighting, cooking, baking, heating, cooling, refrigeration, and other home applications, documentary evidences indicate that access to electricity in Ethiopia is the lowest (46%). Per capita energy consumption is about 100 kWh/year and energy demand on the rise at 10-14% per year. Electricity supply remains limited and unreliable, generating only 4,284MW (MWIE 2017; Lloyd 2014; Getie 2020).

Informal settlers are a group of households that occupies illegal land, live in low quality houses constructed on lands where occupants have no secured tenure, located in areas between the urban center and the cultivated edge of rural areas. In Addis Ababa, informal settlers are about 18.3% of the population (Butera et al. 2016). They are characterized by low electricity consumption, earning irregular income and poor capacity to pay connection fees and electricity charges (Gaunt et al. 2012; Karatasou et al. 2014; Onyekachi 2014; Butera et al. 2016; Subbiah et al. 2016). They lack access to clean, reliable and affordable energy. There is frequent power interruption, fluctuation, outages for long hours and sometimes oversupply that damages household' durables.

The availability of electricity in these settlements varies from place to place. This makes grid expansion difficult and expensive to connect (JICA 2011; Kovacic et al. 2016). These situations force informal settlers to rely on traditional energy sources that emit high carbon monoxide, smoke, and produce less heat (Yu et al. 2008; Karatasou et al. 2014). As a result of population growth, the inability of the economy to supply housing for low income groups, and inefficient land provision, the numbers of informal settlers are continuously swelling and urban sprawling growing fast. This makes the provision of

adequate, reliable, and affordable electricity supply difficult. Furthermore, lack of regular legal measures by local governments against illegal settlement is a growing urban problem (Weldegebriel 2011; Luhar 2014; Dadzie et al. 2018).

In Woreda<sup>2</sup> 12, Yeka sub-city, informal settlers' use low-grade traditional fuels that cause indoor air pollution, produce less heat, and more smoke, hence a major threat to the environment. On one hand, these energy sources consume a lot of time and family labor and urge households to buy power from private suppliers. On the other hand, they are the only alternatives to cook traditional foods (Belay & Aberham 2015). Prior studies tried to relate households' energy consumption decision with their socio-economic characteristics, climate variability, and the influence of various factors on households' energy choice (Bisu et al. 2016; Makonese et al. 2018; Yonas et al. 2016). However, all targeted residents in rural and urban centers. Informal settlers' socio-economic backgrounds, current settlement patterns, and the influence of land ownership on energy choice have not received significant attention.

This study, therefore, tries to identify the various factors influencing informal settlers' choice of energy for domestic use in Woreda 12, Yeka sub city (Addis Ababa). It relates demographic variables and household characteristics; energy source related factors (such as availability, reliability, and affordability of energy sources); households' food consumption behaviors, and other variables such as land title and size of land owned, shelter condition, location of the living area and length of time a household lived with access to electricity. Ethiopia's current energy policy is gradually substituting biomass fuels at household levels by modern energy sources. This aims to stabilize energy prices, increase the supply of alternative fuels, relieve the pressure on wood resources, and maintain appropriate energy mix from renewable sources (JICA, 2011). The study provides some insight to energy suppliers and the government to focus on households that require special support, subsidy and/or outreach service.

## Methodology

The study employed both quantitative and qualitative approaches to generate and analyze data. Primary data was obtained using surveys that involved interviews and multi-tier questionnaires administered to 450 randomly drawn households found in Kotebe Gebriel, Hibret Amba and Demamit. The data was collected by properly selected, well-trained and closely monitored enumerators. The list of informal settlers was obtained from the registry book and computerized data base of Woreda 12 Administration.

Respondents were drawn in four stages. From Yeka sub-city, Woreda 12 was purposively selected out of the 13 Woredas due to its location in the outreach areas and longest territory it shares with neighboring region relative to other Woredas in the sub city. In Woreda 12, there are eight sites and 2,590 informal settlers officially registered by the local administration. From these households, 1926 are electric-users<sup>3</sup> found in seven sites and 664 are non-users of electricity<sup>4</sup> found in three sites. That served as the sample frame. Then two sites from electric-users (that is, Kotebe Gebriel and Hibret Amba with a total of 576 informal settlers) and two sites from non-users of electricity (that is, Kotebe Gebriel and Demamit with 516 informal settlers) were selected purposively. Lastly, the representative sample sizes for study considering relative homogeneity among households within the same site was determined at 95% confidence interval using the formula as follows (Kothari 2004).

$$n = \frac{Z^2 \cdot N \cdot p \cdot q}{\sigma^2 (N - 1) + (Z^2 \cdot p \cdot q)}$$

<sup>2</sup> Woreda is a local term used to describe the lowest administrative unit of Addis Ababa City Administration. It is equivalent to county in Western countries.

