Beyond Electricity Access:

Output-Based Aid and Rural Electrification in Ethiopia

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The study was funded by GPOBA, a partnership of donors working together to support output-based aid (OBA) approaches. GPOBA was established in 2003 by the United Kingdom's Department for International Development (DFID) as a multi-donor trust fund administered by the World Bank. Since 2003, four additional donors have joined the partnership: International Finance Corporation (IFC), Dutch Directorate General for International Cooperation (DGIS), Australian Department for Foreign Affairs and Trade (DFAT), and Swedish International Development Agency (Sida).

GPOBA's mandate is to fund, design, demonstrate, and document OBA approaches to improve the delivery of basic services to the poor in developing countries. Its primary objective is to mainstream OBA approaches within projects carried out by other development practitioners, including developing country governments, international financial institutions, bilateral donors, and private foundations. To date, OBA approaches have been tested in every developing region and applied in the following sectors: energy, water and sanitation, health, solid waste management, education, and information and communication technology. OBA projects have taken diverse approaches, each featuring a unique design and financial model, incorporating lessons from international experience. Pilots have been implemented in urban, peri-urban, and rural areas, employing public and private operators, public-private partnerships, nongovernmental organizations, and community organizations as implementing agencies and service providers. As of September 2014, GPOBA's portfolio consisted of 40 projects and US$190.7 million in commitments for subsidy funding and ongoing technical assistance activities, demonstrating that OBA can deliver a diverse range of services and lasting results for the poor.

Abbreviations and Notes

Abbreviations

BSG	Benishangul-Gumuz	LSMS	Living Standards Measurement Study
CFL	Compact Fluorescent Lamp	MFI	Microfinance Institution
EEPCo	Ethiopian Electric Power Corporation	M&V	Monitoring and Verification
FGD	Focus Group Discussion	OBA	Output-Based Aid
GNI	Gross National Income	PPP	Purchasing Power Parity
GNP	Gross National Product	PV	Photovoltaic
GoE	Government of Ethiopia	RBF	Results-Based Financing
GPOBA	Global Partnership on Output-Based Aid	SHS	Solar Home System
IAP	Indoor Air Pollution	SNNPR	South Nations, Nationalities, and People's Region
LED	Light Emitting Diode	TVET	Technical Vocational Education and Training

Units of Measure

ha	hectare	m	meter
km^2	square kilometer	ml	milliliter
kW	kilowatt	V	volt
kWh	kilowatt-hour	W	watt

Notes

Dollar figures are for 2013, using an exchange rate of 19 Ethiopian Birr (ETB) to 1 US$.

Executive Summary

In many countries of Sub-Saharan Africa, the unfortunate reality is that a high percentage of households cannot afford the electricity connection costs charged by the utility company. Among developing regions, Sub-Saharan Africa accounts for nearly 45 percent of people without electricity (table ES.1). The majority of those without electricity reside in rural areas. Surprisingly, only 1 in 8 people in rural Africa has electricity. In the case of Ethiopia, only 10 percent of rural areas had electricity service in 2014, while the overall electrification rate had reached just 23 percent, meaning that 70 million people in that country were still without power. This remains true even 20 years after publication of the forward-looking policy book, *Rural Energy and Development* (World Bank 1996). It also continues despite the call today by the United Nations and other donor organizations for sustainable energy for all (UN 2011).

Table ES.1 Electricity Access in Developing Regions, 1970–2010

	Population without electricity (millions)	Electrification rate (%)			
Region	2010	Overall 2010	Urban 2010	Rural 2010	Rural 1970
Africa	587	42	69	25	4
North Africa	2	99	100	98	n.a.
Sub-Saharan Africa	585	31	60	14	n.a.
Asia	675	81	94	73	n.a.
China and East Asia	182	91	96	86	20
South Asia	493	69	90	60	12
Latin America	31	93	99	74	23
Middle East	21	89	99	72	n.a.
Developing countries	1,314	75	91	63	12
World[a]	1,317	81	94	68	n.a.

Sources: IEA 2011, 2014; Barnes 2014.
Note: For 1970 figures, Africa refers to Sub-Saharan Africa and China and East Asia refers to China; for China and East Asia and South Asia, 1970 figures are estimated since they were reported together as 15 percent. n.a. indicates data was not available.
a. World includes Organisation for Economic Co-operation and Development (OECD) countries and Eastern Europe/Eurasia.

The electricity connection costs in Sub-Saharan Africa are high compared to the rest of the world (Golumbeanu and Barnes 2013); thus, only providing access to electricity may not be enough to assure high rates of rural electrification. It is also necessary to assist poor households with the cost of adopting an electricity connection. In the past decade, some countries have initiated programs to lower connection costs, making electricity affordable to even their poorest populations. The implication is that the utility companies must begin to think beyond access.

In Ethiopia, an output-based aid (OBA) project was designed to do just that. The idea behind the program was to increase the affordability of connection costs for poor rural consumers so that greater numbers of people within reach of the electricity lines could partake of the many benefits of rural electrification.

The Output-Based Aid Approach in Ethiopia

Under the Universal Electricity Access Program, launched in 2005, the Government of Ethiopia (GoE) already had a goal of increasing the rate of household electricity adoption in rural towns and villages that already had service. In 2007, the World Bank–funded Electricity Access Rural Expansion Project (Phase 2) was initiated to assist the GoE in developing a sustainable program for expanding electricity access in rural communities (World Bank 2013a). As part of the World Bank project, the GoE agreed to allow customers to pay for the electricity connection fee over time, thus making electricity adoption more affordable for rural populations. This component of the project would be financed as part of a Global Partnership on Output-Based Aid (GPOBA) grant, in the amount of US$8 million. The GPOBA grant augmented the World Bank project by helping the Ethiopian Electric Power Corporation (EEPCo), the country's vertically integrated power utility, to finance connection fees by subsidizing the interest rates on loans to poor customers. The GPOBA grant provided 43,000 poor rural households (some 215,000 people) formal connections to grid-based electricity, representing 75 percent of the country's total connections during 2011–13.

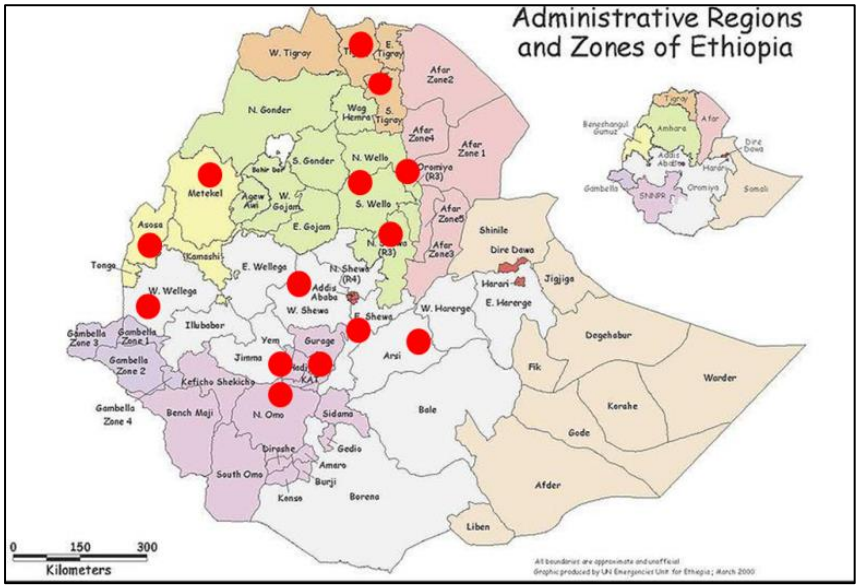
The US$75 connection charge levied by EEPCo is quite reasonably priced for Ethiopia's middle-class households, representing slightly more than 3 percent of annual family income (averaging $470 per capita), but places a strain on the budgets of poor rural households. To make connection fees affordable, GPOBA-participant households were required to make a down payment of just $15 or 20 percent of the $75 connection fee. The remaining $60 balance would be paid in small installments (about $1 per month) over five years. EEPCo, in turn, would receive a subsidy of $35 per household from GPOBA to cover the interest rates of financing the connection charges. In addition, each participating household would receive two free compact fluorescent lamps (CFLs) so that monthly electricity bills would be more affordable for poor households.

The GPOBA financing scheme was made available about 18 months after the community first received electricity service to prevent subsidizing wealthy households that could afford to pay

the upfront fees. It was assumed that those who could afford electricity would pay the full US$75 immediately, and thus the delayed introduction of GPOBA subsidies would be better targeted to poor households. The approach appears to have worked. Many households without electricity had the opportunity to gain access to service under the GPOBA financing scheme. Many of the poorest households got indirect connections once the access programs reached their village.

As part of the GPOBA program, a monitoring and verification (M&V) survey was conducted to assess the impact of the intervention on households in rural Ethiopia. This impact evaluation study is one of only a few rigorous attempts to understand the outcome of rural electrification in Sub-Saharan Africa. The GPOBA program covers five diverse regions spread throughout the country: Oromia; Amhara; Tigray; Benishangul-Gumuz (BSG); and South Nations, Nationalities, and People's Region (SNNPR) (map ES.1).

Map ES.1 Ethiopia GPOBA Program Areas



Source: INTEGRATION Environment & Energy and MEGEN Power Ltd 2014.
Note: Red dots indicate GPOBA program areas included in the survey sample.

The household samples were taken from regions with high concentrations of GPOBA-connected households, which extended from central Ethiopia north toward the border with Eritrea and west toward Sudan. These regions comprise many of the country's most highly populated areas where rural electrification programs will be most active in the coming years.

Impact of GPOBA Intervention on Connection Rates

The aim of the GPOBA program was to assist in accelerating the pace of household electricity connections, thereby increasing the effectiveness of village and town electrification. In this regard,

the project was quite successful. By 2013, for all surveyed villages and towns in the five study regions, the overall share of GPOBA households among households with electricity had reached nearly 42 percent (table ES.2). However, this overall penetration rate does not reflect the large differences in regional penetration rates, ranging from 9.3 percent for the surveyed villages and towns in Amhara to 69.5 percent for those in Oromia. That said, the GPOBA project succeeded in accelerating household adoption of electricity in the five study regions.

