# Effect of Access to Modern Energy Sources on Schooling Outcomes in Ethiopia

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The objective of this paper is to understand the relationship between access to energy infrastructure in the household (electricity, cooking fuels) and schooling outcomes in Ethiopia. The UNDP-WHO reports that in 2009 about 3 billion people rely on solid fuels for cooking around the world; in the case of Ethiopia more than 90 percent of the population use solid fuels for cooking. There is a huge gap in energy infrastructure between urban and rural areas. This issue affects different schooling outcomes given that children (and women) are those who collect firewood for the household's supply of energy fuels. Using data from the Young Lives Longitudinal Survey, I estimate the impact of the time spent collecting firewood on schooling outcomes for Ethiopia. Two groups of schooling outcomes are analyzed: time in school and performance. This paper contributes to the literature by measuring the impact of firewood collection on school performance.

## 1. Introduction

Lack of access to modern energy sources is related with poverty; poverty is related with worse educational outcomes, especially in the earliest years of life. These are critical phenomena in the developing countries. The UNDP-WHO reports that in 2009 about 3 billion people rely on solid fuels for cooking.[2] Those households will face the risk of remaining in the poverty trap and need to make decisions on the time use of their members - including the decision between child labor and schooling.

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[2] Solid fuels refer to crop residues, dung, wood, charcoal and coal.

In the developing world, access to solid fuels for cooking varies between countries, particularly between the urban and rural areas. The percentage of the population that has access to modern fuels in developing countries varies a lot, for example it is 4.2 percent in Ethiopia, 28.8 percent in India, 61 percent in Peru, and 34 percent in Vietnam. [3] Glewwe and Miguel (2008) pointed out that "children in most less developed countries also complete far fewer years of schooling, and learn less per year of schooling, than do children in developed countries"[4]. Additionally, Glewwe et al (2014) reported that the enrollment rates in primary and secondary education have improved in recent years in developing countries, although the secondary enrollment rate is much lower than that for primary education. There is a segment of the population that is most likely to drop out of school and learn less in school, these outcomes could be related to household and dwelling characteristics such as type of fuel used for cooking at home or water source.

Research studying the obstacles and determinants of children's educational outcomes is abundant. Within the determinants, child labor and health status of the children are the ones related to this analysis. Ravallion and Wodon (2000) study how child labor might displace schooling by exploring the relationship between a targeted enrollment subsidy and children's labor force participation and school enrollment in rural Bangladesh. Glewwe and Miguel (2008) provide an extensive review of the relationship between child health and nutrition and several educational outcomes. Ezzatti and Kammen (2001) review the impacts on health of exposure to indoor air pollution from solid fuels, highlighting that it is an important cause of mortality in the developing countries. The literature on the relationship between indoor air pollution and health is

[3] UNDP-WHO (2009). Pg 71-78. These countries were selected because the dataset that is used in this paper includes those four countries.
[4] Glewwe and Miguel (2008). Pg 3562

extensive, not only in the economics literature but also in the health literature. Duflo, Greenstone and Hanna (2008) review the literature related to Indoor Air Pollution (IAP), respiratory health and economic well-being.

In an extensive review of the recent literature on school resources and educational outcomes in developing countries Glewwe et al. (2014) divided the possible factors that affect educational outcomes into school characteristics, teacher characteristics and school organization. Electricity is one of the factors that have been studied as a determinant of the educational outcomes, but the authors do not find strong evidence of electricity having a significant effect on schooling outcomes. The paper highlights some of the obstacles that are faced in developing countries in order to improve the educational outcomes of children; among those, other complementary resources such as dwelling characteristics and utilities are not included in the analysis.

The relation between the collecting environmental resources, such as firewood or water, and schooling outcomes, has been studied in some extend. Wagura Ndiritu and Nyangena (2010) analyze the relation in the Kenyan context; Levison et al. (2014) perform a analysis for some Tanzanian villages; and Nankhuni and Findeis (2004) perform a study for Malawi. Rogers (2014) estimates the long-term costs of collecting firewood in Tanzania. Daka and Jérome (2011) explore the relationship between the availability of electricity at home and children doing their homework for Madagascar.

This paper attempts to answer the following question: does access to modern energy sources improve a child's educational achievement through an improved study environment? It also tries to contribute to the general literature on the factors that determine schooling and

educational outcomes. When studying the factors that determine the educational outcomes in developing countries it is important distinguish between school attendance and other schooling outcomes such as test scores. This paper will use both measures: school attendance ( to primary and secondary school) as well as tests scores, which measure the amount that the children learn. The analysis will be based on a longitudinal dataset from Ethiopia.