<sup>3</sup> Electric-users are households using electric power for cooking and baking. They got this electric power from the Ethiopian Electricity Utility legally or from their neighbor by sharing electric cost.

<sup>4</sup> Non-users of electricity refer to households who either do not use electric power at all or use it only for illumination purpose by buying from their neighbors at 50 Birr per lamp per.

Where,  $N$ , &  $n$ , = Population and sample sizes respectively  
 $p$  = Maximum possible proportion ( $p = 0.5$  and  $q = 1-p$ )  
 $\sigma$  = Precision level or margin of error at 0.05  
 $Z$  = The number of standard deviations at 95% confidence level

Based on this formula 450 sampling units (of which 229 are electric-users and 221 are non-users of electricity) were drawn randomly. The respondents (electric-users and non-users) were selected using proportional sampling method that gave them equal chance of inclusion in the study. The pilot study helped to observe the general housing condition, the landscapes, and availability of infrastructures in the study area. During fieldwork, the activities of data collectors were closely monitored. And to minimize distortions and personal biases associated with respondents' opinions and attitudes, the validity and reliability of the data gathered was verified carefully at the initial data entry and validation stage using SPSS and Stata. The determinants of households' electricity use status and their consumption behaviors in informal settlements were analyzed using descriptive approach supplemented by analytical methods. The study was carried out based on the premise that sources of energy and consumption patterns vary among urban dwellers' based on their land ownership status, income groups, residents' geographical location and food consumption behaviors.

## Results and Discussion

### *Demographic and Household Characteristics*

*Sex and age structure:* Gender-based electric-use status survey showed that from the total households interviewed, 63% are male headed while the rest are female headed. In terms of electric-use status, 48.59% of male headed households are electric-users and 51.41% are non-users of electricity while 54.82% of female headed households are electric-users and 45.18% are non-users. Since the difference between male and female electric-users is small, the relationship between sex of the household head and access to electricity is not significant. But the findings of Rahuta et al. (2019) show female-headed households are more reliant on fuel wood.

In terms of age, 88.65% of electric-users and 85.52% of non-users are 30-60 years. Although the difference is narrow, it implies that there is still a relationship between households' electric-use status and age brackets. That is, household heads<sup>5</sup> from 30-60 years of age have relatively better access to electricity. However, studies conducted among rural household heads of Nigeria indicated that as age increases, they tend to shift away from natural gas and use more fuel wood (Baiyegunh & Hassan 2014). In Ethiopia, they are more likely to consume charcoal and less kerosene and electricity (Gebreegziabher et al. 2012). In Iran, the relationship between the household head age and level of electric consumption are inversely related (Soltani et al. 2019).

*Family size:* According to Soltani et al. (2019), as family size increases, households' energy consumption increases. In this study, 11% of electric-users have less than 3 members, 53% have 3-4 and 35% have more than 4 family members. The number of families using firewood and charcoal also fluctuates indicating there is no predictable pattern of relationships between family size and type of energy consumed by households in informal settlements.

*Marital status:* Survey results show that among electric-users, 85% are married, 12% are singles, and 3% separated. From non-users of electricity, 71% are married, 24% singles and 5% separated. In both cases, married households constitute the majority implying being married does not guarantee households' access to electricity.

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<sup>5</sup>.Household head is the one who has an income and decision making power in family affairs. In Ethiopian culture, it mainly refers to the husband for married couples.

*Education of the household head:* In this study, 30% of household heads are below grade 9 where 25% are electric-users. From households with grade 9 education level and above, 63% are electric-users. From electric-users, 2.62% are below grade 4, 12.23% are from grade 4-8, 25.76% are from grade 9-Diploma, and 59.36% are degree and above. These data show with higher levels of education, the number of households using electricity increased consistently. In line with this, Ayele (2019) and Yonas et al. (2016) revealed that households' headed by individuals with higher levels of education are less likely to use kerosene and more likely to depend on electricity. Yonas et al. (2016) and Bisu et al. (2016) described that this is because education speeds up cultural changes on households' energy consumption behaviors and a key variable to switch from lower level energy sources to clean energy sources.

