Impact of Rural Electrification on Poverty Reduction
Evidence from Rural Districts of Tigrai, Northern Ethiopia

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Abstract
Lack of electricity is one of the major impediments to growth and economic development of rural economies in any country. Electricity contributes to the reduction of poverty. However there is a very limited empirical study that has examined the causal relationship between the massively accomplished rural electrification endeavors and poverty reduction in the Ethiopian context. This study seeks to fill the knowledge gap. The study was conducted with the objectives to determine impact of Rural Electrification Program on households’ welfare: income, health and education and on the development of both on-farm and off-farm commercial activities. This study has shown that the impact of electricity on reduction of poverty is positive and significant. The impact of electricity access on household income is found to be insignificant and also having the wrong sign. In addition to this some other theoretically important variables are found to be having the wrong sign or became insignificant or both.

Keywords: Rural Electrification- Impact on Poverty Reduction-positive and significant-impact on household income-insignificant

Introduction
Poverty is a major obstacle for sustainable development not only for developing countries but also the entire world. This is acknowledged by the United Nations member states who adopted the Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets - with a deadline of 2015 - that have become known as the Millennium Development Goals (MDGs). The partnership also includes a number of international organisations including the World Bank, International Monetary Fund, International Fund for Agricultural Development and World Health Organization. Although some countries are on track to meet the goals, other countries, particularly in Sub-Saharan Africa are not. Tackling poverty has therefore become one of the main objectives of multilateral donors, such as the World Bank and other organisations, together with economic growth. One way of alleviating poverty is to promote access to modern energy, in particular to electricity. Poverty reduction necessitates economic growth which accompanied by good governance and sound macroeconomic management, results in sustainable and socially inclusive development (ADB, 2002). Significant access of the poor to education and health services, water and sanitation, employment, credit, and markets for produce is needed. Furthermore, the vulnerability of the poor to economic shocks and natural disasters must be reduced to augment their well-being and encourage investment in human capital and in higher-risk and higher-return activities. Public policy reforms and investment in physical infrastructure will significantly contribute to the pursuit of socially inclusive rural–urban development (ADB, 2003).

There is limited empirical evidence available addressing the nexus indicated by figure 1 above. Econometric studies available generally do not trace in detail the links described above. Nonetheless, they provide useful assessments of the more important links, indicating their quantitative and statistical significance. These measures are typically represented as elasticity denoting the responsiveness of a variable to a determinant. While differences in econometric model specifications, data, and definitions call for caution in the interpretation of results across countries, they do lend helpful insights into the connection between physical infrastructure and poverty reduction. To the knowledge of the team proposing this study, few econometric results are found regarding the impacts of electricity and upon poverty reduction and they are mainly in Asian countries. Kwon (2000) estimated growth elasticity with respect to poverty incidence of 0.33 for good-electricity provinces and 0.09 for bad-electricity provinces of Indonesia. This implies that poverty incidence falls by 0.33% and 0.09%, respectively, for every 1% growth in provincial GDP. Provincial electricity also appear to directly improve the wages and employment of the poor, such that a 1% increase in electricity investment is associated with a 0.3% drop in poverty incidence over five years.

There is relatively better empirical evidence showing that irrigation significantly contributes to farm productivity and wages, reducing poverty and income inequality (the latter implying that the poor benefit more than the non-poor). For instance, A dollar worth of output in irrigated farms generates a total employment value of 4.75 dollars. Further, farm income in irrigated areas is 77% higher than that in unirrigated areas in Bihar, India (Bhattarai et al., 2002). It is believed that there is a significant contribution of electricity to the growth of the rural non-farm sector in some districts of China leading to poverty reduction, an estimated elasticity of 0.42 (Fan et al. 2002). Electricity investment has a strong impact on poverty, such that for every 10,000 Chinese yuan spent for electricity development, 2.3 persons are brought out of poverty (Ibid). There is very limited empirical evidence regarding the impact of electrification particularly in the Ethiopian context.

The Ethiopian economy has been growing at 11% per year for the previous six years (IMF, 2009) with the relatively similar rate of growth in further successive years. Growth in the industrial and commercial sectors has been even faster. This, together with rapid electrification through the Universal Electricity Access Program (UEAP), has caused rapid growth in electricity demand. Demand is expected to grow as rapidly in the future due to further economic expansion and the drive for universal electrification. Electricity sales have been growing at the fastest pace ever with 13.5% growth in the past five years. This rapid growth in demand started in the year 2000 and has gotten faster in the latter years. It is to be noted that this unprecedented growth was also accompanied by frequent and substantial power cuts. This means unconstrained demand growth would be even faster, probably close to 20 percent per year (ERG, 2009).