Given the few research on the relationship between the access to modern fuels and educational outcomes, the results of this paper will contribute to gain more knowledge about this relation. Moreover, it would be the first study to investigate other type of schooling outcomes, such as test scores and it will use panel-data following children during the 2002-2009 period.

## 2. Energy and Education Situation in Ethiopia

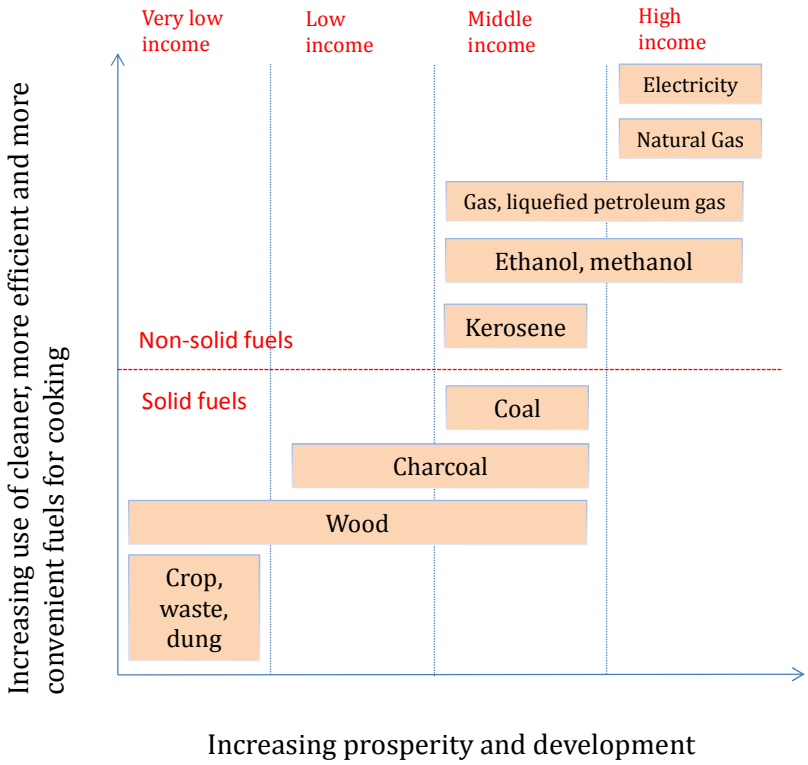
### *Definitions*

This paper will follow the UNDP-WHO's definition of modern fuels. Access to modern fuels is measured as the percent of people that use electricity, liquid fuels or gaseous fuels as their primary fuel to satisfy their cooking needs. These fuels include liquefied petroleum gas (LPG), natural gas, kerosene (including paraffin), ethanol and biofuels, but exclude all traditional biomass (e.g., firewood, charcoal, dung and crop residues) and coal (including coal dust and lignite).

In addition the concept of "energy ladder" will be recursive used in the paper. The energy ladder shows the improvement of energy use corresponding to an increase in household income. As income increases, the energy types used by households should be cleaner and more efficient. On the other hand, energy types become more expensive when moving from traditional biomasses to electricity. The following figure graphically represents the concept of the energy ladder:

Although the energy choices of households seem to be highly correlated with their income levels, some authors have shown that some socio-cultural factors such as opportunity costs (Heltberg, 2005) also play an important role (Atanasov, 2010).