*Family income:* With an increase in income, households are more likely to shift to clean energy sources and the percentage of biomass use is expected to decrease (Rahuta et al. 2019). In this study, households using electricity and biomass for domestic use increased with an increase in family income. The increase in the consumption of firewood and charcoal by non-users of electricity is mainly attributed to lack of access to electricity. To corroborate the relationship between family income and electricity use status, data on household heads' employment status and type of employment was organized. The result showed 56% are hired, 38% self-employed, 4% unemployed, and 2% retired. The proportions of electric-users that are hired are 68%. This implies that hired household heads are more likely to get access to electricity than those who are unemployed due to their stable income and capacity to pay the electricity bills. Further, 91% of hired household heads are permanent employees, 8% are contract and the rest 1% are daily and hourly workers. Among permanently hired employees, 71% are electric-users showing the high chance of getting access to electricity.

### ***Energy Source Related Factors***

*Availability and reliability of energy source:* Informal settlers commonly use firewood, charcoal and electricity for domestic energy. The study result indicated that 5% of electric-users and 49% of non-users used biomass for baking and 2% of electric-users and 47% of non-users used biomass for cooking. From electric-users, 48% used electricity for baking and 51% for cooking. Further, 42% of electric-users described electricity as often available (6-7 days per week), 53% from 3-5 days, 3% from 1-2 days a week, and 2% have no power at all. About 60% of electric-users rated the overall electricity supply situation as moderate while others indicated frequent interruption and power fluctuation that determined households' energy choice in informal settlements.

*Price of energy:* The most expensive energy source in the study area was kerosene and LPG as described by 47% of the respondents followed by electricity by 35%, and biomass by 18%. That is, relative to kerosene, LPG, and electricity, traditional sources of energy such as animal dung, firewood and charcoal were low in cost in informal settlements. Yet due to its convenience to use and cleanness, non-users of electricity want to get access to it and 61% of them are even willing to share electricity meters with their immediate neighbors and pay the service charges required together. The survey data revealed that, depending on the proximity to electricity lines and connection period, electricity connection fee ranges from 650-10,000 birr<sup>6</sup>.

*Technological, socio-economic and environmental reasons:* Households also choose energy sources based on their short and long-term effects. Some choose due to the availability of efficient appliances at low cost in the market (technological reasons). Others use energy sources that save family labor, time and reduce the work load of women and children (socio-economic reasons). Others choose energy sources that are clean and healthy (environmental reasons). For example, 86% of households chose firewood and charcoal and 14% electricity, LPG, and kerosene for technological reasons. On the other hand, 95% of households' chose electricity and 5% firewood, charcoal and kerosene for socio-

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<sup>6</sup> Birr is the currency of Ethiopia. The average official exchange rate in September 2021 was 1USD = 46 Birr.

economic and environmental reasons. This implies the need to balance households' technological, socio-economic and environmental requirements.

It is also observed that 86% of electric-users and 99% of non-users used firewood 1-3 times per week for baking. This implies that electric-users used both electricity and biomass while non-users solely relied on animal dung, firewood, and charcoal. For cooking purposes, 69% of electric-users and 52% of non-users of electricity used firewood at least once in a day indicating that when non-users of electricity did not use firewood, they either did not cook at all or cooked using charcoal. But for electric-users, in addition to electric power, they could use firewood and charcoal. As a result, 97% of electric-users and 68% of non-users cook food 1-2 times per day using charcoal whilst electricity is solely used for baking and cooking by households that had access to it. These empirical evidences show, in addition to electric power, electric-users used more charcoal than non-users of electricity and such unfair use of electric power and forest resources by few people could raise controversies among citizens.

The average, minimum and maximum energy expenditure per month and the number of households that used each source is compiled in Table 1. Based on this data, the average expenditure for firewood is the highest and with the exception of firewood, the proportion of electric-users' consuming all sources of energy is higher than non-users' of electricity. The main reason for this is that those who had access to electricity were using traditional sources and the overall effect of this practice is unfair utilization of natural resources, air pollution, and a series of health problems to human life.