Massive investments in hydro-electric power have positively affected Ethiopia’s economy and opened up the potential for significant increases in productivity and output. Ethiopia increased its electricity generating capacity 29-fold between the 1960s (65 megawatts average in 1960s) and 2011 (1917 megawatts); an increase of 8.9 times on a per capita basis (IFPRI, 2011). The compari-
son with 1959 is even more striking, as there was essentially no electricity generation in Ethiopia at that time -- only 2.3 megawatts of diesel-powered capacity. The introduction of hydro-electric power in the subsequent decades, and especially the large surge in capacity since 2005, has raised electricity generating capacity enormously (IFPRI, 2011).

Actual electricity use is generally only about 35 to 45 percent of theoretical generating capacity, however, largely because through much of the year there is insufficient water behind the hydro-electric power dams for full-scale operation. Domestic use accounted for 30 percent of total use in 2006/07; commercial and industrial use accounted for 20 and 28 percent, respectively; overall, electricity use grew at an average rate of 12.5 percent per year from 2002/03 to 2006/07, with the highest growth rate for street lighting (27.1 percent per year)³. Survey evidence suggests that the productivity effects of electrification could be very large, particularly, as measured by output per worker. A 2008 survey data of small-scale handlooms in Addis Ababa and SNNPR (Ayele et al. 2009) indicates that productivity per worker is about 40 percent higher for electrified versus non-electrified firms in SNNPR. This productivity effect is achieved in large part because in towns with electricity access, producers work longer hours and firms share workspaces with electric lights at lower rental cost. Workers in non-electrified rural villages on average worked only 7.2 hours per day, whereas their counterparts in other electrified (but rural) villages worked 10.7 hours per day.

General Objective Of The Study:
- The overall aim of the study is to estimate causal impact of access to electricity on household welfare, to be indicated by selected socioeconomic (mainly income, health and educational) outcomes.

Specific Objectives:
- To determine impact of Rural Electrification Program on the three key dimensions of households’ welfare: income, health and education.
- To assess the impact of Rural Electrification Program on the development of both on-farm and off-farm commercial activities.
- To put forward logically sound recommendations based on scientifically rigorous impact evaluation.

Hypothesis
Electricity provides the necessary infrastructure for a range of income-generating activities, in terms of accessing new ventures (e.g. poultry) as well as the better operation of the old ones (like electricity-operated irrigation equipment). The extended working hours in the evening enables the households, especially women, engaging themselves in home-based income-generating activities like sewing, handicrafts etc. Due to the expansion of local markets in the electrified villages, the households in the vicinity (even without electricity) are exposed to increased employment opportunities compared to the households in the non-electrified villages. The same applies to the expansion of industrial base.

Income and employment:

H0 = Households with and without electricity do not differ in terms of net income.
H1= Households with electricity have higher net income compared to those of households without electricity.

Education: Electricity enables the school-going children to study in a more productive way due to the extended study hours in the evening as well as due to the comfort offered by electrical appliances. Thus, electricity facilitates literacy, enrolment and attainment. Along with their affordability, the enlightened outlook towards education due to media exposure contributes to their willingness in pursuing higher studies for their children, especially girls. The operation of night schools in the electrified villages can also contribute in rejuvenating the thirst for education for adult and female members as well.

H0 = Electrified and non-electrified areas do not differ in terms of education.
H1 = Electrified areas have higher years of schooling.

Description of study area: According to the report of the 2007 housing and population census, the number of population of the region was 4.3mof which 49.2% are males and the remaining are females. On the other hand, 19.5% of the population is living in urban areas where as 80.5% is living in the rural areas .An electrification program was also formulated and has been implemented both in the urban and rural areas throughout Ethiopia. In relation to this program, a great endeavor has been undertaking to expand the electric power both in the rural and in the urban areas. As a result, 197 towns and rural centers are already benefited from the electrification program. In general, 121953 households have already got electric consumption counter and this means that the electrification covers 12 % of the total households (BPF, 2010).

This study took five villages from five different Tabias that are located in two woredas namely Kilte Awlaelo
The villages are Sherafo from tabia Mahbere Woini, Brki from tabia Mesanu both of which are in Kilte Awlaelo woreda; Romanat from tabia Mahberegenet, Ashegoda from tabia Kedamay Woyane, and Milazat from tabia Mahberekidusan. From these villages Brki, Romanat and Milazat are electrified while the remaining are not.

**Figure 2: The conceptual nexus between rural electric supply and household welfare**

**Methodology:**

Pre-proposal development (consultative) discussion with key partners; Designing the appropriate methodology is one of the most crucial tasks to accomplish, required being multi-phased and rigorous. The first phase in developing the research methodology for this study was to formulate the study design, followed by definition of impact indicators and identification of testable hypotheses linking the Rural Electrification programme (REP) and project interventions with explicit and implicit goals established. In the process of finalizing key technical issues pertaining to this study, the team which developed this research proposal had conducted rapid assessment and held consultative discussions with relevant partners in the Ethiopian Electric Power Corporation (EECO), Northern Regional Head Office (Mekelle), and Regional Bureau of Plan and Finance.