Table ES.2 Share of GPOBA Households among Households with Electricity in the Study Regions

Region	Share of GPOBA connections (%)
Oromia	69.5
Amhara	9.3
SNNPR	36.9
Tigray	58.5
BSG	38.8
Overall share of GPOBA households	41.8

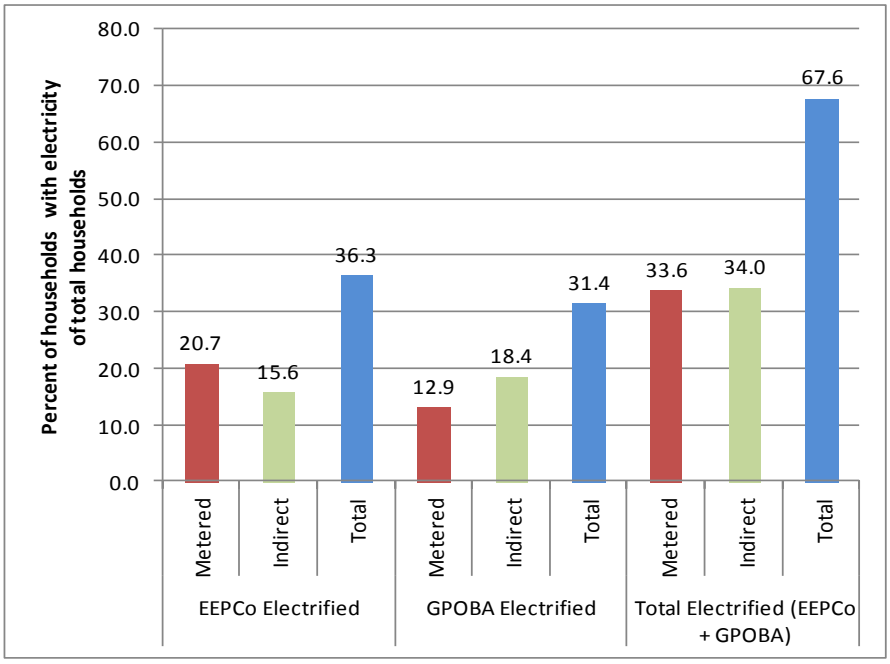
Source: Ethiopia Impact Evaluation Survey 2014.
Note: These percentages are GPOBA connections as a share of total new EEPCo connections in the respective regions.

Many of the new households with electricity had indirect household connections. Households indirectly connected to the electricity grid adopted electricity by stringing lines to their neighbors' houses and paying them fixed charges based on their number of appliances. The high number of new indirect household connections can be directly attributed to the expansion of service to the villages and towns covered under the GPOBA program. Indirectly connecting to electricity through households with a formal meter was attractive for a variety of reasons. Some households had lost hope of being able to obtain a direct connection serviced by EEPCo, and thus turned to getting electricity from next door. Despite the problems encountered (e.g., dangerous wiring to their homes), this meant that many of the poorest households could get immediate service by using a neighbor's legal (metered) connection. They avoided the long process and formal requirements of obtaining a meter from EEPCo. Some survey respondents mentioned that, as applicants for obtaining a metered connection, they had to show a land ownership certificate to EEPCo. Households with indirect connections avoided such delays. Moreover, EEPCo's regulations do not allow electricity connections for non-concrete houses due to safety reasons. For those families living in households made of substandard materials—usually the poorest customers in the villages and towns—taking an indirect connection was their only available option and thus these households benefited the most from indirect electricity connections.

It should be noted that taking an indirect connection was not a matter of reducing monthly electricity costs. Generally, such households paid higher prices through fixed charges for lights

and appliances, highlighting their willingness to pay for electricity. However, they avoided administrative delays and having to pay the upfront fees to initiate service.

Figure ES.1 Metered and Indirect EEPCo and GPOBA Household Connections, 2014



Source: Ethiopia Impact Evaluation Survey 2014.

The number of households connected directly to an EEPCo meter was actually lower than that of those obtaining electricity indirectly from other households. The metered connection rate for all households was just over one-third of households, which was quite similar to the rate of indirect connections. The total cumulative direct and indirect connections for a village averaged more than 67 percent (figure ES.1), meaning that the effective number of rural electrification connections was more than double the numbers reported by EEPCo.

Despite some positive features of indirect household connections, there were also drawbacks. The main ones were poor technical household installations, dangerous wiring, and an uncontrolled number of indirect connections to a single meter. In one case, 12 households were indirectly connected to a single household with a metered connection. In another, the wires connecting the households were hanging dangerously low. Poles that could be easily toppled carried wires from one house to another. Thus, even though the indirect connections were convenient, many were based on poor installation practices. Also, even slight delays in bill payment could sometimes lead to an arbitrary cutoff of service.[1]

[1] The World Bank has engaged in dialogue with the utility on technical solutions to regularize indirect connections.

Household Energy Use and Impact of Electricity

Electricity is a necessary but insufficient condition for development. The benefits of rural electrification invariably result from the use of some type of appliance or machinery. Thus, it is necessary to trace the pathways of electricity and its eventual social and economic impacts. For example, electricity provides improved household lighting (Nieuwenhout et al. 1998), which immediately increases children's study hours (Barakat et al. 2002; World Bank 2002; Unnayan Shamannay 1996); this, in turn, improves school attendance and higher educational attainment for children. Community or street lighting provides higher levels of community illumination during evening hours, but the real benefit is a greater sense of security.

The successful adoption of grid electricity first means having access to a reliable and inexpensive electricity supply. Consumers then begin purchasing a variety of electric appliances, such as light bulbs, radios, television sets, space coolers/heaters, cooking devices, and other small machines. The next step is that these appliances produce results (e.g., more light, allowing for longer study hours or increased home production; greater access to information and entertainment; more comfort; better food preservation; more efficient cooking; and more motive power for productive uses (World Bank 2002; IEG 2008). At times households use small cooking devices, such as hotplates or electric coils, for heating water. In the case of Ethiopia, people sometimes cook with the electric *injera mitad* (essentially a round hot plate for cooking traditional breads). In some instances, electric lighting and small grinders allow people to prepare food more efficiently, thereby freeing up time for other activities (World Bank 2004).

Changes in Appliance Use

The use of appliances can result in intermediate outputs (e.g., extended study time, longer hours of operation for home businesses, better business knowledge, and more efficient business operation). These intermediate outputs can lead to such final development outcomes as improved education, better health, and higher income. Taking the education benefit as an example of this process, one finds that increased study time due to electric lighting can likely result in better school performance. In the long run, this leads to higher educational attainment and ultimately higher income. A fairly large body of literature, beginning with Mincer (1974), discusses the returns to education. Similarly, many studies have focused on the productive uses of electricity. The main findings of such studies are that complementary conditions, such as active markets and available credit, are needed in order to realize the full benefits of rural electrification (Cabraal, Barnes, and Agarwal 2005; Asaduzzaman, Barnes, and Khandker 2009).

Electricity offers households new opportunities, including improved quality of household lighting, enhanced flow of information, and better communication opportunities. Households purchase new appliances so that they may realize such benefits. The availability of electricity enables households to purchase a wide array of appliances. Of course, they will be limited by their income; however, even the poorest households value the purchase of new appliances.

In the Ethiopia study, most households have not had electricity for long. The GPOBA households have had electricity for only one or two years. Even the EEPCo households have not had electricity for much longer. It is well established that households accumulate new appliances over the years. After expending income to purchase appliances in a first wave, they will save money and plan for later purchases. Thus, the results of this survey are a snapshot of this first round of purchasing household appliances.

The use of household energy for lighting, cooking, and communication has already been examined. The question is which electric appliances produce such better outcomes (table ES.3). We know that 100 percent of households with electricity have incandescent lamps or CFLs. The GPOBA program stressed the use of CFLs by providing households two free lamps when they adopted a GPOBA connection. Despite logistical problems in providing these lamps under the program, more than half of GPOBA households had CFLs. A surprising finding was that 47 percent of EEPCo-connected households also had this type of lamp. The incandescent lamps were still quite popular because they stayed lit even with voltage drops. Perhaps due to the significant voltage fluctuations in the service areas, both EEPCo and GPOBA households had a high level of incandescent lamps. Only a small number of households without grid electricity had electric lamps since these households had to use either batteries or solar home systems (SHSs) for lighting.

Many households with electricity appreciate the impact that rural electrification has on communications. Mobile phones are found in about three-quarters of rural households that have electricity and in just less than one-fifth of households without electricity. Households without electricity often charge their phones at charging stations or in a neighbor's home. Radios and cassette players are also popular in homes with electricity. Nearly half of homes with electricity have plug-in radios, compared to one-quarter for homes without electricity. No doubt, those without electricity use expensive batteries to power radios. Even after a short period of having electricity, about one-third of households purchase a television set. This surprising finding attests to the popularity of television for obtaining news and entertainment. Very few households without electricity have television sets.

Table ES.3 Electric Appliances of Households in Rural Ethiopia, 2014

Type of appliance	EEPCo households (%)	GPOBA households (%)	Households without electricity (%)	Nearby village without electricity (%)
Lighting				
Incandescent lamps	69	74	5	0
CFLs	57	48	0	0
Communication				
Mobile phones	73	70	18	15
Radios or cassette players	46	45	24	18
Televisions	33	28	1	0
Other appliances				
Refrigerators	6	3	0	0
Hair dryer or clippers	1	1	0	0
Water boiling kettles	1	0	0	0
Injera mitad	5	4	0	0
Space heaters	2	1	0	0
Total households = 760	224	265	211	60

Source: Ethiopia Impact Evaluation Survey 2014.
Note: Households without electricity are in villages with electricity. Some households in this category have electricity from other sources, such as batteries or PV solar home systems (SHSs). Communication equipment can be run on batteries.