**Table 1: Households' Monthly Expenditures for Alternative Energy Sources based on Electric-Use Status**

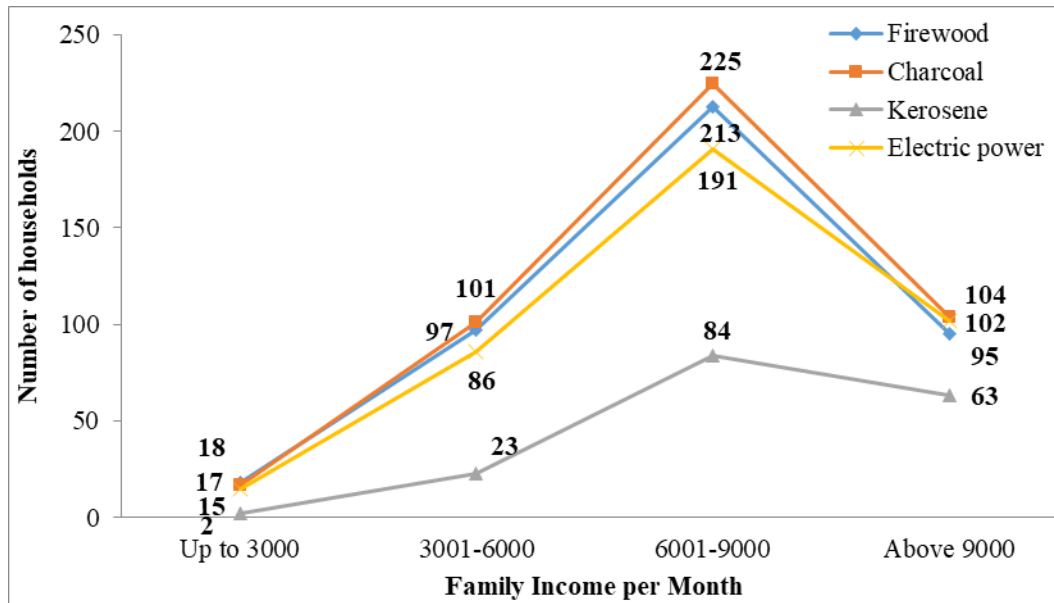
| Energy source  | Monthly expenditures (Birr) |      |      | Number of households |     |
|----------------|-----------------------------|------|------|----------------------|-----|
|                | Mean                        | Min. | Max. | EU                   | NUE |
| Firewood       | 402                         | 60   | 1200 | 204                  | 219 |
| Charcoal       | 248                         | 50   | 800  | 226                  | 221 |
| Kerosene       | 132                         | 20   | 400  | 96                   | 76  |
| Electric power | 301                         | 25   | 1200 | 229                  | 165 |

*Note: EU=Electric-users; NEU=Non-users of electricity; Source: Authors*

Figure 1 shows the influence of households' family income on the use of energy sources. Based on this data, as family income increased up to 9,000 birr, the number of households expending for each energy source increased and then sharply declined. This is mainly because the number of households' earning high income generally decreased.

Households whose family income was below 9,000 birr mainly used firewood and charcoal and those that earned above 9,000 birr used charcoal and electricity. They spent 402 birr for fire wood and 248 birr for charcoal per month. This indicates that firewood was more used by low income households while electricity was used by high income groups. Kerosene was least utilized energy source, often used temporarily or for emergency purpose.

**Figure 1: Households Consuming Alternative Energy Sources and Family Income**



Source: Authors

**Households’ Food Consumption Behaviors**

As presented in table 2, informal settlers’ choice of energy is influenced by households’ food consumption behaviors. The study showed that many households preferred to use animal dung, firewood, and charcoal to add the taste and flavor of food staffs, roasting and boiling coffee, fry and dry cereals like sweet corn and potato chips, and prepare ‘*Doro Wot* and *Shiro Wot*’, influenced by cultural factors and individual’s long standing consumption habits. In relation with this, an interview made with one of our respondents in kotebe gebriel on April 5, 2020 indicated