In addition to the timeliness and relevance of the proposed study, there are technical issues discussed which include, among others, the contexts and objectives of Rural Electrification Program (REP) and the proposed study, explicit and implicit goals of REP, impact indicators, testable hypotheses, universe and sample, and field implementation. After threadbare discussion among the participants, the study team and the stakeholders reached at consensus on those key issues methodologically vital for the study.

**Data source:** Households are the targeted units of generating primary data. We propose to utilize existing panel data (found in the EEPCO, northern region, Mekelle) that regularly collects basic data on the electrification service expansion with the accompanied electric energy consumption. We used a detailed questionnaire to get data from households during 2012 on rural electrification, factors that may influence electricity use and its level of contribution for households’ welfare.

**Overall study design:** In line with the objectives of the study, absence of baseline (pre-test) measurement observation necessitated adoption of Post-test-only Control Group Operations Research Design, which is depicted as follows:
Where,

RA = Random assignment of cases to the experimental group and the control group

X = Program intervention/experimental intervention (rural electrification)

O1 = Observation measurement for HHs with electricity

O2 = Observation measurement for HHs without electricity

The rural electric service expansion study is designed to evaluate impact(s) using 'with-without' (electricity) scenario to gauge the impact of Rural Electrification Program (REP). In addition to the observation measurements O1 and O2, an additional sample category – the households without electricity in the electrified villages (Observation measurement 03) – will thus be included in the study design to evaluate the spillover effect of REP. However, in the process of designing the actual study and pre-test of the household survey instruments, it was decided to collect retrospective information on some specific indicators like ownership, property and assets for households which suffer less memory recall problems.

At the level of household, the study proposed three types of observation measurement:

O1 = Observation measurement for households with electricity (HE)*

O3 = Observation measurement for households without electricity in electrified villages (WE-EV).

O2 = Observation measurement for households without electricity in non electrified villages (WE-NEV).

In order to capture all the dimensions of impact of REP, all categories of customers (consumers) were considered. In addition to the households, observation measurement were made on irrigation (pump owners and plot owners), industry, and commercial units using rural electrification (experimental) and not-using electricity (control). The survey technique included both qualitative and quantitative methods. as it will be discussed in the later sections of this proposal.

**Sample design:** EEPCO’s Bill Centres (BCs) in the sample framed rural districts were determined. EBCs were determined in the first stage followed by the selection of households. In lieu of purposive selection, *probabilistic sampling strategy* was adopted to ensure desired level of confidence with *probability proportionate to size* (PPS) according to the number of villages electrified. As for this purpose, the following statistical formula was used:

\[
n = \frac{NZ^2PQ}{(N-1)C^2 + Z^2PQ}
\]

Where,

\(n\) = Sample size

P = a dichotomous probability

Q = 1 – P

N = Size of the population

Z = Standard normal variate

C = Precision level.

An approximate conservative value of P=50% is used with a confidence level of 95% and precision level 10%. Choice of P=50% leads to a better approximation to normality which is needed for the above formulation. Choice of precision level = 10% is allowable in social science studies in order to minimize costs related to trade-off between Type I and Type II errors. Thus, a workable sample size of BCs is determined to be N=37. However, the impact of sample size relative to stated population size needed to be considered as well. We notice that n/N exceeds 5%. Thus, sample size (n) has to be adjusted downward by n/N (Cochrane, 1999). Thus, the revised final sample size of BCs is, \(n = 23\).

In order to ensure representativeness of twenty-three (23) sample BCs, stratified (proportionate) random sampling procedure was adopted. The age-length of BCs has been used as the criteria for such stratification. The three strata are as follows:

<table>
<thead>
<tr>
<th>Table 1: Sample sizes by electrification status and households (Quantitative data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrification status</td>
</tr>
<tr>
<td>Village/area with electricity: Unit with electricity (experimental)</td>
</tr>
<tr>
<td>Unit without electricity (control)</td>
</tr>
<tr>
<td>Village/area without electricity (control)</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

To complement quantitative information obtained through semi-structured questionnaires, qualitative information will be collected through *focus group discussions* (FGDs) and *key informant interviews* from the two major categories of households (Experimental and control).
Because of absence of counterfactual state, estimating the impact of infrastructure projects is a major methodological challenge (Heckman and Robb, 1985). For example, in this study, we can observe households either with access to electricity or without, but cannot observe outcomes for the same households in both situations. The most convincing approach to solve this missing data problem is to conduct a randomized experiment where the counterfactual is created from a random subset of the eligible sample frame or population.