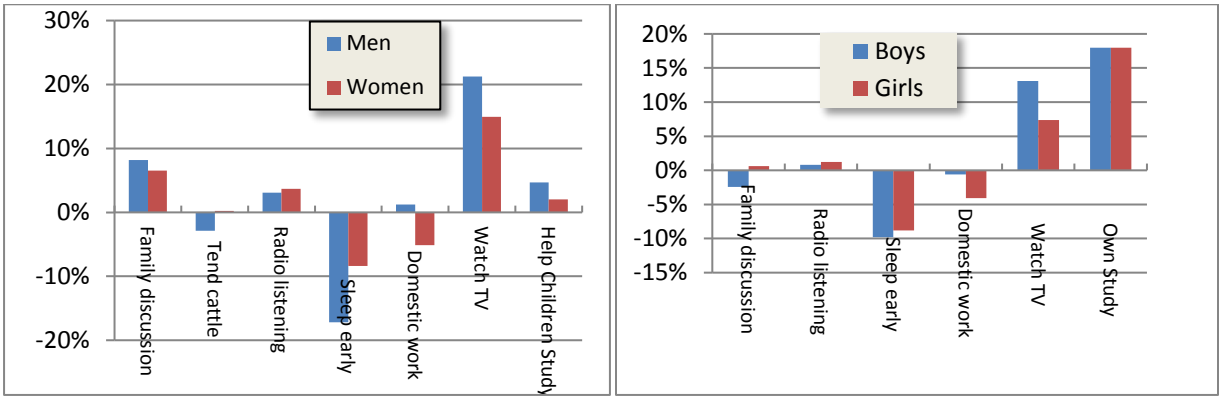
Most other appliances have not yet been purchased, owing to the short time that the surveyed households have had electricity. The most surprising appliance purchase was the electric *injera mitad*—a hotplate for cooking traditional Ethiopian flatbread—which is used by nearly 5 percent of rural households with electricity. Costing about US$100, this hotplate draws quite a bit of power. A similar number of refrigerators have been bought. The purchase of these two appliances could have a profound effect on rural household cooking practices.

Changes in Living Patterns

With better lighting, communication, and entertainment, family members no doubt change their time-use patterns, especially during the evening hours. In the survey, questions were asked about the two main activities of household members before and after adopting electricity. These questions were asked of men, women, boys, and girls in the households. Although households were likely to do more than two things in an evening, focusing on the two main activities uncovered some patterns of social change resulting from the rural electrification project.

In households without electricity, the main activities of men involved discussions with family members and tending to cattle; more than one-quarter indicated that they went to sleep early in the evening (figure ES.2). But this living pattern changed once electricity was adopted. After obtaining electricity, men still tended cattle. However, because they did not have to go to sleep early, they had time for other activities. The main change was the increase in television viewing, from almost zero before electrification to about one-quarter after adopting service—about the same number as those owning a television set. No doubt, more households will be viewing television in the future as sets become more common in villages and towns with electricity. Perhaps due to the availability of better lighting, men's family discussion time increased significantly. Also, men tended to listen to the radio a bit more than they did prior to having electricity.

Figure ES.2 Top Main Evening Activities Before and After Electricity, 2014



Source: Ethiopia Impact Evaluation Survey 2014.
Note: The question asked only for the top two main activities of households before and after electrification. The figures are the main activities (% responses after electricity minus before electricity). The % figures are only for households with electricity answering the question; the others were treated as missing values.

The main activities of women before having electricity differed quite a bit from those of men. Interestingly, however, the changes due to adopting electricity were quite similar. Overall, women's main activity was domestic work, including cooking. After adopting electricity, women did not go to sleep as early as before, and they did less domestic housework, which freed up time used for activities that were quite similar to those of men. More women in households that adopted electricity watched television and participated in family discussions. Thus, the main change for men and women in rural households that adopted electricity related to communication. Light allowed households to stay up longer and participate in family discussions. For those households with televisions, nearly all men and women watched it as a main activity in the evening.

The living patterns of children in homes without electricity differed from those of adult household members. The main difference was that, before electricity, children studied after dark by the dim light of kerosene lanterns. Between one-quarter and one-third of children in households

without electricity studied in the evening. Otherwise, they participated in family discussions and went to sleep early.

Once a household adopted electricity, children's evening study time (both boys and girls) increased by about 15–20 percent, reaching well over half of all households with electricity. More boys and girls watched television in the evening, but the figure was only about 10 percent, compared to over 20 percent for adults. Thus, television viewing does not appear to substitute for study time. The number of boys and girls that went to sleep early declined significantly for those living in households that adopted electricity. For girls, the increase in study time may also be attributed to a decline in doing domestic chores during evening hours.

Television viewing offers useful information that can enhance the productivity of inputs used in household production, leading to increased income. Family members gain knowledge and awareness of events and activities that are socially beneficial. Furthermore, according to the focus group discussions (FGDs), women gain awareness of reproductive health issues, which can empower them in household decision-making. Such changes are expected to contribute to the improved welfare of all household members. FGD participants also wondered whether electricity would bring new services to their community, including the opening of business establishments.

Impact on Businesses and Public Institutions

Rural electrification is not just important for rural households; it is also essential for business development. This study finds that the benefits of electricity are quite pervasive for household businesses, private companies, and public institutions. As a result of having electricity, households engage in home production and sometimes even add on to their homes to sell groceries or other retail goods. Existing small businesses immediately adopt electricity, which permits them to stay open for longer hours and display their goods in an attractive manner. Some even buy additional appliances, such as refrigerators and cooking devices, to better serve their customers. Businesses are also established because of new opportunities created by the availability of electricity in villages and towns. Generally small in scale, rural businesses provide a wider range of community services and generate income for their owners.

Many public institutions have adopted electricity to improve their services for the community. Unfortunately, about half of them cannot afford electricity for lack of a budget to cover the expense. This issue might be addressed by local governments as they gain more experience with having electricity in their towns and villages. Summing up, electricity not only has significant social impacts for households; it also plays an important role in the economic development of communities.

Recommended Policies and Way Forward

One paradox of rural electrification is that high rates of electricity adoption, along with good pricing policies, are necessary to make programs financially sustainable for the utilities over the long term. For subsidies, a general rule of thumb is to have cost-covering fees that are fair to both customers and the electric utility company and to provide financial assistance to new customers desiring to adopt electricity through either loans or subsidies on household connection costs. Lowering the upfront costs of connection will free up cash for customers to purchase appliances, which means a higher level of household benefits from electrification and a better revenue stream for the utility company due to greater electricity use.

It follows that high adoption rates result in better prospects for the financial viability of the electric utility companies. The converse also holds true. Programs with low initial rates of adoption and thus lower revenue streams for the utility companies—like many of those found in Sub-Saharan Africa—make it more difficult for the utility companies to maintain electricity lines and provide quality service. Thus, it is in the financial interest of the utility companies to strive for high electricity adoption rates and encourage the purchase of appliances by rural households.

In Ethiopia, the rural electrification program is still in its initial stages. This study's surveys identified the following key policy areas for encouraging greater adoption of electricity and improving the country's overall rural electrification program.

- *Raise the overall price of electricity to reflect the cost of service after taking into account any capital cost subsidies for extending service to rural areas.* Having subsidies for new connections is a good policy, but Ethiopia's extremely low electricity price makes it difficult for the utility to recover its costs, thus causing problems for rural electrification as a business. Since poor households do not represent a significant revenue stream for the service provider, it is crucial that the design of OBA schemes ensure sufficient incentives for utilities to reach low-income households.

- *Have simple and effective mechanisms for targeting the poor.* In this GPOBA program, targeting was achieved by combining geographic criteria with self-selection methods. The targeting was consistent with the Ethiopian government's policy of providing equity and broad geographical coverage for its rural electrification access program.

- *Facilitate house wiring in both standard and substandard housing*. One major issue identified in this study was EEPCo's policy of connecting only those homes made of concrete, which frustrated many poorer households who were ineligible for electricity service. They, in turn, decided to string wires to a neighboring house with a legitimate meter. Most of the problems involving indirect household connections could be avoided

by developing standard waterproof ready boards for installation in houses constructed of substandard materials.

- *Officially connect households with indirect electricity connections*. Ethiopia's electrification rates could be higher if more attention were paid to finding ways to service poor households. Switching from indirect to officially metered connections would mean lower electricity prices for such households; in turn, they would consume and pay for more electricity, which might help to improve the utility's financial condition.

- *Provide credit, encourage appliance adoption, and promote intersectoral synergies*. Given the expense of putting up poles and transformers and stringing wires, the investment could be optimized by implementing complementary programs that encourage greater use of electricity. This might include ensuring that electric appliances are available for local purchase. Also, many of the world's most successful rural electrification programs have included close cooperation between ministries and agencies that provide other types of development assistance, including education, agriculture, and rural development. Promoting such intersectoral synergies would not only improve the impact of rural electrification; it would also increase the financial benefits for EEPCo due to higher levels of electricity use.

- *Focus on women-headed households*. In most countries, women-headed households are generally among their poorest groups. In the five rural regions of Ethiopia covered by this study, women-headed households comprised just over 15 percent of the population. These households often cannot afford the upfront costs of electricity; at the same time, they are quite responsible about paying their bills. The connection subsidy program should attempt to identify and support women-headed households for program participation. In Ethiopia, the results of a gender-focused GPOBA program could be integrated into the utility's standard operating procedures.

- *Make meters more readily available to prevent delays in providing customers with service.* The survey found that a shortage of electricity meters had led to delays in signing up new customers. This issue could be easily resolved by diversifying the sourcing of meter supplies and allowing them to be imported. Inexpensive and reliable meters are readily available from other countries.

- *Decentralize and lower the cost of bill collection.* Generally, the best practice is to have the electricity company develop low-cost ways to collect bills. This might include making payments possible at local banks or public institutions or through local contacts in the community (e.g., village leaders) or money transfer using mobile phones. Other more technical options might include the use of load limiters or prepaid meters.

- *Provide better-quality CFLs or other, more efficient lighting options*. According to the survey and FGDs, the CFLs provided under the GPOBA scheme did not work well under the low-voltage conditions found in most villages and towns. Future programs need to consider alternative lighting options, including light emitting diodes (LEDs), that work under periodic low-voltage conditions.

- *Provide technical assistance and loans for businesses.* Many successful rural electrification programs encourage business development by providing new business loans and assistance in setting up businesses to take advantage of electricity. In addition, assistance could be given to promote electricity-driven appliances that would make life easier for people in rural areas. Such complementary programs would increase EEPCo's revenues and result in a greater socioeconomic impact for rural communities.

- *Connect public institutions.* This study found that only about half of the public institutions in newly electrified villages and towns adopted electricity. The connection and use of electricity by public institutions should be subsidized; however, the responsibility of subsidizing electricity should not be placed on EEPCo. Rather, the government should consider it as a normal budget cost of providing public services. The electricity used by public institutions can provide the utility a stable source of revenue for serving rural areas.