**Figure 1 - Energy Ladder**



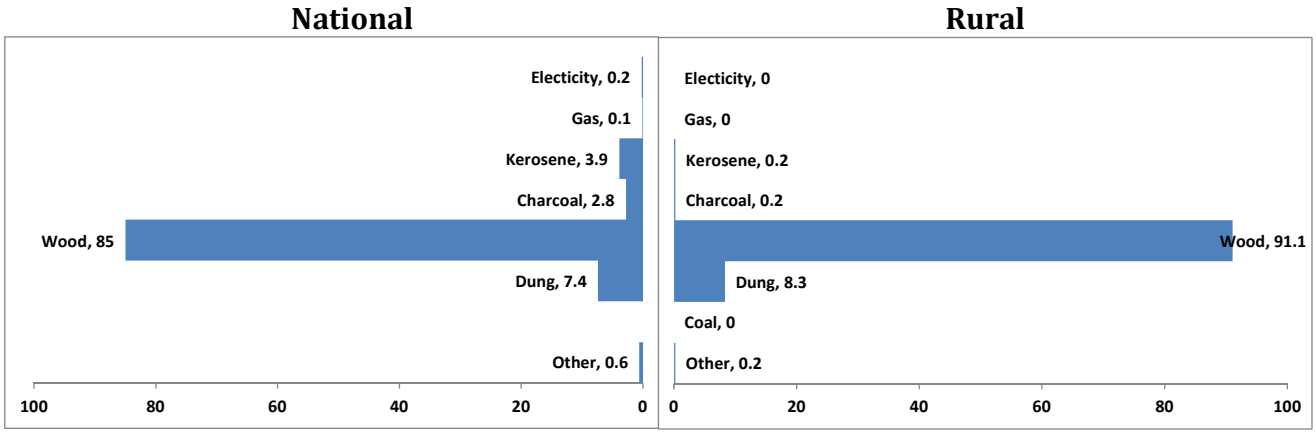

WHO (2006) pg 9.

### *Indicators*

Access to energy is not common in Ethiopia. Just 4.2 percent of the population has access to modern energy sources for cooking; the situation is even more dramatic in the rural areas where just 0.2 percent of the population can cook using modern fuels. As of 2009, most of the population of the country relied on firewood for cooking (85 percent), followed by dung (7.4 percent) and kerosene (3.9 percent), as shown in Figure 2. Regarding the modern energy sources, kerosene

leads the list with 3.9 percent of the national population (0.2 percent of the rural population), followed by 0.3 percent of the population using electricity for cooking and 0.1 percent using gas. According to the UNDP-WHO report, the rural population of Ethiopia did not have access to electricity or gas as their cooking fuel.

**Figure 2 – Fuels used for cooking**




Data: UNDP-WHO (2009)

Access to electricity shows an even greater disparity within the urban and rural areas of the country. At the national level, 15 percent of the households have electricity, where two percent of the rural population has access to electricity while in the urban areas the coverage reaches 80 percent of the population.

On the other hand, looking at some education indicators, one can conclude that the country remains lagged and there are disparities besides the government efforts.5 He differences between the youth literacy rates are evident: 33.3% of the young females (ages 15-24) are literate while 55.9% of the young males are literate. Differences regarding the primary completion rate are

[5] The indicators were taken from the World Development Indicators database.

small between girls and boys: 53.2 percent and 57.2 percent respectively, but the national level is low compared to other developing countries.

Ethiopia presents a similar situation to the rest of the developing world regarding, the countries of interest exhibit universal primary schooling (it is close to 100 percent), while the secondary enrollment rate drops dramatically to 36 percent. Even if universal primary schooling has been achieved in the country, the pupil-teacher ratio will affect the amount learned by each student. The country has a large pupil-teacher ratio for both primary and secondary school, 54.1 and 43.1 respectively. Finally, public expenditure on education reaches 4.7 percent of the GDP and 25.4 percent of the government expenditure.

## 3. Literature Review

Access to modern energy sources can impact children's educational outcomes through several channels including: i) the use of solid fuels at home can affect the child's health; ii) a household that has to produce its own energy has to employ time of some of the household members to perform this task. Several authors have shown the relation between child health and educational outcomes or child labor and schooling, but there is a lack of research trying to go back to one of the determinants of child labor or the factor which produces the negative health outcomes.

The World Health Organization has highlighted the importance of indoor air pollution (IAP) as a consequence of the use of inefficient stoves function by using biomass fuels. The WHO (2011) reports that "nearly 2 million people a year die prematurely from illness attributable to IAP due to solid fuel use". Among the causes, pneumonia is the one that affects children under five years of

age most critically while chronic obstructive pulmonary disease impacts women most. Rehfuess, Bruce and Smith (2011) present an overview of solid fuels usage and some impacts in different health outcomes as well as how it impacts other household decisions. They discuss the time and household expenditure issue and argue that even if a household does not spend time collecting biomass fuels, "spending money on inefficient fuels can place severe constraints on household budgets". Ezzatti and Kammen (2001) review the impacts on health of exposure to IAP from solid fuels, highlighting that it is an important cause of mortality in the developing countries.

Duflo, Greenstone and Hanna (2008) reviewed literature related to IAP, respiratory health and economic well-being. They conclude that the relation between IAP and respiratory health has been well documented and allows concluding the importance of looking for strategies to reduce the IAP. On the other hand they argue that research on the relation between IAP and economic well-being has been mainly focused on the poverty trap, but research on its impact in productivity or schooling has yet to be conducted. As mentioned before, Daka and Jérôme (2011) explore the relationship between availability of electricity at home and its impact on children doing their homework. They found that electrification has a positive impact on the ability of children to keep up with their education, mainly because these households required housework from the children and with access to electricity they were able to do their homework in the evenings.