Data analysis: The collected data were analysed using appropriate quantitative techniques to uncover causality, establish stronger evidence ensuring robustness. Appropriate micro-econometric techniques that account for endogeneity, unobserved heterogeneity, attrition, initial conditions and state dependence will be employed. Besides, non-parametric technique (for example, matching method) was used given the nature of the data, i.e. non-experimental data, to evaluate the impact of access to electric power on household health and welfare.

More briefly we employed mix of different statistical analysis techniques: descriptive techniques, difference tests and econometric models to address each research question of the project.

Descriptive Approach; To give an overall portrait of the data and get birds eye-view of the interrelationship among reproductive health, population dynamics, economic growth and household welfare, we present descriptive statistics like mean, median, standard deviations, frequencies and percentages among others. Besides, we analyze the qualitative data descriptively.

Mean/Median Difference Test ;To undertake over all comparative analysis, we test mean and median difference of household poverty (welfare) indicators and other indicators supposed to be affected by access to electricity. We test statistical difference in household per capita consumption expenditure between households in treatment and control areas.

Econometric Models; Different econometric models and estimate the impact of electricity on poverty reduction. Using the HH survey data collected, we specified a household welfare model in (1) that control for other regressors or factors that affect household welfare. In order to investigate the causal or partial correlation of each factor on a response variable, we used the following sets of models that address each research question of the project.

Impact assessment is tricky and specifications in (1) could reveal biased estimates about the effect of electrification on household poverty.

\[
\ln C_i = \alpha + \beta H_i + \delta E_i + \psi X + \gamma_{\text{electric}} + \epsilon_i
\]

Where \(\ln C_i\) is the natural log of per capita household consumption expenditure, \(H_i\) is vector of regressors accounting for households human capital, \(E_i\) is vector of variables representing for labor market opportunities and participations, \(X\) is vector of regressors controlling for other factors that affect household welfare, \(\text{electric}\) is indicators of variables measuring access to electricity or electrification infrastructure variables. \(\alpha\) is the intercept, \(\beta, \delta, \psi\) and \(\gamma\) are vector of parameters to be estimated measuring the effect of human capital, labor opportunities and other control variables respectively. \(\epsilon\) is parameter of our main interest that measures the effect of electrification infrastructure on household welfare. \(\epsilon_i\) is a white noise disturbance term.

We specify a household welfare model that takes in to account the effect of rural electrification as in (1) above. In fact we control the effect of other factors that affect household welfare by including them as regressors. That is household’s welfare measured in terms of per capita consumption expenditure is affected by the household’s physical and human capital and access to electric power and other village characteristics. During estimations, we use several set of indicators to capture household poverty such as per capita consumption expenditure, poverty indices (head count and poverty gap).

We also try to estimate the impact of electrification on poverty by using a logit regression the model of which can be specified as under.

\[
Y_i = \beta_0 + \beta_1 X_i + \gamma E + \epsilon_i
\]

Where

a) \(Y_i = 1\) when the household is none poor (taking an income of one dollar a day).
b) \(Y_i = 0\) when the household is poor.
c) \(X_i = \) all determinants of the probability of becoming non poor but electricity.
d) \(E = \) electricity access \(= 1\) for households with access and \(= 0\) for households without access.

The main target of this study is to estimate the above equation and see the coefficient \(\gamma\).
Review Of Related Literatures

Basic Concepts on Socio-Economic Impacts of Rural Electrification; It is universally accepted that electrification enhances quality of life at the household level and stimulates economy at a broader level. The immediate benefit of electrification comes through improved lighting, which promotes extended hours of study and reading and other household chores, and in turn contributes to better educational achievements. Lighting can also benefit many other household activities, such as sewing by women, social gatherings after dark, and many others. Communication devices such as radios and television also improve the access to information by rural households and can provide entertainment to family members. In addition, household’s economic activities both from inside and outside home benefit tremendously from electricity. For example, crop productivity can be increased by the application of electric irrigation pumps, businesses can be operated longer hours in the evening, electric tools and machinery can impart efficiency and production growth to industrial enterprises, and so on. The benefits of electricity have been discussed in a large body of literature (Cabraal and Barnes 2006; Barnes, Peskin and Fitzgerald 2003; Kulkarni and Barnes 2004; Khandker 1996; Filmer and Pritchett 1998; Roddis 2000; World Bank 2002; Agarwal 2005).