To implement these innovations, a specialized institution within the power company might be needed to deal with the challenges of rural electrification (Barnes 2007). The world's best electricity programs have set up specialized institutions, either within or outside of the main utility, to deal with the problems involved in rural electrification. They have also featured a firm government commitment to the program, along with a clear plan for system expansion that avoids political influence. In addition, most successful programs have had a high enough electrification rate that distribution companies obtain revenues by pursuing customers instead of government subsidies for system expansion. Also, many traditional distribution companies have adopted low-cost distribution methods (e.g., single phase). If geography permits, single wire earth return (SWER) systems can drastically reduce distribution costs. They also lower the initial barriers to adopting electricity and emphasize the community's early involvement in the program.

Providing electricity in rural Africa is a long-term investment, making it imperative that the electric utility companies be given appropriate incentives to serve rural areas. In rural Ethiopia, the GPOBA intervention was an important first step in focusing the state electricity company on providing service to some of the country's poorest people. But certainly this is not the last step. The future of rural electrification in Ethiopia depends on the ability of the government and EEPCo to make a serious commitment to adopting the principles of successful rural electrification programs and working together to provide electricity for all of Ethiopia's people. Mainstreaming results-based financing (RBF) in access programs is one option aimed at making connections affordable to the poor while keeping the utility accountable for quality connection service.

Even some of Ethiopia's poorest populations have demonstrated a willingness to pay for electricity service. Tackling the problems inherent in implementing the rural electrification program will not be an easy task. To address the problems it encounters in providing electricity to its rural areas, Ethiopia needs to find solutions that will not financially harm its electricity company. Once this is accomplished, the electricity provided to rural areas will have a high level of benefits for Ethiopia.

1. Beyond Access: Encouraging Household Electricity Adoption

Sub-Saharan Africa trails all other developing regions in household electricity access, accounting for nearly 45 percent of the world's people without electricity. Across the subcontinent, less than one-third of households have electricity. The rate of rural electrification is less than 15 percent, compared to about 70 percent worldwide. Even in urban areas, electricity has reached only about three-fifths of residents. By contrast, urban electrification rates exceed 90 percent in most parts of the world. Projected population growth in many countries of Sub-Saharan Africa is expected to outstrip growth in rural electrification, despite increasing percentages of rural populations with electricity. As a result, the absolute numbers of those without access to service will continue to rise, thereby widening the electricity gap (IEA 2010, 2011).

Slow Rates of Access Expansion and Household Adoption

Various factors have accounted for the slow rates of electricity access expansion and household adoption in Sub-Saharan Africa (Zomers 2001). In many countries of the region, conservative distribution utilities have persisted in traditional policies that emphasize service extension in urban areas, which are more profitable than remote and sparsely populated rural areas. In addition, power-supply shortages and network deficiencies may have weakened the utilities' incentives to pursue access. Furthermore, plans to extend electrification to rural areas have often been subjected to political pressure, which, more often than not, has prevented the utilities from charging cost-recovery tariffs. The result has been a draining of the investment capital needed to extend electricity service, leaving the utility companies in a chronically weak financial position (Zomers 2001). Moreover, poor targeting of subsidies has often allowed wealthier customers to enjoy subsidies they do not need (Komives et al. 2005; Foster and Briceño-Garmendia 2010).

In many countries of Sub-Saharan Africa, initial connection rates in villages newly added to the electrical grid are as low as 10–20 percent of possible connections, and that number increases quite slowly over time. At present, the utilities lack incentives to expand service in areas where customers cannot afford the upfront connection charges. Making things worse, low load factors result in returns on investment that are too low to justify the substantial costs of extending service. Even in urban areas, where the cost of extending service to new customers is comparatively low,

many utility companies provide service only to those households wealthy enough to cover all connection charges in full and in advance.

Although the rate of electricity access today is still low, significant progress has been made in recent decades. In 1970, 1.75 billion of the 2 billion people living in rural areas of developing countries were without electricity (World Bank 1996). During the 1970s and 1980s, that number grew to well over 2 billion, owing to population growth and meager international efforts involving rural electrification programs (Barnes 2014). In that period, incremental growth in the number of people with electricity was not even keeping pace with population growth. Finally, during the late 1980s and early 1990s, the number of rural people in developing countries without electricity started to decline, due mainly to significant programs in China, India, and Thailand. By 2010, that figure had further declined to about 1.3 billion (table 1.1).

Table 1.1 Electricity Access in Developing Regions, 1970–2010

	Population without electricity (millions)	Electrification rate (%)			
Region	2010	Overall 2010	Urban 2010	Rural 2010	Rural 1970
Africa	587	42	69	25	4
North Africa	2	99	100	98	n.a.
Sub-Saharan Africa	585	31	60	14	n.a.
Ethiopia[a]	70	23	85	10	n.a.
Asia	675	81	94	73	n.a.
China and East Asia	182	91	96	86	20
South Asia	493	69	90	60	12
Latin America	31	93	99	74	23
Middle East	21	89	99	72	n.a.
Developing countries	1,314	75	91	63	12
World[b]	1,317	81	94	68	n.a.

Sources: IEA 2011, 2014; Barnes 2014.
Notes: For 1970 figures, Africa refers to Sub-Saharan Africa and China and East Asia refers to China; for China and East Asia and South Asia, 1970 figures are estimated since they were reported together as 15 percent. n.a. indicates data was not available.
a. Figures are for 2014.
b. World includes Organisation for Economic Co-operation and Development (OECD) countries and Eastern Europe/Eurasia.

The unfortunate reality is that, in many countries of Sub-Saharan Africa—even in those communities with electricity—a high percentage of households cannot afford the upfront connection costs charged by the supply companies. The resulting low rates of rural electrification create serious obstacles to the region's development, given that electricity is a necessary condition for development (IEG 2008; World Bank 2002). The significant loss in welfare benefits ranges from opportunities for studying at home, improved communication via television and radio, and better health to the creation of new jobs and productivity gains for businesses. Because electricity access improves school attendance, deficits in access may also represent a loss in the development

of human capital (Khandker, Barnes, and Samad 2009, 2012a, 2012b). Surprisingly, only 1 in 8 people in rural Africa has electricity. This remains true even 20 years after publication of the forward-looking policy book, *Rural Energy and Development* (World Bank 1996). It also continues despite the call today by the United Nations and other donor organizations for sustainable energy for all (UN 2011).

According to 2014 data, Ethiopia has a large gap in electricity access between urban and rural areas. Most large urban areas have nearly universal electricity coverage. In large towns, 95 percent of people have electricity, compared to 83 percent of people in small towns. However, the situation differs markedly in rural areas. According to the most recent Living Standards Measurement Study (LSMS) Survey, only 9 percent of people living in truly rural areas (i.e., excluding small towns) have access to electricity. This study covered some of Ethiopia's larger regions (table 1.2).

Table 1.2 Electricity Rates in Urban and Rural Ethiopia by Connection Type, 2013

	Electricity, total (%)			Electricity, government (%)			Electricity, shared (%)		
Region	Rural	Small town	Large town	Rural	Small town	Large town	Rural	Small town	Large town
Tigray[a]	13	93	88	6	52	31	8	41	56
Afar	18	100	100	6	62	8	11	38	92
Amhara[a]	9	95	92	3	32	32	6	62	60
Oromia[a]	8	81	97	3	45	32	5	35	65
Somalie	3	60	69	1	9	15	1	51	55
BSG[a]	10	67	0	4	42	n.a.	6	25	n.a.
SNNPR[a]	10	76	98	3	35	29	7	40	69
Gambelia	4	91	100	0	73	13	3	18	87
Harari	67	n.a.	100	25	0	65	43	n.a.	35
Addis Ababa	n.a.	n.a.	95	n.a.	n.a.	60	n.a.	n.a.	36
Diredwa	24	0	100	3	n.a.	52	21	0	48
Total	9	83	95	3	39	39	6	44	55

Source: Ethiopia LSMS Survey 2013.
Notes: Some rows do not add up due to rounding; n.a. = not available.
a. Region included in the survey.

The implication is that, up until now, the country's rural electrification policies have favored urban areas. This is common for countries in the first stages of promoting electricity access because demand for electricity will be higher in urban areas and more financially rewarding for the utility companies. However, this situation hampers development and quality of life in rural areas. In response, Ethiopia has been exploring ways to promote electricity adoption in rural areas, including a pilot program of output-based aid (OBA) that would lower the upfront expenses associated with connection costs.

Thinking Beyond Access in Rural Africa

Many electricity companies in Sub-Saharan Africa are well aware of the benefits of making connection charges affordable to their customers, and some have initiated programs to lower those charges through subsidies or credit schemes (annex 1). In many countries, fully subsidized connection programs have been supported by donors.[2]

However, given the scale of the effort required to achieve universal access in Sub-Saharan Africa and the financial challenges already faced by the region's utilities, subsidies should be carefully structured to improve poor households' access to electricity without distorting energy markets (box 1.1).

Box 1.1 Criteria for Assessing Subsidy Policies

When making decisions about which groups to target for subsidies and their form, eligibility criteria, and financing, policies must be carefully assessed, using three main criteria:

· *Efficacy*. This means ensuring that the subsidy reaches those for whom it is intended—the poor, who would not otherwise have access to electricity—rather than allowing it to reach wealthier households who would connect to the grid without a subsidy.

· *Efficiency*. This refers to structuring the subsidy so that it encourages service provision at the least cost. Often energy-sector restructuring projects do not consider how to improve energy access while, at the same time, maintaining effective financial policies to support the financial viability of the utilities.

· *Cost-effectiveness.* This ensures that the subsidy achieves social goals at the lowest program cost, while providing the utilities incentives to serve poor and rural populations.

Sources: World Bank 2002; Barnes 2007; Barnes and Halpern 2000.

Some of the newer subsidy programs in such countries as Kenya, Liberia, Senegal, and Uganda have been based on results-based financing (RBF) or output-based aid (OBA),[3] meaning that subsidy payments are disbursed on the basis of pre-agreed and independently verified outputs, such as functional household connections, internal wiring or distribution of energy-efficient lamps,

[2] Full connection subsidies, like overly broad consumption subsidies, may distort the markets for electricity and, because they are limited in scope, may not be well targeted to the right populations. Political interference in selecting the villages that benefit from subsidies may foment dissent among villages that are passed over. Even within a given village, distinctions between consumers (those labeled "poor" and therefore eligible for a subsidy versus those excluded from the subsidy) can create dissension.