that  
 “የእሳቱ ሙቀትና ነበልባል ከሚፈጥረው ደስታ ባሻገር በኩባት፤ በእንጨት እና ከሰል የተዘጋጀን ምግብ ጣእምና ሽታ ሴ ቶችና ተለልቅ ሰዎች ቀረቶ ህጻናትም ጠንቅቀው ያውቁታል” (let alone women and old people, even children can identify the taste and flavor of foods cooked by traditional energy sources and enjoy the heat and fume of biomass). They associate their energy choice with the way they have experienced it from childhood. However, some disagree on the belief that “ለምንምገባው ምግብ ጥሩ ጣዕምና ሽታ የሚሰጠው የምግቡ አዘጋጃጀት እንጂ ለማብሰያ የምንጠቀመው የሀይል ምንጭ አይደለም” (instead of the type of energy used, the way food is cooked or baked gives the preferred taste and flavor).

On the other hand, households preferred to use electricity for baking Injera mainly because it saved time and labor, and it is a clean and healthy source. However, since electricity is low and unreliable supply (especially during peak hours), many of the households used a combination of two or more energy sources to cook different dishes at a time, get fresh foods on time, and save labor and time.

**Table 2: Households’ Food Consumption Behaviors and Energy Choice**

| Purpose of energy | Firewood & charcoal |     | Kerosene & LPG |     | Electric power |     | Two or more sources |     |
|-------------------|---------------------|-----|----------------|-----|----------------|-----|---------------------|-----|
|                   | EU                  | NUE | UE             | NUE | UE             | NUE | UE                  | NUE |
|                   |                     |     |                |     |                |     |                     |     |

<sup>7</sup> Doro Wot is chicken cooked occasionally and the best cultural dish in Ethiopia where as Shiro Wot is a staple food prepared from peas, beans and other cereals.

|   |     |     |   |    |     |     |     |     |
|---|-----|-----|---|----|-----|-----|-----|-----|
| - Add the taste and flavor of food staffs     | 150 | 117 | - | 3  | 1   | 4   | 78  | 96  |
| - To roast and boil coffee                    | 209 | 192 | 2 | 3  | 6   | 18  | 12  | 8   |
| - To dry and fry cereals                      | 222 | 199 | 2 | 4  | 3   | 17  | 2   | 1   |
| - To prepare cultural Ethiopian dishes        | 164 | 145 | 2 | 3  | 38  | 39  | 25  | 34  |
| - To bake Injera <sup>8</sup>                 | 37  | 78  | 1 | 4  | 164 | 107 | 27  | 32  |
| - Helps to get food variety                   | 8   | 38  | - | 2  | 41  | 11  | 220 | 169 |
| - Help to frequently cook and get fresh food  | 1   | 3   | - | 10 | 6   | 32  | 222 | 174 |
| - Increases the number of meals taken per day | 21  | 8   | - | 2  | 2   | 24  | 206 | 186 |

Note: EU=Electric-users; NUE=Non-users of electricity; Source: Authors

### **Shelter Condition and Other Factors**

*Shelter condition and type:* The data indicated that 76% of households lived in either good or very good house condition made of steel, wood, and cement/blockets. About 86% of electric-users and 66% of non-users live in either good or very good homes. Though the difference is small, these figures illustrate households living in a good and above housing condition are more likely to get access to electricity. That is, as households' shelter type and condition improves the tendency to get access to electricity increases.

*Number of rooms owned:* The survey data showed that the number of electric-users who owned more than 2 rooms were 78% and the number of non-users of electricity who owned more than 2 rooms were much smaller than the number of electric-users. This simple comparison indicates that as the households' number of rooms increase, informal settlers' access to electricity increases.

*Number of years lived in the area:* The number of years households lived in the area significantly affects households' access to electricity. For example, 77% of electric-users and 38% of non-users of electricity lived above 6 years in the area. The number of electric-users connected to electricity lines in the recent 5 years at the time of the survey was 36% and those before 5 years were 64% indicating informal settlers' likelihood of getting access to electricity increases with the increase in the number of years lived in the area.

*The suitability of the living area to the urban plan:* In an effort to know opinions of households on the suitability of the dwelling space for living and the urban plan, 68% of electric-users and 50% of non-users' homes were not located in suitable living area and contradicted with the urban plan. This situation heavily affects households' access to electricity.