Given its substantial benefits, electrification (along with access to other sources of modern energy) has been identified as essential for fulfilling the Millennium Development Goals (MDGs) (UNDP 2005). The World Bank views electrification as an integral part of development and has supported electrification projects in many developing countries. Most of the electrification projects financed by the Bank in many developing countries often expand coverage of grid electrification with specific objectives in mind, for example, improving welfare (income, education, etc.), establishing institutional mechanisms for rural electrification, providing inputs to power sector reform, formulating guidelines for tariffs, subsidies, and others. Among the multiple objectives, making a positive impact on the livelihood of rural people is the foremost. However, without proper assessment of such projects it is impossible to determine if, and to what extent, these objectives are achieved.

It is well documented that farm productivity improves with the use of electric pumps for irrigation. Non-farm productivity in both small commercial and home businesses also may increase due to the ability keep working or stay open after dark. This improved productivity may be the result of having electric lighting during the evening hours or more efficient electric tools and machinery. Gaunt (2003) indicated that Rural Electrification is conducted with economic and social considerations mentioned in the table below:

<table>
<thead>
<tr>
<th>Table 2: Rural Electrification: economic and social considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economic considerations</strong></td>
</tr>
<tr>
<td><strong>Impacts</strong></td>
</tr>
<tr>
<td>Households with modern energy</td>
</tr>
<tr>
<td>Improved regional economy</td>
</tr>
<tr>
<td><strong>Assimilation and Change</strong></td>
</tr>
<tr>
<td>Business Development Increase economic activities</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
</tr>
<tr>
<td>Lower household energy costs New businesses, Viable utilities</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Operation and Use</strong></td>
</tr>
<tr>
<td>Appliance purchasing and use</td>
</tr>
<tr>
<td>Revenue collection Profitable utility</td>
</tr>
<tr>
<td><strong>Outputs</strong></td>
</tr>
<tr>
<td>Households and businesses connected at acceptable costs</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Activities</strong></td>
</tr>
<tr>
<td>Selective electrification based on IRR viability, Cost-reflective tariffs</td>
</tr>
<tr>
<td><strong>Inputs</strong></td>
</tr>
<tr>
<td>Investment, materials, skills, integrated development plans</td>
</tr>
</tbody>
</table>

Adapted from Gaunt, 2003

As against these claims several scholars [McCawley, 1978] question the benefit of rural electrification when each of the claimed impact is viewed separately.
Table 3: Electricity alone cannot cause development

<table>
<thead>
<tr>
<th>Expected Impact of Rural Electrification</th>
<th>Arguments against the expected impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Increase rural literacy, improve education</td>
<td>Increase schooling and adult literacy programs</td>
</tr>
<tr>
<td>2 Decrease in population growth</td>
<td>Other more efficient methods available</td>
</tr>
<tr>
<td>3 Stem rural-urban migration</td>
<td>No evidence shows that RE plays an important role</td>
</tr>
<tr>
<td>4 Irrigation</td>
<td>Depends on the physical features of the locality.</td>
</tr>
<tr>
<td>5 Stimulate rural industrialization</td>
<td>Electricity is less important to small local industries</td>
</tr>
<tr>
<td>6 Increase employment</td>
<td>Increase in productivity may risk unemployment</td>
</tr>
</tbody>
</table>

Source: McCaule 1978

Electricity and Education: The impact of electrification, if any, on the propensity of a child to stay in school indicates that RE indirectly improves the propensity of child to stay in school via increase in the mother’s knowledge and education. This might be capturing an increase in reading/studying hours due to illumination after dawn.

Health: Through media access to increased health knowledge and improved health and fertility outcomes, RE benefits the quality of health services and lowers costs by extending opening hours and significantly strengthening the cold chain for vaccines—though it does not increase the extent to which such services are offered. Electrification was also found to reduce worker absenteeism in both health clinics and schools by improving living conditions and morale. However, the cases studied are few, so further analysis is required.

Benefits of Rural Electrification: Education, Health, Status, and Income: The household users had quickly taken advantage of grid connection. Each had on average two lights per room. Refrigerator, TV, and radio ownership rates varied between 1 for every 2 households and 1 per household, and some households owned satellite dishes (nationally, 72% of Tunisian households owned refrigerators as of 1994, and 92% had televisions, of which 70% were colour). The beneficiaries were well aware of the benefits that rural electrification could bring.

Increased economic opportunities for women in the home and the village are perceived as one outcome of electrification. Electric lighting makes evening activities possible, and many girls say they prefer to stay in the village and earn a living using a sewing machine, weaving or knitting, rather than going to the city to work as maids. Sewing workshops and hairdressers (presumably a result of the increased fashion consciousness!) figure prominently among the new economic activities linked to electrification. Equipment is often donated to households through various State development programmes. Refrigeration is also valued for providing the ability to conserve food and medicines, and save money by rationalizing shopping.