[3] Results-based financing (RBF) is a concept comprising a range of public policy instruments, whereby incentives, rewards, or subsidies are linked to the verified delivery of pre-defined results. OBA, one of the better-known RBF approaches, aims to make access to basic services affordable to the poor. An OBA subsidy is reimbursed to the service provider upon verification of the outputs (in this case, electricity connection).

and billing cycles (annex 1). OBA strongly emphasizes the targeting of low-income households based on various criteria, including geographic region, means-testing, or community-based evaluation (World Bank 2005).

The distribution of electricity—whether for social or productive uses—is a capital-intensive enterprise, and the cost of providing household connections can be quite high. Charging new customers one-time, upfront fees to recover service connection costs can constitute a powerful disincentive to many people who wish to obtain electricity, but cannot afford the upfront costs (Golumbeanu and Barnes 2013).

Striking the right balance between making it easier for households and small commercial enterprises to gain access to grid electricity and ensuring the financial health of the distribution companies is a challenge (Maurer and Nonay 2009). But it has been proven that careful planning to expand electricity access can be aligned with ensuring the utilities' financial sustainability and operational efficiency (Barnes 2007; World Bank 2010a; AEI 2012). In most countries of Sub-Saharan Africa, this goal is achievable, but key policy issues must be addressed.

Broadly speaking, tariffs must be high enough to allow the utilities to recover their costs and finance new investment, but not so high as to frustrate demand and deny access to poor households that consume small amounts of electricity (subsistence consumers). This dilemma can be resolved by implementing graduated tariff structures, whereby unit costs rise with higher levels of consumption. Similarly, connection charges must be high enough to reimburse the utilities for the connection cost, and financing solutions should be explored to address customer affordability issues.

The pricing of electricity—particularly the relative advantages and disadvantages of various tariff structures—has been the subject of a vast amount of research. In addition, many projects have focused on the importance of improving generation and distribution systems to improve service reliability. In terms of distribution, much research has focused on low-cost system design, but connection charges have received much less attention, even though high connection fees are a significant deterrent to poor consumers that desire to connect to a network.

Ethiopia's Output Based Aid Experience

Over the past 15 years, Ethiopia has focused on raising electrification rates, mainly by extending the national grid system to more villages and towns. Yet the number of households without electricity remains quite high. By 2014, the country's overall electrification rate had reached just 23 percent, meaning that 70 million people were still without a connection (table 1.1). Yet this rate was about 8 percent higher than the 15 percent rate in 2007. This increase can be attributed, in part, to recent efforts to lower barriers to household adoption in villages and towns with electricity service, as well as the growing use of electricity in urban areas. As of 2014, more than

85 percent of people in urban areas had electricity, but the rate of rural electrification remained at just 10 percent. Thus, one of the main challenges for Ethiopia is increasing electricity access in rural areas.

GPOBA Program Background

The World Bank–funded Electricity Access Rural Expansion Project (Phase 2) was implemented in 2007 to assist the Government of Ethiopia (GoE) to develop a sustainable program for expanding access to electricity in rural communities (World Bank 2013a). As part of the project, an OBA program provided grants to make the adoption of electricity more affordable for rural populations.

The overall objective of the rural electrification project was to support broad-based economic development and, over the long term, help alleviate poverty. The project was implemented by the Ethiopian Electric Power Corporation (EEPCo), the country's vertically integrated power utility. In 2007, EEPCo had about 1.13 million customers, representing only about 17 percent of the population. During GPOBA grant preparation in 2007, only 33 percent of the population in Addis Ababa, the nation's capital, had electricity. Despite these low numbers, Addis Ababa accounted for more than 60 percent of total electricity consumption at that time. In the other urban areas, the electrification rate was only 20–30 percent. Obviously, in rural areas, where 85 percent of the population resided, the electrification rate was much lower, at just 2 percent.

Before the GPOBA grant program commenced, the GoE in 2005 launched the Universal Electricity Access Program. This umbrella program, which would be implemented by EEPCo, aimed to increase the coverage rate from the 2007 17 percent level to 50 percent over a five-year period. It envisioned connecting virtually all rural towns and villages to the grid within a 10-year horizon. To this end, in 2005 the GoE proposed allocating approximately US$2.0 billion (about 17 billion Birr) over 10 years. This was a significant investment for EEPCo, representing about 16 percent of its overall investments for the corresponding period. With those resources, the Universal Electricity Access Program was to be able to provide access to 4.8 million new customers, representing a population of more than 22 million.

One of the challenges of the Universal Electricity Access Program was the low connection rates in rural communities. While some new customers could afford the upfront fee of about US$75 to connect to the grid system, many others considered the fee too high, preferring to forgo an electricity connection. As part of the World Bank Electricity Access Rural Expansion Project (Phase 2), the GoE agreed to allow customers to pay for this fee over time, thus lowering the financial barrier to adopting electricity. This project component would be financed as part of a Global Partnership on Output-Based Aid (GPOBA) grant facility.

Program Goal and Objectives

The goal of the GPOBA program was to make electricity connections more affordable for the poor, thus enabling higher numbers of poorer households to adopt electricity. To accomplish this, the utility provided loans to finance the connection fees; households, in turn, made monthly repayments, which were included on their electricity bills. The GPOBA intervention was limited to rural areas being provided electricity by EEPCo for the first time during the years 2013–15. This program was considered a new way to promote higher connection rates in these communities being provided electricity service. The expectation was that, if the project succeeded, providing loans to lower connection costs for poor households would become a future standard practice for EEPCo.

Under the earlier Universal Electricity Access Program, Ethiopia had the goal of increasing the rate of household electricity adoption in rural towns and villages newly connected to service. The GPOBA intervention augmented this program by helping EEPCo to finance connection charges. Previously, households had to pay the US$75 connection charge to initiate service. Rural households participating in the GPOBA project were allowed to pay this amount over five years. The process worked as follows: Households were required to make a down payment of $15, representing 20 percent of the $75 connection charge levied by EEPCo. The remaining $60 would be paid in small installments of about $1 per month over five years. EEPCo, in turn, would receive a subsidy of $35 per household from GPOBA to cover the interest rates incurred financing the connection charges. This interest would not be charged to the households, who would only pay the $75 spread out over five years. In addition, each GPOBA-participant household would receive two free compact fluorescent lamps (CFLs), which would make monthly electricity bills more affordable for poor households.

To avoid subsidizing wealthier households and better target the poorest ones, the availability of GPOBA financing was, by design, delayed for about 18 months after the community first received service. The reasoning was that wealthier households, who could afford to pay the upfront $75 fee, would adopt full service right away.

This GPOBA technique appears to have worked. The results of an impact assessment analysis reported in this study show that increasing numbers of households adopted electricity because they could spread out the connection cost over time. In the GPOBA communities surveyed in 2011, 37 percent of households adopted electricity. That same year, an additional 18 percent of households adopted electricity, agreeing to pay the upfront fees over time, with interest rates financed by GPOBA. This meant that a total of 55 percent of households in the GPOBA communities adopted electricity, a relatively high figure compared to other communities in Ethiopia and even internationally, where initial connection rates are about 30 percent. By program completion in 2013, that adoption rate had risen to 68 percent of households, mainly due to the expansion of electricity connections made possible by GPOBA financing. Although many of the

poorest households are still without electricity, numerous households have been able to adopt electricity under the GPOBA financing program.

According to the household income data from the impact survey in this study, for the poorest 20 percent of households participating in the GPOBA program, about 7 percent of yearly income would be spent on the monthly connection charges over five years. This figure compares to 42 percent of a year's income for the same group paying the full US$75 connection fee upfront (table 1.3). Obviously, for higher income groups, the monthly charges spread out over five years would represent an even smaller percentage of yearly income.

Table 1.3 Electricity Connection Fees and Affordability

Income quintile	Yearly income (US$)	GPOBA monthly electricity payments (% of yearly income)	Flat electricity fee (% of yearly income)
Lowest	177	6.8	42
Second	381	3.2	20
Third	624	1.9	12
Fourth	1,104	1.1	7
Highest	2,187	0.5	3
Average	851	1.4	9

Source: Ethiopia Impact Evaluation Survey 2014.
Note: Because the income in the survey was underreported, the actual percentages are probably even less.

It should be kept in mind that the GPOBA and EEPCo connections differed only in terms of the upfront costs and provision of two free CFLs. The GPOBA grant innovation allowed customers to make monthly payments, thus making connection charges more affordable, while EEPCo still connected and serviced households following the usual practice of full upfront payment of connection fees. Although the recovery of connection charges through spreading them out over monthly bills is not yet common practice in Sub-Saharan Africa, some countries are experimenting with trial programs (annex 1).

Challenges and Achievements

The GPOBA grant program's original goal of connecting 228,571 households (about 1.34 million people) was not achieved. The moratorium on new connections in 2008–10, in response to power supply constraints resulting from poor hydrology and delays in the commissioning of dams, slowed the utility company's momentum; thus, it had difficulty restarting the program at the same level it had achieved prior to 2007. In addition, the Ethiopian government decided to sole-source the supply of meters to support local industry development; however, the appointed local firm was not

up to the task and failed to deliver on time. As a result, EEPCo ran out of meters, and all access programs were interrupted from April to December 2012, at which time the sole-source decision was reversed. In early 2013, EEPCo was able to procure meters from alternative sources and resume project implementation.

Taking the ambitious electricity promotion targets into account, EEPCo employed external resources to install a significant number of new connections, which adversely affected the quality and safety of connections. The independent verification agent hired by the World Bank to certify outputs for subsidy disbursement under the GPOBA grant observed that, in some instances, EEPCo was not in full compliance with GPOBA technical and safety requirements, which delayed disbursement of funds. The independent verification agent also noted that distribution of CFLs was limited due to the utility's lack of storage capacity. EEPCo initiated measures to address these challenges; however, because grant disbursements were made based on verified results, the revenues expected by EEPCo under the program lagged behind.