While there has been little research trying to explain the relationship between access to different energy sources and the educational outcomes of the children in developing countries, some research linking infrastructure availability or improvement and household welfare has been conducted. Jacoby (2000) looked at the impact of rural roads and welfare gains of Nepali households; Jalan and Ravallion (2003) estimated the impact in child health of access to piped

water in India. It has been argued that estimating the costs of infrastructure is an easier task than estimating the benefits of it. The role of access to infrastructure is still part of the policy debate, for instance the World Bank (2004) argues that infrastructure provisioned by the government is often inefficient and inequitable.

Research on the relationship between health and education is abundant. Glewwe and Miguel (2008) provide an extensive review of the relationship between child health and nutrition and the educational outcomes. Glewwe, Jacoby and King (2001) found large effects of early childhood nutrition on learning, delayed entry and grade repetition in the Philippines. Miguel and Kremer (2004) found an effect in increased schooling and reduction in absences of deworming in Kenya. Duflo and Hanna (2006) found a large absence rate from school in India due to poor health.

Thus the lack of access to modern energy sources might have a greater impact on the educational outcomes, given the multiplier effect of the deterioration of the children's health. But there is little research connecting these topics and going one step further, the impact of lack of access to modern solid fuels on the educational outcomes, which could be indirectly transmitted through the health status of the child or can be directly impacted through less time spend at the school or doing homework.

Another branch of the education literature has focused on the relationship between child labor and schooling. Assaad, Levison, and Zibani (2010) show that domestic work performed by girls is associated with lower rates of school attendance. Assaad, Levison, and Dang (2010) argue that there is a threshold of 10 hours of domestic work for girls and 14 hours for boys which will impact attendance. Ravallion and Wodon (2000) explore the relationship between a targeted enrollment subsidy, children's labor force participation and school enrollment in rural

Bangladesh. They test whether the enrollment subsidy increases schooling. Their results suggest that families that received the subsidy had an enrollment rate that was 0.15 higher than that of other households; additionally the children who received the subsidy had a labor participation rate that was five percentage points lower. The effects are larger for boys than for girls. Their methods and results suggest that when some policy intervention is implemented, the intra-household decisions regarding child's labor may be changed in a positive way, thus improving access to modern solid fuel might decrease child labor such as picking up wood and could increase school attendance as well as other educational outcomes.

Most of the households that lack of access to modern energy sources reside in rural areas. The UNDP-WHO (2009) report shows that there is wide variation among countries in their share of population with access to modern fuels; it is also clear that with in most developing countries rural areas are more affected by this phenomenon than urban areas. Not only is the gap in access to modern fuels important for this paper, the difference in the educational outcomes between children residing in urban and rural areas is also important. Orazem and King (2008) show that the urban-rural gap is larger than the gender gaps in developing countries, and they highlight the fact that the gap increases with children's age and reaches its peak at the 15-17 age group, especially for girls. This result suggests that the empirical analysis should be conducted not only separating urban and rural areas, but also boys and girls. Their findings suggest the importance of incorporating age groups in the model. Some age groups are more likely to participate in household work, especially when it is physical, such as picking up wood and carrying it; it seems that these age groups are more likely to drop out of school.

The relation between the collection of environmental resources and schooling outcomes has been studied in some extend, especially in Africa. Wagura Ndiriti and Nyangena (2010) show that the children involved in resource collection are less likely to attend school in Kenya. Levison et al. (2014) analyze the relationship between water and firewood collection on school enrollment in Tanzania. Nankhuni and Findeis (2004), perform a similar analysis for Malawi.

Additionally, Rogers (2014) estimates the long term impact of collecting firewood as a child. By using a long-term panel data set, she concludes that in Tanzania, when a child spend an additional hour collecting firewood it will decrease their earnings by 1.7 percent of their income 30 years later.

# 4. Conceptual Framework

This paper attempts to answer the following question: does access to modern energy sources improve a child's educational achievement? But, how does one measure the effect of lack of access to modern fuels on schooling? One way could be by using a method that compares the educational attainment of children who live in households with access to modern fuels with those who do not. Although it is a starting point, this comparison alone will not allow understanding how schooling decisions are taken inside the households which can use different types of cooking fuels.