Beneficiaries and health staff attributed at least part of the reduction in the birth rate in their areas to rural electrification, which increased the effectiveness of family planning and other health programmes. Clinics report being able to expand the range of their equipment and services: for example, televisions and videos are used to present programmes on public health and disease prevention in some waiting rooms; instruments can be sterilized; and vaccines for babies and anti-tetanus shots for pregnant women are more widely available. According to a nurse attached to one clinic, the availability of refrigeration for vaccines and medicines has contributed to a noticeable reduction in childhood diseases, diarrhoea and poisoning (Chaieb, 2001).

Rural Electrification and its Impact on Microenterprise and Employment Creation: While stimulation of productive enterprise is claimed to be among the benefits of electrification, few studies have tried to quantify these benefits using an impact evaluation methodology. For example, the USAID evaluation of RE in Bangladesh (Barkat and others 2002) identifies those enterprise activities that use electricity and attribute the total income from these to electrification, thus ignoring the possibility of substitution of either one activity for another or energy sources and so overestimating the benefit. The Independent Evaluation Group (IEG) (2004) analyzed three different effects considered important to achieving higher economic benefits: (i) complementary infrastructure—
such as roads, transport, markets, bank, and adult literacy; (ii) stock of equipment and tools of microenterprises; and (iii) hours of operation. The empirical evidence relating to each of these points is discussed in the following sections.

Are complementary infrastructures—such as roads, transport, markets, bank—and adult literacy more likely in electrified communities?

Complementary infrastructure such as roads, transport, markets, buildings, equipment, and training and information—often not provided in tandem with electricity—are important to achieve economic benefits from electrification (Cecelski 2004). IEG (2004) examined two issues: First, is general infrastructure, such as roads for access to markets, available in electrified communities? Second, are business-specific services more available? The first question is clearly a matter of correlation communities in percentage of households operating a microenterprise as their primary or secondary occupation. Below are his findings on the same: Significant differences in access to road, transport, and even market between electrified and non electrified communities are not surprising. The economics of extending the grid to rural areas is least prohibitive for communities closer to a road. Thus, communities closer to a road are likely to be electrified first, and other facilities and infrastructure usually expand over time.

Does electricity increase productivity/profitability through increased hours of operation and use of equipment and tools?

Electrification status of the household was significantly and positively related to equipment and earnings in Ghana, but not hours worked; it was positively related to hours worked and revenue earnings in the Philippines and to revenue earnings in Laos. In Ghana the Electrification has a small but significant impact on the revenue earnings of the microenterprise. The possible channels are increase in number of hours worked per day by the household members and use of electrical equipment (IEG, 2004).

What are the direct economic benefits from RE? Who gains these benefits? What are the indirect economic benefits (employment generation), and who gains them? How does the distribution of benefits change as coverage of electrification programs expands?

Direct economic benefits from RE occur as electricity supply lowers the cost of energy to the user, resulting in an increase in consumer surplus. Such benefits tend to favour the well-off, because connection charges and tariffs are often prohibitive for the poorest. The pattern of electrification favors the non-poor, but distribution becomes more equitable as electrification coverage expands. RE does not in general drive industrial development, but it can spur growth of home businesses. Such businesses mostly employ family labor and increase their hours once electricity becomes available. Electrification thus provides a small, but not negligible, boost to the incomes of some households. However, the evidence base on this point remains thin (Dinkelman, 2010).

Electricity may also change work opportunities in rural areas, by stimulating the growth of new firms that create jobs outside the home. Quite apart from this, electricity may directly create jobs within households by enabling the production of new goods and services for the market: for example, food preparation and storage for larger groups becomes easier; operating small appliances to provide market services becomes feasible (e.g. hairdressers, cell phone charging stations, local craft production). In this way, household electrification could unleash previously unrealized demand for labor and an increase in market work, even without the growth of firms.

From this analysis, it may be concluded that availability of modern energy services, particularly electricity, has had only a modest impact on creation of small industries. Foley (1990), cited in Rogerson (1997), observes the increased economic activities and higher living standards due to arrival of electricity in certain areas. Therefore, it can be concluded that electricity service is among the factors needed in influencing the decisions of local entrepreneurs to invest in a variety of productive enterprise. However, due to lack of reliable information about impact of electricity services on MEs development, many local entrepreneurs have little use of electricity services for production. The supply of electricity in rural areas can have negative impacts on some people, particularly to the most vulnerable people who may be displaced; for them there may be no alternative source of livelihoods Meadows, K. et al., (2003).

Data Analysis And Results

Descriptions of Study Area and Sample Respondents

This study takes five tabias from Kilte Awlaelo in Eastern zone of Tigray and Enderta woreda in South Eastern zone of Tigray. The names of the tabias and the corresponding villages taken are given as follows. From these villages the study takes a total of 150 households of whom 42 are female headed while the remaining 108 are male headed households. In terms of access to electricity 60 have electricity connection while the remaining 88 are without access to electricity.