Table 1.4 EEPCo and GPOBA Connections, FY 2011–13

	Program implementation period			Total
Connection type	2011	2012	2013	connections
Planned GPOBA (no.)	36,456	90,000	102,115	228,571
Actual GPOBA (no.)	7,079	14,135	21,792	43,006
Actual GPOBA (%)	19.4	15.7	21.3	18.8
Actual EEPCo (no.)	10,814	21,560	24,790	57,164
Share GPOBA of EEPCo (%)	65.5	65.6	87.9	75.2

Source: World Bank 2013a.
Note: Actual EEPCo connections include all GPOBA connections.

Despite these implementation difficulties, the GPOBA program accounted for about 75 percent of the total connections in Ethiopia over its two-year implementation period (2011–13) (table 1.4). The pace of the GPOBA program accelerated year by year. Starting in June 2011, a total of about 7,000 households were provided new metered connections. In the second year, this figure doubled to more than 14,000 and reached nearly 22,000 by the third year. Thus, despite the late start-up, a total of about 43,000 households (some 236,000 people) received an electricity connection through EEPCo under the GPOBA program. Moreover, these figures do not take into consideration the large number of indirect household connections. As discussed below, taking these unofficially connected households into account raises the number of households that obtained electricity as a result of the GPOBA intervention to 90,000.

Impact on Connection Rates

The GPOBA grant contributed to the effectiveness of village and town electrification by accelerating the pace of household connections. By 2013, the overall share of GPOBA households among those with electricity averaged about 42 percent for all surveyed villages and towns in the five study regions (table 1.5).

Table 1.5 Share of GPOBA Households among Households with Electricity in the Study Regions

Region	Share of GPOBA connections (%)
Oromia	69.5
Amhara	9.3
SNNPR	36.9
Tigray	58.5
BSG	38.8
Total	41.8

Source: Ethiopia Impact Evaluation Survey 2014.
Note: These figures show the share of GPOBA connections as a percentage of total new EEPCo connections for the five study regions.

However, this high overall electricity penetration rate masks large differences in regional penetration rates, which ranged from 9.3 percent for the surveyed villages and towns in Amhara to 69.5 percent for those in Oromia. That said, the GPOBA project succeeded in accelerating household adoption of electricity in the five participating regions.

Program Timeline

Although the World Bank project and GPOBA program were approved in 2008, they encountered difficulties from the start. Ethiopia depends on hydropower and is thus vulnerable to drought. Hydropower projects scheduled to come online in 2008 were delayed due to poor hydrology. As a result, the GoE placed a moratorium on new electricity connections due to power shortages. Therefore, the timeline for all World Bank electricity access projects, including the GPOBA program, were scaled back. This unfortunate delay reduced the number of connections possible under the GPOBA intervention (box 1.2).

Despite delays, the GPOBA grant program achieved a higher level of electricity adoption rates in Ethiopia during 2011–13, compared to other access projects. The independent verification of outputs and socioeconomic development impact evaluation study were carried out at the same time. The independent verification survey, based on actual connections achieved by EEPCo and satisfactory billing over three months, was necessary for disbursement of GPOBA grant funds. The impact evaluation study, which measured the impact of those achievements, included baseline surveys, focus group discussions (FGDs), and a final impact evaluation survey. The goal of the surveys was twofold: (i) to provide an assessment of the program impacts and (ii) to offer policy guidance for future work. The main findings of these surveys are described in the subsection below.

Box 1.2 Timeline of the Ethiopia GPOBA Program

2008	The World Bank–funded Electricity Access Rural Expansion Project (Phase 2), including the GPOBA grant component, is initiated. Several power-supply projects in Ethiopia are delayed due to poor hydrology.
2009	The Government of Ethiopia (GoE) places a moratorium on new electricity connections due to shortages of electricity supplies. The World Bank project is delayed and the project end date is extended.
2010	New power-supply projects are finally completed, and new supply gradually becomes available in Ethiopia.
2011	The GoE lifts the moratorium on new electricity connections. The World Bank project and GPOBA program restart, with an end date of 2013. (The GPOBA program is extended through June 2013.) GPOBA verification and baseline surveys are initiated. The baseline for the impact evaluation survey is started. EEPCo begins connecting new households under the World Bank project and the GPOBA program.
2012	EEPCo runs out of meters in April. The Ethiopian government delays procurement of meters and, in December, begins contract negotiations with a local meter supplier.
2013	The World Bank project and GPOBA program are completed.
2013–14	GPOBA baseline and impact evaluation surveys and background reports are completed.

Key Findings

Accelerated Rate of Rural Electrification. The GPOBA program accelerated the rate of rural electrification in villages where the intervention was made available. By the program's close in 2013, nearly 90 percent of new households adopting electricity were GPOBA participants, attesting to the program's popularity. For communities participating in the GPOBA program, this expansion reached 68 percent of households in the villages, including many poorer households who could not otherwise afford the upfront costs of an electricity connection and house wiring.

High Number of Indirect Connections and Willingness to Pay. The project M&V survey found that many households had connected to electricity indirectly; that is, they had wired (sometimes dangerously so) to a neighboring house with a legitimate meter. While households with informal connections paid no upfront costs for electricity, they typically paid a fixed fee per light or appliance. This resulted in higher monthly costs compared to regular EEPCo service (chapter 3). Thus, these households demonstrated a high willingness to pay for electricity service.

Business Adoption of Electricity. Once a community had access to power service, all businesses adopted electricity. This finding supports the important role that electricity plays in businesses. However, there was limited support for accelerating business development, suggesting the need for technical assistance to further improve the development impact of the rural electrification program.

Household Appliance Adoption. Households purchased a wide array of electric appliances, but complained that both brands and types of appliances were limited in local stores. Since the impact of electricity is exclusively through the use of appliances, it would be important to encourage local shops or new businesses to carry more items. This might be accomplished indirectly by facilitating end users' access to financing, perhaps through microfinance institutions (MFIs) or credit lines

Delayed Electricity Adoption due to Meter Shortage. A shortage of meters during the project was a significant barrier to achieving higher rates of rural electrification. This shortage was caused, in part, by the sole-sourcing of meters to a local manufacturer that could not deliver on orders. Currently, the utility is exploring the use of multiple meter suppliers to provide more timely support to the access programs, as well as connection innovations (e.g., load limiters and prepaid meters).

Cost of Internal Wiring. Households must pay for internal wiring, which is an obstacle to electricity adoption for poor households. One option for resolving this issue is the use of ready boards, a less costly technology, for poor households. If internal wiring is financed through GPOBA schemes, an outreach campaign is recommended on this additional responsibility of the utility.

Low Price of Electricity. The price of electricity in Ethiopia is among the lowest in Africa. This national policy has ramifications for the financial health of the utility and the continued rollout of the rural electrification program. EEPCo expressed reservations about expending significant resources on bill collection, given the small revenue streams from rural communities with electricity. Higher prices for electricity would increase the profitability of bill collection and provide a greater financial incentive for the utility to promote rural electrification with enough revenues to cover O&M expenses.

Summary

The connection costs in Sub-Saharan Africa are high compared to the rest of the world (Golumbeanu and Barnes 2013). In the past decade, some countries have initiated efforts to lower these costs so that electricity is affordable for even their poorest populations. In Ethiopia, the US$75 connection fee is quite reasonably priced for a middle-class household. With a per capita income of only $470 a year, this amounts to slightly more than 3 percent of family income.

However, for poor households in rural areas, even $75 is a strain on their budgets, amounting to more than 40 percent of one year's income. As a result, the GoE, in collaboration with the World Bank, decided to find way to reduce the impact of high connection fees on electricity adoption. The result was the GPOBA scheme carried out through EEPCo to provide loans for connection costs. The goal was to make the adoption of electricity more affordable for Ethiopia's poor rural households by spreading out connection cost payments. The availability of loans for connection costs was delayed by 18 months after the community received electricity to ensure that poorer households would receive the loans and accompanying subsidies. The GPOBA subsidy of $35 covered the five-year interest on the loans offered through EEPCo so that households would not have to pay more than the $75 connection fee. In the next chapter, we examine the socioeconomic features of households in the GPOBA program study regions.

2. Socioeconomic Characteristics of Study Regions

The Ethiopia GPOBA impact evaluation study is one of the first rigorous attempts to understand the impact of connection charges on household adoption of electricity in Sub-Saharan Africa.[4] It is also among the first studies in Sub-Saharan Africa to examine the impact of rural electrification shortly after households adopt electricity. To date, evaluating the impact of electricity on development in Sub-Saharan Africa has garnered little attention. Most evaluation research in the region has been based on electricity use rather than its actual impact on households (Bernard 2012). This study breaks new ground, being among the first to provide evidence of the impact of electricity for development. The lessons learned will help other countries seeking to assess the value of promoting lower connection costs for their rural populations just now gaining access to electricity. The GPOBA program implemented in 2011–13 was spread throughout most of rural Ethiopia, including some of the country's poorest and most highly populated regions. Because many of the towns and villages covered are located in areas with low levels of education and little access to roads and other infrastructure services, obtaining a representative sample for the impact evaluation survey was quite challenging. In the end, the survey team covered 22 towns in five regions that are representative of Ethiopia's rural areas with poor infrastructure (annex 2).

Key Features of Study Regions

The GPOBA program covered five diverse regions spread across Ethiopia where rural electrification programs will be most active in the coming years (table 2.1). These regions cover most of the country's rural population. Household samples were taken from areas with high concentrations of GPOBA-connected households, extending from central Ethiopia to the northern border with Eritrea and west toward Sudan (map 2.1).

[4] The recovery of connection charges through monthly payments over time is not yet common practice in Sub-Saharan Africa, though some countries are experimenting with trial programs (annex 1).