An adaptation of Ravallion and Wodon's (2000) model of household schooling decisions in developing countries will be used in order to analyze how parents' choices on sending their children to school, and their children's time allocation between school and work, are affected by a dwelling characteristic: energy access. This, combined with Orazem and King's (2008) model in

for how long a child stays in school is explained by some particular characteristics of the child, including the time allocation decisions by parents. Orazem and King point out that parents might value their time in school differently, thus the time allocation decision between work and school for boy and girls could differ.[6]

The child is the smallest unit of observation, but given that children usually do not make the time allocation and type of fuels decisions in their households, the model will focus on the household. In addition, as the analysis focuses on the relation between energy access and educational outcomes, educational outcomes and energy access need to be defined. The following educational outcomes will be used in this study: school enrolment (whether a child is attending school) and test scores. Energy access is defined as the type of fuel that the household uses to cook. To begin, assume that households do not decide what type of cooking fuels they use because it is determined by government policies. It will depend on the infrastructure provided by the government in the area in which the household is located.[7]

Some other children's characteristics are related to our variables of interest and might become crucial for the analysis. First, the analysis has to be narrowed to those age groups that are subject to attend primary and secondary school (7-18 years). Also it is important to distinguish which age groups are more vulnerable to work at home and be more likely to accept the parent's decisions. Additional to age groups, the analysis will be conducted separately by gender. Orazem and King (2008) take into account the fact that boys and girls play different roles in household

[6] Orazem and King (2008). Pg 3508.

[7] The concept of energy ladder, which is linked to energy poverty, will be used to order the different types of energy. As households get more income it is supposed to improve its energy sources moving to more clean and efficient fuels. For example they will start using fuels that are cheap and locally available, such as crop waste, dung, leaves, wood, etc. The next step is to get coal and charcoal. Next they will move to kerosene and gas, to finally reach electricity. Moving up into the energy ladder implies not only an economic effort form the household but also infrastructure provided by the local authorities or government.

work, not only in the number of hours working at home but also in the tasks each group conduct. For example it has been argued that girls are more likely to cook and take care of the other children in the household while boys are more likely to perform field work. Finally, given that households with lack of access to modern fuels need to produce their own energy, the household has to buy those fuels or get them by themselves, therefore the time spent picking up fuels will play a critical role in the time constraint of the child.

Another group of variables will help me control and get more accurate results: household size/composition, location (urban/rural), educational attainment of the family, income; location variables such as school availability, price of schooling and infrastructure. It would also be useful to know if the energy production (wood, coal, etc.) is an additional income source of the household.

The theoretical model should predict that the lack of access to modern fuels decreases school attendance and amount learned by the children. Access to modern fuels should decrease child labor at home, but will not completely be abolished - it will depend on the sources of income of the family and their location.

Following Ravallion and Wodon (2000), assume that parents are free to determine their children's time allocation. The parents' utility function is:

$$U = U(S, C, Z) \qquad (1)$$

where the household consumption is C, S is the child's school attendance. Assume also that the utility function is strictly quasi-concave in C and S. A set of exogenous household and local variables Z is included to allow for heterogeneity.

The child's total time available (T) can be allocated to schooling (S) and work (W):

$$T_C = S + W_C \qquad (2)$$

The household consumption will be composed of the intake of minimum daily calories of the household $C_{min}$ (basic needs) and consumption of other goods $C_{other}$:

$$C = C_{min} + C_{other} \qquad (3)$$

Assume that the basic needs ($C_{min}$) are supplied with food, therefore it will be a function of the type of energy fuel used for cooking $e$ and the time that some members of the family spends producing the "basic good" $W_{cook}$.

$$C_{min} = F(e, W_{cook}) \qquad (4)$$

$W_{cook}$ could be performed by adults or children in the household, so each household will have a different time constraint depending on who performs the task. In the case that children are the ones in charge of cooking in the household $W_{cook}$ is included in the $W_C$ variable of equation (2). On the other hand, if an adult is the one producing the "basic good" $W_{cook}$ will be part of the parents' time constraint.

Additionally, the energy production function (e) of the household depends on child's labor or adult's labor performing the energy collection:

$$e = f(W_{ce}, W_{pe}) \qquad (5)$$

$W_{ce}$ stands for child's labor on energy production and $W_{pe}$ stands for parents' labor on energy production. Some households are located in areas where government provides infrastructure that allows them to access to modern energy sources, thus the energy production

function will be conditional on government policies (GP). GP can take values of 0 and 1, where 0 stands for areas without access to modern energy sources while 1 stands for those areas where government provides adequate infrastructure to access to modern energy sources:

$$e = f(W_{ce}, W_{pe}|GP = 0) \qquad (5a)$$

$$e = f(W_{ce}, W_{pe}|GP = 1) \qquad (5b)$$

Taking into account the different types of house work that children can perform equation (2) becomes:

$$T_C = S + W_{cook} + W_{ce} \qquad (6)$$

The parent's time constraint will be:

$$T_P = W_{other} + W_{cook} + W_{pe} \qquad (7)$$

Given this relation, one can assume that in areas where government provides energy infrastructure children do not need to allocate time for energy production. In contrast, children who live in areas without government infrastructure will be part of the energy production function of the household. As result the household maximization problem will become:

$$Max\ U(S, C, Z)\ \ s.t.$$

$$C = C_{min} + C_{other} \qquad (a)$$

$$C_{min} = F(e, W_{cook}) \qquad (b)$$

$$e = f\left(W_{ce}, W_{pe}\ \middle|GP\right) \qquad (c)$$

$$T_C = S + W_{cook} + W_{ce} \qquad (d)$$

$$T_P = W_{other} + W_{cook} + W_{pe} \qquad \text{(e)}$$

From the maximization problem, I will be able to estimate the optimal value of schooling for each household and it will also impact the child's performance in the tests. Therefore the utility function will depend on both school attendance and performance: $S = F(SA, Test)$.

*Section under revision*

# 5. Methods and Procedures

When studying the factors that determine the educational outcomes in developing countries it is important to distinguish between school attendance and the amount that children learn. Given that access to modern solid fuels varies between urban and rural areas the results will be presented separately depending on the geographic location. Urban and rural areas differ not only on the availability of energy sources or electrification rates, but also in some other infrastructure dimensions such as roads and schools that might lead to different results if urban and rural areas are combined in the analysis.

The analysis will be based on longitudinal datasets from 4 developing countries. The datasets include information on household and child characteristics, in addition to education variables such as school attendance and test scores in several subjects. Ideally, the datasets should have information on community and school characteristics. The expected results are that households that do not have access to modern energy sources have to adapt the time use of their members, especially children that are in schooling ages, and this would lead to lower enrollment rates in primary and secondary education and also to a lower amount of learning (if enrolled school).

## *Data*

This paper uses the Young Lives Longitudinal Survey (YLS), an initiative of Oxford University in order to study childhood poverty. As mentioned throughout the text, the analysis focuses in Ethiopia. The YLS has similar data for India (state of Andhra Pradesh), Peru and Vietnam, thus the analysis could be replicated for those countries. The entire project (YLS) has information for 12,000 children, their households and their communities; as of 2014, three rounds of the survey are available. For each round two different cohorts where surveyed: the younger cohort (children born in 2001-2002) and an older cohort (children born in 1994-1995). There are around 3,000 observations per country in each round; 2,000 in the younger cohort and 1,000 in the older cohort. [8] This paper will focus on the older cohort of Ethiopia, for whom there are data when the children were 7-8 years (2002), 11-12 (2006), and 14-15 (2009); this means, 974 observations.

The survey has data at the community, household and individual level on: employment, income, property ownership, education, health, and family composition. The household survey includes data on fuel for cooking and heating; time use data for children aged 5-17[9] and anthropometric measures. The child survey includes data on school activities and test scores.

Some variables are critical for the analysis. First, the variables related to educational outcomes: school attendance and test scores - these educational outcomes are measured by using the question regarding current school enrollment and the test scores on vocabulary (Peabody Picture Vocabulary Test –PPVT), math, reading and writing. Second, those questions related to

[8] http://www.younglives.org.uk/
[9] This includes the category of collecting firewood or water for the household.

energy infrastructure: access to electricity and type of fuels used for cooking or heating. The time use module provides information on whether the children of the household allocate time collecting firewood or water, unfortunately, there are no data on whether if the adults are also doing this task.

## *Methodology*

In order to estimate the difference in educational outcomes between children living in households with access to modern energy sources and those living in households using biomass energies for cooking, the program evaluation framework will be used. The main idea is to be able to estimate the effect on educational outcomes given that the type of energy fuels for cooking is neither randomly distributed by the government nor randomly selected by the households. The standard practice in the literature when modeling school attendance is based on the following question: "Are you currently enrolled in school?". Unfortunately there are several reasons why a child does not attend school; therefore the analysis will be restricted to those communities that have schools:[10]

Assume that there are only two states of the world, the state of having access to modern energy sources (D=1) and the state without them (D=0). The corresponding outcomes for each state of the world will be denoted as $S_1$and $S_0$ for the corresponding school enrollment outcomes and $T_{i1}$ and $T_{i0}$for the test score *i* for each children in each treatment group.[11] Thus the gain that