*Land title and size:* Informal settlers owned land through different means. About 71% owned land through purchasing from land owners in the expansion areas, 6% through land grabbing, and 23% through inheritance. Per the land policy of Ethiopia, individuals have the right to use the land under their custody and cannot sell or transfer to third party except through inheritance. In view of this, about 77% of households were typical informal settlers. Surprisingly, however, all households who inherited land from their families were still considered informal settlers and 41% of them did not use electricity power for baking and cooking. Conversely, 48% of typical informal settlers had access to electricity power. The survey data indicated that the minimum land size under the custody of households in informal settlements was 71m<sup>2</sup> and the maximum was 400m<sup>2</sup>. The average land size was 172m<sup>2</sup> and 88% owned below 240m<sup>2</sup>. From households who owned below 240m<sup>2</sup>, electric-users accounted for 48% and from those who owned more than 240m<sup>2</sup> land, this group reached 73%. This implies that there is close association between land size owned and the likelihood of getting access to electricity.

*Proximity of households' home to electric line:* Distance between non-users' home and the nearest electricity line or a transformer can also restrain access to electricity. Survey results showed that non-users of electricity lived in between 8-700 meters away from the nearest electricity pole or a transformer (the average being 105 meters). However, 60% of electric users and 89% of non-users of electricity were situated within 200 meters' radius from the electricity facility. This indicates that non-

<sup>8</sup> Injera is flat bread traditional staple food made from fine iron-rich Teff typically grown in Ethiopia sometimes mixed with wheat, barley or sorghum flour.



users' proximity and geographical location to electricity facilities could not be a reason for restraining them from getting access to electricity. In the first place, most of non-users lived mixed with electric-users in their informal settlements.

## **Conclusions**

This study has identified alternative energy sources for domestic use in informal settlements and the factors that affect households' electricity use status in Addis Ababa. However, owing to households' socio-economic differences, all factors do not have equal importance in determining their energy choice and consumption levels. As a result, households that had access to electricity were found using more biomass and even consumed more charcoal than non-users of electricity.

Legality of land ownership, proximity of the living area to electricity lines and its suitability to the urban plan had less influence on informal settlers' access to electricity. On the other hand, the number of years a household lived in the area, land size owned by the household; shelter condition/type and the number of rooms owned; the age, education level, family income and employment type of the household head; and number of dependent family members all played a significant role in influencing informal settlers' access to electricity.

The availability, reliability and affordability of electric supply were growing problems in informal settlements. High electricity connection fees and ever rising electricity tariffs had inhibited them from access to electricity. Associated with population growth and increased energy consumption, the availability and cost of biomass had also become a growing problem in informal settlements. Food consumption behaviors and cultural factors also play a significant influence on households' energy choice decisions.

## **Recommendations**

It is noted that informal settlers occupy small and unauthorized land, earned irregular income, and are unable to pay connection charges and monthly electricity bills. These characteristics signify the need to take appropriate measures. Some of the recommendations that could increase households' access to electricity include three suggestions. One, to clearly segregate the provision of electricity supply and formalizing informal settlers based on factors such as education of the household head, family size, number of years lived in the area, shelter size and condition. These conditions may encourage more people to involve in informal settlement and unplanned urban expansion. The government, therefore, has to formalize informal settlers' and the Ethiopian Electric Utility shall provide electricity services based on the conformity of the land owned to the urban plan and proximity to electricity facilities. They should also balance households' socio-economic backgrounds; the availability and affordability of energy sources; and stabilize electricity prices by giving high priority to hydropower development.

Secondly, untargeted subsidies on the one hand and progressive electricity tariffs on the other set indiscriminately for all groups of households should be thoroughly revised by considering the inadequate power supply and residents' paying capacity. To this end, subsidies should target the poor and discounts and encouragements given to those who use electricity power during off-peak hours. The initial connection fee should also take into account the residents' paying capacity and willingness to share costs among households in the surrounding areas.

Lastly, although Ethiopia's energy policy underlines the need to transform from traditional to modern energy sources, due to the scarcity and the rising cost of electricity, most households (including electric-users) heavily use firewood and charcoal for cooking/baking, roasting, and boiling coffee, and drying and frying cereals. To create a change in households' food consumption habits, there should be aggressive awareness creation campaigns that encourage them to use energy efficient stoves accompanied by reliable electricity supply.

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