Table 2.1 Number and Percentage of Households by Electricity Status, 2014

	Population has electricity		Total	
Region	Yes	No	Percent	Households (no.)
Tigray[a]	774,199	282,702	27	1,056,900
Afar	114,981	42,422	27	157,404
Amhara[a]	3,635,136	953,983	21	4,589,120
Oromia[a]	5,045,932	1,383,155	22	6,429,087
Somalie	389,066	46,980	11	436,046
BSG[a]	184,814	22,993	11	207,807
SNNPR[a]	2,764,578	584,030	17	3,348,608
Gambelia	58,519	23,438	29	81,957
Harari	7,040	44,992	86	52,032
Addis Ababa	36,776	766,584	95	803,361
Diredwa	30,117	80,883	73	111,001
Total	13,041,158	4,232,162	25	17,273,320

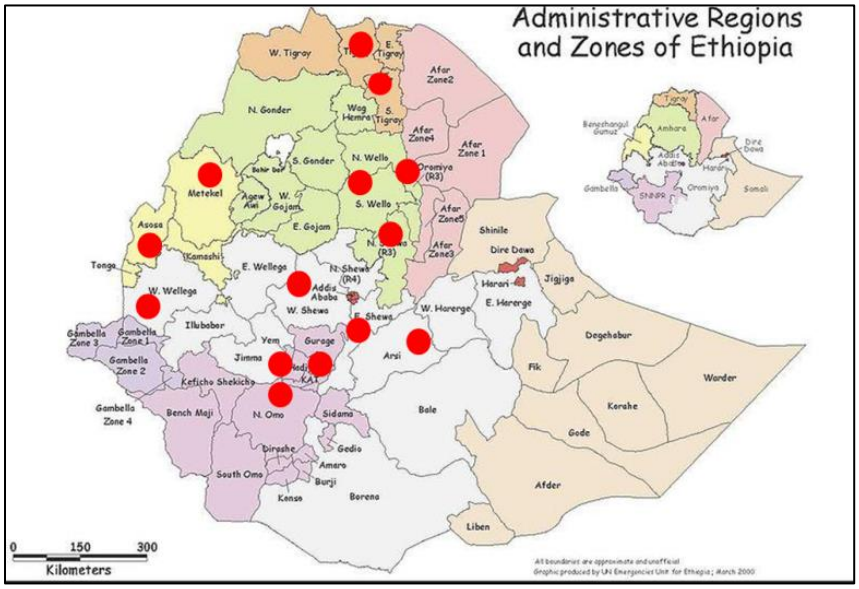
Source: Ethiopia Living Standard Survey 2014.
a. Region covered in the GPOBA Impact Evaluation Survey.

Oromia. With a total population of about 27 million (2007 figure) and a large land area (284,538 km^2), Oromia is Ethiopia's largest national regional state, sharing borders with nearly every region except Tigray. Oromia is known for its coffee production, representing more than half of Ethiopia's total coffee production. Most of the country's livestock (cattle and horses), as well as beehives, can be found in this region. Rural households occupy small agricultural plots of about 1.2 ha on average, which is only slightly above the national average. About three-quarters of the region's people have farm-related jobs.

Amhara. Located in northwestern Ethiopia, the Amhara region has a population of 17 million, nearly 90 percent of whom live in rural areas. The region is fairly densely populated, at about 108 people per km^2, with an average rural household size of 4.3 members. Most people derive their incomes from agriculture. Like Oromia, Amhara is known for its coffee production, which amounts to nearly half of the country's total coffee production.

Tigray. Located in northern Ethiopia, this national regional state has about 5 million people, nearly 80 percent of whom live in rural areas. Tigray is Ethiopia's third most densely populated region, with an average of 119.1 persons per km^2. The average rural family size is 4.6 members. As in many other rural areas, subsistence agriculture is the main source of household income.

Map 2.1 Ethiopia GPOBA Project Areas



Source: INTEGRATION Environment & Energy and MEGEN Power Ltd 2014.
Note: Red dots indicate GPOBA project areas included in the survey sample.

Benishangul-Gumuz (BSG). BSG is a smaller, mostly rural regional state in northwestern Ethiopia. It is also one of Ethiopia's most ethnically diverse regions. Nearly 85 percent of BSG's nearly 1 million people live in rural areas. The region's population density is about 20 persons per km^2, making BSG the country's most sparsely populated region. Even so, rural household size is quite similar to that of other states, at about 4.5 members on average. Owing to its relatively abundant agricultural land, BSG has attracted immigrants from the northern highlands.

South Nations, Nationalities, and People's Region (SNNPR). Located in southwestern Ethiopia, SNNPR is one of the country's larger and most rural regions. Some 90 percent of its 14 million people live in rural areas. It is also one of Ethiopia's most densely populated regions, averaging about 140 people per km^2. The average household size is slightly higher than for other regions, at about 4.8 members. Like other regions, the main source of income is agriculture-related.

Socioeconomic Features of the Sampled Areas

The five study regions are fairly representative of the socioeconomic characteristics of rural Ethiopia. The household survey focused on rural areas that were either without electricity or had been recently provided service. As expected, the sample shares some of the more general characteristics of poor households in Ethiopia. The 760 households in the sample are spread throughout the five regions. These surveyed households represent a total of 4,148 family members, including 1,858 children under the age of 13 years (table 2.2). Although the number of family

members varied widely (from 1 to 13), the average household size among those interviewed was 5.5 members. This is slightly above the national average, perhaps reflecting that the sampled households are, on average, somewhat poorer than those in other regions.

Table 2.2 Household Members in the Ethiopia Impact Evaluation Survey, 2014

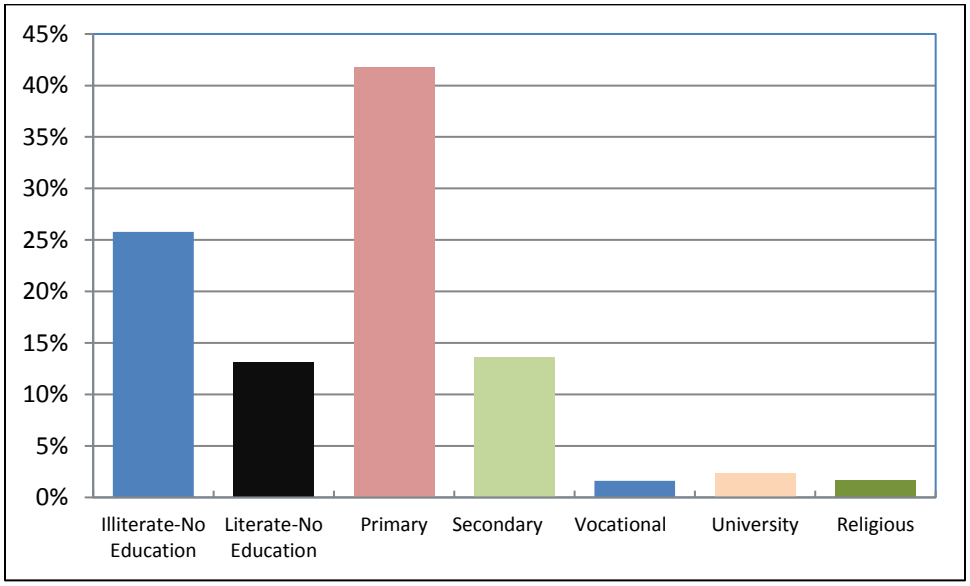
Gender	Adults	Children	Total
Male	1,142	933	2,075
Female	1,148	925	2,073
Total	2,290	1,858	4,148
Members per household (average no.)	5.5	2.9	n.a.

Source: Ethiopia Impact Evaluation Survey 2014.
Note: n.a. = not applicable.

Education

Ethiopia faces many social and political obstacles that have restricted progress in education for many years. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), most people in Ethiopia believe that work is more important than education. The typical pattern is for people to start work at a very early age with little or no education. Although school attendance is gradually improving, some parents still cannot afford to send their children to school. Children in rural areas are less likely to attend school than those in urban areas.

Figure 2.1 Highest Level of Education Completed in Sampled Households, 2014



Source: Ethiopia Impact Evaluation Survey 2014.
Note: Persons in both literate and illiterate categories have no formal schooling. The survey question was for all family members, including children.

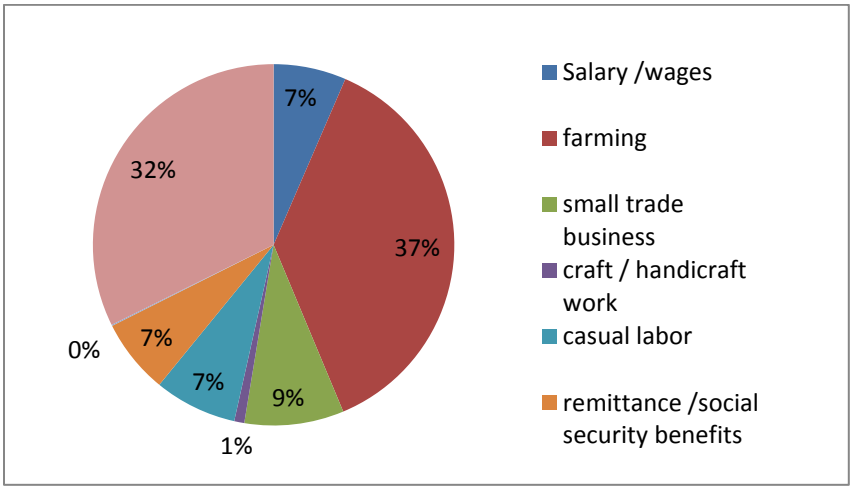
Nevertheless, progress on education is evident from the survey. Children are more likely than their parents to have formal education. Among the household members in the survey without any formal education, two-fifths are adults (figure 2.1). As in many other developing countries, primary school is the highest level of education attained among most household members. Among the 40 percent of household members who have achieved a primary education, many are children, compared to only about 25 percent for household heads. Only about one-third of household heads have any form of education. As might be expected, female literacy is much lower than for males. Only a very low percentage of household members in the sampled regions have attended secondary school or college.

Occupation

Agriculture accounts for nearly 41 percent of the gross domestic product (GDP) in Ethiopia (CSA 2007). In rural areas, many economic activities are dependent on agriculture; these include marketing, processing, and export of agricultural products. Overwhelmingly, agricultural production is done by small-scale farmers and small enterprises. Even a large portion of commodity exports are provided by the small agricultural cash-crop sector. The principal crops include coffee, pulses, beans, oilseed, cereals, potatoes, sugarcane, and vegetables.

The survey found that household heads were generally employed, but many family members had no formal work. About one-third of household members over the age of 15 had no source of income. For those that did work, farming accounted for the main source of employment income. Other popular forms of work included small trade businesses, casual labor, and salaried employment (figure 2.2). These varied sources of income are common throughout rural areas of Ethiopia.