[10] To do so I will use the community and individual surveys, the community survey has data on availability of schools in the community while the individual survey has data on reasons why the child is not attending to school (school availability). An alternative is to use another GP variable, which tells me whether there are schools in the community.
[11] The survey includes different test scores, the subscript *i* refers to each one of the tests scores included in the Young Lives Survey.

the children will have from moving from biomass fuels at home to modern energy fuels could be denoted as:

$$\Delta = S_1 - S_0 \quad (8)$$

or

$$\Delta_i = T_{i1} - T_{i0} \quad (9)$$

To exploit the longitudinal aspect of the survey a differences-in-differences estimator (DID) will be used. In this case I will not assume that there are baseline data and then the treatment was randomly assigned. I will assume that in every new survey wave the government has intervened in some areas by building infrastructure that allows households to access modern energy sources. Therefore the variable $I_i^D$ will equal 1 for households who were given the treatment ($D_{it-1} = 0$ and $D_{it} = 1$) and 0 otherwise. The coefficient of interest will be $\alpha_{TT}^*(X_{it})$ and $\beta_{TT}^*(X_{it})$in the following equations:

$$S_{it} - S_{it-1} = \varphi_0(X_{it}) - \varphi_0(X_{it-1}) + I_i^D \alpha_{TT}(X_{it}) + \varepsilon_{it} \quad (10)$$

for the case of school enrollment. And the following equation for test scores:

$$T_{jit} - T_{jit-1} = \gamma_0(X_{it}) - \gamma_0(X_{it-1}) + I_i^D \beta_{TT}(X_{it}) + \varepsilon_{it} \quad (11)$$

A positive sign of $\alpha_{TT}^*$ is expected. But the magnitude of the effect is unlikely to be the same for the different countries. Some countries have higher enrollment rates in general so the $\alpha_{TT}^*$ for the school enrollment equation should be smaller or even non-significant in the case of those countries. Similarly, a positive sign of $\beta_{TT}^*(X_{it})$ is also expected.

There is a possibility of having few observations going from one state to another from one wave to another. Therefore, using propensity scores to generate counterfactuals is going to be useful. The propensity scores will be estimated using a probit model in which the dependent variable is $e_{it}$, which stands for the type of energy source that a household uses for cooking. It takes values of 1 if the household uses a modern energy source and 0 otherwise. $X_{it}$ is a vector of household and children's characteristics and $GP_{it}$ is a dummy variable that tell us if there is energy infrastructure provided by the government for the household *i* in period *t*.

$$p(e_{it}) = Prob(X_{it}, GP_{it}) \qquad (12)$$

After estimating the propensity scores, the DID analysis will be estimated again using those households in the common support area.

*Section under revision*

# 6. Preliminary Findings

Preliminary analysis of the data shows that access to energy reflects the country's situation. Table 1 presents the proportion of children in the survey living in households with electricity for the three rounds available:

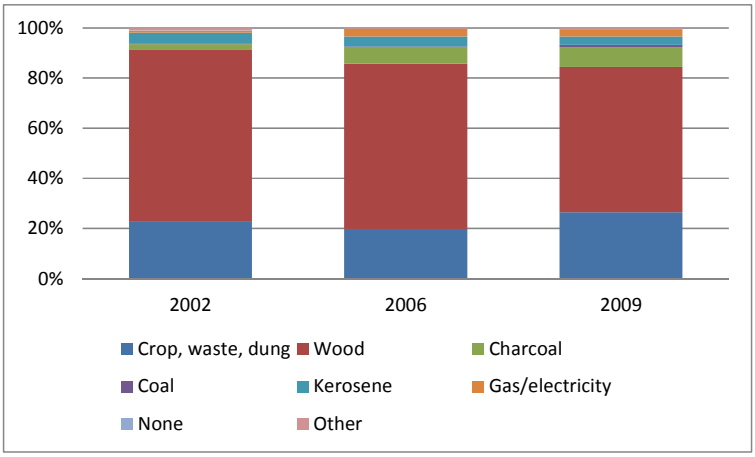
**Table 1 - Access to electricity**

| Round | Total | Urban | Rural |
|---|---|---|---|
| 2002 | 35.3 | 88.9 | 6.3 |
| 2006 | 53.9 | 94.2 | 13.5 |
| 2009 | 53.6 | 94.8 | 24.5 |

Source: Author's estimation using YLS.