The breakdown of villages according to their respective tabia and woreda is given by the following table.

<table>
<thead>
<tr>
<th>woreda</th>
<th>Tabia</th>
<th>Village</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kilte Awlaelo</td>
<td>Mahber woyini</td>
<td>Sheraf</td>
<td>Not electrified</td>
</tr>
<tr>
<td></td>
<td>Mesanu</td>
<td>Brki</td>
<td>Electrified</td>
</tr>
</tbody>
</table>
When we see the age structure the households in the sample the situation is given by the following table.

### Table 4.2 Age structure of Respondents

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number of Hhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-35</td>
<td>66</td>
</tr>
<tr>
<td>36-50</td>
<td>48</td>
</tr>
<tr>
<td>51-65</td>
<td>27</td>
</tr>
<tr>
<td>&gt; 65</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>149</strong></td>
</tr>
</tbody>
</table>

Source own survey 2012

The above table clearly shows that the respondent households are predominantly young headed households.

When it comes to the levels of schooling of household heads the result of this survey is given in the following table. The table shows that predominantly the households are headed by illiterate households.

### Table 4.3 Levels of schooling of household heads

<table>
<thead>
<tr>
<th>Schooling</th>
<th>Number of Hhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>85</td>
</tr>
</tbody>
</table>

Effect of Electricity on Household Welfare; This study takes the levels of household income and consumption spending as proxies of the levels of household welfare. So first what we do is we present the levels of means household income and consumption spending in each village. This is done in the following table.

The above table shows that Ashegoda has the highest level of income while the lowest income is that of Romanat. Therefore, if we were to judge wellbeing just by income we would say Ashegoda is relatively well-off while Romanat is the poorest. But since the literature sufficiently shows that income is not a good measure of wellbeing we also wanted to see the levels of consumption spending. Interestingly what we find is that Romanat has the highest level of consumption while Ashegoda has the second lowest (after Sherafo) – also note that mean income in Sherafoos the second largest. The next thing we do is try to see whether the levels of income and consumption spending are affected by electricity access or not. The result of this endeavour is given by the following table.

### Table 4.4 Electricity and Household Welfare

<table>
<thead>
<tr>
<th>Access</th>
<th>Number</th>
<th>Mean consumption Spending</th>
<th>Mean Food Spending</th>
<th>Mean non Food Spending</th>
<th>Mean Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>With access</td>
<td>60</td>
<td>5024.65</td>
<td>1058.25</td>
<td>3949.73</td>
<td>5177.8</td>
</tr>
<tr>
<td>Without</td>
<td>88</td>
<td>3600.6</td>
<td>817.0</td>
<td>2777.46</td>
<td>11081.10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>148</strong></td>
<td><strong>5024.65</strong></td>
<td><strong>1058.25</strong></td>
<td><strong>3949.73</strong></td>
<td><strong>5177.8</strong></td>
</tr>
</tbody>
</table>

Source own survey 2012 (t tests are given in appendix)

The results as summarized in the above table show that the effect of electricity on consumption spending is positive and quite large. The same story holds when we break down the consumption spending in to food and non food. But in relation to income we see that the effect appears to be counter to expectation. This can be explained by the possibility of a significant difference in terms of other factors like having irrigation and fertile land that affect the level of income in a significant manner.

At last we also tried to see the effect of electricity on level of education which in its own right can be taken as a component of wellbeing and a determinant of it also. The result is given in the following table.

### Table 4.5 Electricity and Level of Schooling

<table>
<thead>
<tr>
<th>Access</th>
<th>Number of HHs</th>
<th>Mean Level of schooling</th>
</tr>
</thead>
</table>
With electricity  & 60 & 3.28 
Without electricity & 88 & 1.11 
Total & 148 & 

Source own survey 2012 (t tests are given in appendix)

The above result shows that having access to electricity has a visible effect on the level of schooling. This holds good since electricity enables households to have more spare time as some of the labour demanding works can be simplified with electricity. Not only that but also having access to electricity may lead to good access to information which will influence their decision on whether to go to school positively.

Impact of Electricity on Poverty: In order to see how electricity impacts up on poverty we estimated a regression of determinants of poverty on the probability of becoming non poor. We take the one dollar per day measure of poverty as a basis to classify households in to poor and non poor. In this study we gathered income and spending data of households for three consecutive months of the year 2012. So using this data we find that the poverty line will be $900 of income for the three months. Taking an exchange rate of 18 Birr for one dollar we find that the poverty line is 16,200 Birr of income for the three months.