Figure 3 presents the evolution of the main fuel use for cooking. It is clear that wood is the main fuel used for cooking; in 2002, 68.5 percent of the children lived in households that relied on wood for cooking, by 2009, this proportion was around 58%. It is important to notice that the second fuel in the list is cow-dung; the proportion of household using cow-dung as their main fuel for cooking is close to 20 percent in all the rounds. From Figure 3 one can conclude that almost 90% of the households use solid fuels for cooking, those that are not defined as modern fuel according to our definition.

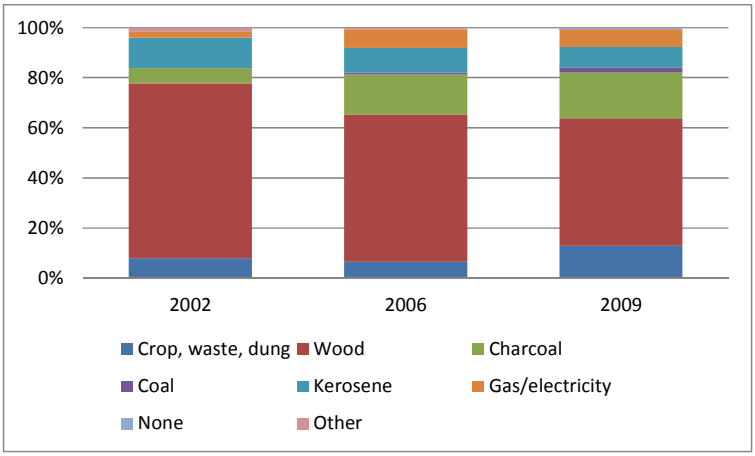
**Figure 3 - Main fuel using for cooking**




Source: Author's estimation using YLS.

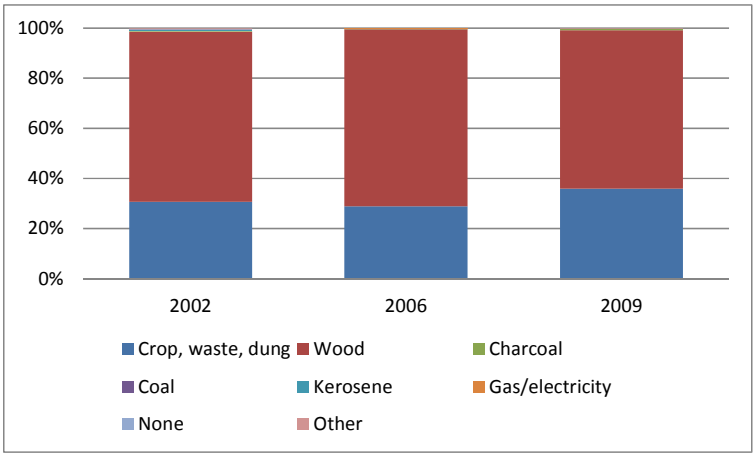
Figures 4 and 5 present the situation for urban and rural households, one can conclude that wood is the main fuel for cooking, followed by cow-dung for the case of the rural households and charcoal or kerosene in the case of the urban households. These preliminary indicators reflect the gap between the urban and rural areas of Ethiopia in terms of the energy infrastructure and give a light of the importance of estimating the results separately for the urban and rural areas.

**Figure 4 - Main fuel using for cooking, Urban Areas**




Source: Author's estimation using YLS.

**Figure 5 - Main fuel using for cooking, Rural Areas**




Source: Author's estimation using YLS.

Regarding the education indicators, Table 2 summarizes the evolution of school attendance for the three available rounds and separately for boys and girls. School attendance increased dramatically from the first to the second round, children start primary school at 7 years in the country, and some of the children were 6 years old during the first round interview. It is also important to mention that school is compulsory until age 12 in Ethiopia.

**Table 2 - School Attendance**

| Round | All | Boys | Girls |
|---|---|---|---|
| 2002 | 65.6 | 63.1 | 68.2 |
| 2006 | 94.8 | 93.6 | 96.0 |
| 2009 | 89.4 | 87.6 | 91.4 |

Source: Author's estimation using YLS.

Finally, the relationship between access to modern energy sources and school attendance can be summarized in Table 3.

**Table 3- School attendance and energy used for cooking at home**

| Round | All | Non-Solid F. | Solid Fuels |
|---|---|---|---|
| 2002 | 65.6 | 96.2 | 63.8 |
| 2006 | 94.8 | 98.5 | 94.5 |
| 2009 | 89.4 | 91.8 | 89.3 |

Source: Author's estimation using YLS.

The results on Table 3 suggest that children living in households that rely on solid fuels as their main fuel for cooking enter later to school and might be more likely to dropout when they are entering secondary school.

*Section under revision, results from the statistical model in progress.*

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