Table 4.6 Households by Poverty Status

<table>
<thead>
<tr>
<th>Poverty status</th>
<th>Mean income in ETB</th>
<th>Number of HHs</th>
<th>% of HHs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non poor</td>
<td>22468.4</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>poor</td>
<td>5264.3</td>
<td>120</td>
<td>75</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>150</td>
<td>100</td>
</tr>
</tbody>
</table>

Source own survey 2012 (t tests are given in appendix)

The above result shows that the poor section of the sample is very large (75%) while the non poor section is quite small. What is surprising is the difference in mean income that we found. The non poor section of the sample are found to have a mean income which is more than four times (426.8%) that of the poor ones.

Table 4.7 Regression of Income Poverty on Determinants (Description of Variables)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>incomepov</td>
<td>The probability of becoming non poor based on income</td>
<td>Dummy=1 non poor =0 poor</td>
</tr>
<tr>
<td>mardumy</td>
<td>Marriage status of HH head</td>
<td>Dummy=1 married =0 otherwise</td>
</tr>
<tr>
<td>sexofhh</td>
<td>Sex of HH head</td>
<td>Dummy=1 male headed =0 otherwise</td>
</tr>
<tr>
<td>ageofhh</td>
<td>Age of HH head</td>
<td>continuous</td>
</tr>
<tr>
<td>walkdistps</td>
<td>Distance to the nearest primary school as measured by walking minutes</td>
<td>continuous</td>
</tr>
<tr>
<td>fertilizer</td>
<td>Use of fertilizer</td>
<td>Dummy=1 users =0 non users</td>
</tr>
<tr>
<td>Loanfreque-y</td>
<td>Frequency of loan taking</td>
<td>continuous</td>
</tr>
<tr>
<td>loan</td>
<td>Taking of loan</td>
<td>Dummy=1 took loan =0 did not take loan</td>
</tr>
<tr>
<td>Equib</td>
<td>Equib membership of HH head</td>
<td>Dummy =1 member =0 non member</td>
</tr>
<tr>
<td>Edir</td>
<td>Edir membership of HH head</td>
<td>Dummy =1 member =0 non member</td>
</tr>
<tr>
<td>Outputmktd-s</td>
<td>Distance of output market as measured by walking minutes</td>
<td>continuous</td>
</tr>
</tbody>
</table>
As stated before income poverty is regressed on the above stated variables and the result we find is given as follows. The above result shows that electricity access has a positive and significant effect on the probability of becoming non poor which approves the hypothesis we had in chapter one. The other variable with a significant on the outcome variable in this regression is found to be fertilizer use but the negative sign of the coefficient is a freak result since based on theory we expect it to have a positive effect. All the other variables included are found to be insignificant.

Next to this we want to see whether the effect of electricity access on poverty is coming through its direct effect on income and consumption or indirectly through household asset creation and level of schooling. To see this first we regressed totalhhinc-e (household income) on electricity access and other determinant variables and found the following result.

The result we find is contrary to our expectation since it has a negative sign with a 5% level of significance. In a similar fashion with the above regression result the other statistically significant variable affecting income is found to be fertilizer use but now with the theoretically correct positive sign.

In order to see the other channels through which electricity may affect poverty we regressed consumption spending, level of schooling and household asset creation on a set of respective determinant variables including electricity as one determinant in each of them. First we present that consumption spending. The above result shows that con spend which is consumption spending to be affected positively by electricity access while the other variables found to have a significant effect is edir membership only.

Regarding the effect of electricity access on education as represented by years of schooling we regressed years of schooling on a set of determinant variables including electricity access and the result we found is given by the following table.

The above result shows that electricity access has both a positive and statistically significant effect on level of schooling. The other variable found to be significant is age and it has the correct sign.

The last we want to see is the impact of electricity access on household asset creation. To get this we regressed households asset value on a set of determinant variables electricity access included and find the following result.

**Impact of Electricity on Household Asset Creation:** Here again we find that electricity access has both a positive and statistically significant effect on asset creation. We also find participation in safety net programs to have a statistically significant but negative effect on household asset value.

**Concluding Remarks**

a) This study has shown that the effect of electricity on reduction of poverty is positive and significant.

b) The effect is also found to have come through increased consumption spending which means there is an improvement in wellbeing and also through increased asset creation and years of schooling which show that the impact is not one shot rather kind of sustainable.

c) Therefore, the commitment of the government to connect rural villages to the national grid and also enable them to have access to electricity using various means like solar energy should continue vigorously since it is having the desired impact.

d) The impact electricity access on household income is found to be insignificant and also having the theoretically wrong sign.

In addition to this some other theoretically important variables are found to be having the wrong sign or became insignificant or both. This shows that there is a need to carry out further research on this topic so that there can be a firm ground to enhance the gains from electricity expansion.

**References**


[18] Oona Nanka, Bruce. 2010. Socio economic Drivers of Rural Electrification in Sub-Saharan Africa Energy Economics Centre (SEEC), University of Surrey