Figure 2.2 Main Source of Income for Household Members over 15 Years of Age, 2014



Source: Ethiopia Impact Evaluation Survey 2014.

By income source, there was little difference between households with and without electricity. For the impact evaluation, this situation presented an ideal sampling opportunity; that is, if the employment patterns of households with and without electricity had differed, this would have introduced a source of bias into the comparison between the two groups. Because both groups had similar employment patterns, analysis of the impact of electricity on other socioeconomic behavior was less problematic.

Household Income

Ethiopia is one of the world's poorest countries, with a GNP per capita income of only US$383 in 2013. Its measure for GNI purchasing power parity (PPP) was somewhat higher, at $1,380 per capita, but still reflects its poor status (table 2.3). These figures are representative of both urban and rural areas, meaning that rural households in the impact evaluation survey have even lower income levels.

Table 2.3 Average GDP and GNI per capita in Ethiopia, 2009–13

Income measure	Currency	2009	2010	2011	2012	2013
GNI per capita PPP	Current international dollars	950	1,060	1,170	1,260	1,380
GNP per capita	Current US$	382	343	357	472	383

Source: World Bank data for 2009–13.

Results from both the baseline and impact evaluation surveys confirm that residents in the GPOBA study area are poorer than the national averages. The most likely explanation is that the national averages cover both urban and rural areas. In addition, the limited number of income questions in the baseline and impact surveys likely underestimated cash income. In 2014, the average annual cash income was US$851 per household, which increased (table 2.4). Regional variations in income are also quite dramatic. Tigray has the highest income level, at more than twice that found in BSG. Of course, the PPP income would be higher, but this still illustrates that the study regions are quite poor. Even in the wealthiest survey regions, households are surviving on less than $100 per month. As imprecise as these numbers are for both the surveyed areas and nationally, the obvious conclusion is that households in the new areas being connected to the national electricity grid are poor.

Table 2.4 Average Annual Cash Income of Study Households by Region, 2014

	Impact evaluation survey, 2014	
Region	Birr	US$
Oromia	12,834	675
Amhara	19,434	1,023
SNNPR	13,695	721
Tigray	21,817	1,148
BSG	7,809	411
Total	16,164	851

Source: Ethiopia Impact Evaluation Survey 2014.
Note: For the impact evaluation, income data was missing for five households.

Clearly, such low levels of income impact the affordability of electricity connections. For the households in the survey, those directly adopting GPOBA connections and from EEPCo's regular expansion program have higher levels of income than those without electricity (table 2.5). This finding is quite common among most developing countries since wealthier households can better afford the expenses associated with having electricity, including connection costs. Even households in nearby control villages without electricity have higher levels of cash income than households in villages with service that have not yet adopted electricity. It is little wonder that such households, with a monthly income of only about US$65, have difficulty affording the $75 connection charge, given that this amount represents close to 10 percent of their yearly cash income. Nearly 70 percent of households in the rural communities with electricity adopted service, meaning that many poor households have adopted electricity; however, they have adopted electricity in lower numbers compared to better-off households.

Table 2.5 Average Annual Cash Income of Study Households by Household Type and Survey Comparisons, 2014

Household type	Impact evaluation survey, 2014 (US$)
EEPCo	918
GPOBA	932
Without electricity	680
In control village	844
Total	851

Source: Ethiopia Impact Evaluation Survey 2014.
Note: Income data was missing for five households.

The survey questions underestimated the actual amount of yearly cash income for households in the survey areas.[5] Informal evidence from the survey suggests that many respondents have intentionally underestimated their cash income. Indeed, in a number of cases, estimates of household income provided by respondents were inconsistent with the quality of their homes or number of household appliances. However, this underestimation is expected to be consistent across households in the survey; thus, comparisons among household groups should remain valid. It can be concluded that the study areas are quite poor, regardless of the income measure.

Conclusion

The World Bank–supported Ethiopia GPOBA program was well targeted toward rural communities without electricity, including poor households in some of the country's poorest areas. The findings show that household income was earned mainly from small farms and casual labor. The income level of the sampled households was well below national averages and was accompanied by low levels of education. The next chapter describes the evaluation carried out to assess whether the GPOBA intervention succeeded in promoting electricity adoption among some of world's poorest people.

[5] Underestimation was even greater for expenditures. Although the impact evaluation survey included detailed questions on energy expenditures, other expenditures were lumped into broad categories. As a result, in this study's survey, cash income was used to classify households by income class. Although there are absolute errors, the comparisons between groupings should be similar since the errors would be similar for all groups. Cash income also aligns better with income figures from other national surveys.

3. Connection Costs and Electricity Adoption

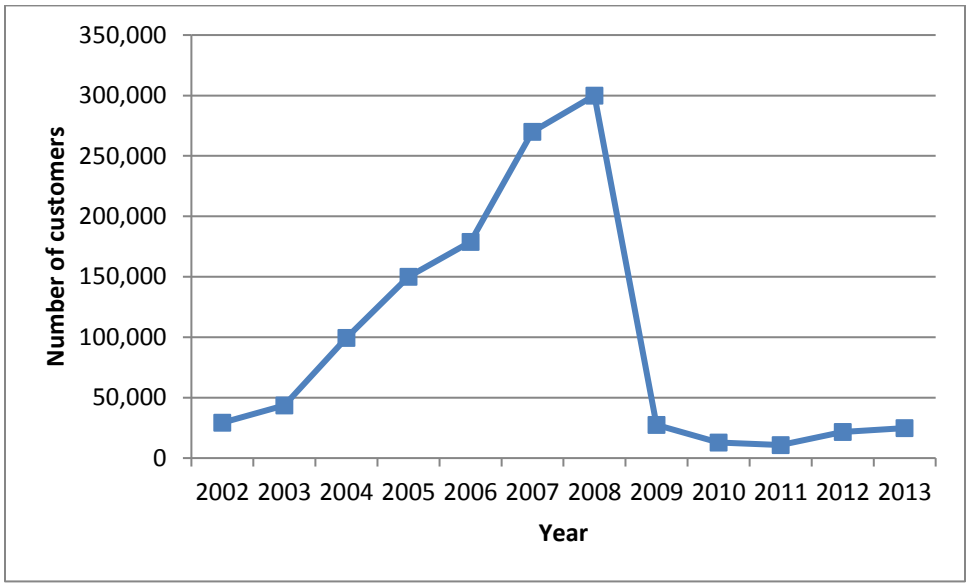
Given the low level of electrification in rural Ethiopia, expanding the grid system to more villages and towns is one obvious way to raise electrification rates. Another important way is to promote electricity adoption among households without service in villages and towns with coverage. Compared to other countries in Sub-Saharan Africa, which has some of the world's highest electricity connection charges, Ethiopia's connection charge of US$75 per household is modest. Despite the country's low income level of $470 per capita GDP, the cost of an electricity connection is quite affordable for middle-class households. But for many poor households in rural areas, the connection charge is beyond reach. Thus, an important challenge for the country's rural electrification program is finding ways to increase household connection rates among poor households.

This chapter assesses the role of the GPOBA intervention in accelerating electrification rates in rural Ethiopia by providing financial assistance to lower connection costs and thus encourage adoption among poor households. The section below provides a historical overview of electricity connection rates in Ethiopia. This is followed by an assessment of the impact of both the GPOBA-assisted scheme and the EEPCo national expansion program.

Expectations for EEPCo and GPOBA Programs

The World Bank has been involved in assisting Ethiopia's power sector for the last 15 years. Initially, this assistance was mainly confined to upstream power generation and transmission projects. Since 2002, however, access expansion programs have been initiated under the World Bank's Electricity Access Rural Expansion Project. Under the initial IDA-funded energy access project, launched in 2003, EEPCo accelerated geographical coverage of the network and received funding for the needed meters, accessories, and connection cables to ramp up customer connections. By 2008, the utility company was connecting 300,000 customers per year (figure 3.1). EEPCo also enjoyed a stable financial situation, which enabled it to cover the funding of its operational costs.

Figure 3.1 EEPCo Yearly Customer Connections, 2002–13



Sources: World Bank 2012, 2013a.

Unfortunately, the scale-up in electricity access being implemented by EEPCo faced major challenges in 2008. That year several large power-supply projects were delayed due to drought, as discussed in chapter 1 (box 1.2). Given that power supply was unreliable due to poor hydrology and delays in commissioning dams, the Ethiopian government decided to delay implementation of electricity access projects, placing a moratorium on expanding new connections (with the exception of some unavoidable ones) to help rein in the pace of electricity demand growth until new power plants could be brought back into operation. Figure 3.1 shows the dramatic reduction in the number of new EEPCo customers that resulted. After the power-supply projects were completed in late 2010, the moratorium on new electricity connections was lifted. In early 2011, EEPCo and the World Bank agreed to restart the second phase of the electricity access program, complemented by GPOBA grant funds. Growth in new electricity connections resumed, albeit at a much slower pace, owing, in part, to EEPCo's limited stock of meters for connections.

Starting in 2011, the GPOBA plan was to reach 230,000 households—more than 1 million people—with new electricity connections (table 3.1). In addition to improving household connection rates, another goal of the GPOBA scheme was to distribute about 450,000 energy-efficient compact fluorescent lamps (CFLs) to ensure that electricity was affordable to even the poorest households. Also, the efficiency of the CFLs would mean that the new power requirements for EEPCo could remain at modest levels.

Table 3.1 Projected Total Number of Customers with Electricity

	Grid customers with electricity (thousands)					
Fiscal year	All potential customers	All customers directly connected	Residential customers	Indirectly connected residential customers	Total customers	Connection rate (%)
2008[a]	142	22	18	6	28	20
2009	149	62	52	26	88	59
2010	156	81	69	27	109	70
2011	164	119	101	21	141	86
2012	172	143	122	15	159	92
2013	180	149	127	15	165	92
2014	189	155	132	16	172	91
2015	198	161	137	17	178	90

Source: World Bank 2007a.
Note: Indirectly connected customers adopt electricity from a nearby household with a legal (metered) connection.
a. Fiscal year 2008 is half a year.

Under the GPOBA grant component, it was anticipated that the connection rate for new households in villages with electricity would increase by about 20 percent. This would be accomplished by spreading out the upfront connection expenses for household adoption (table 3.1). As will be seen later, these projections were optimistic.

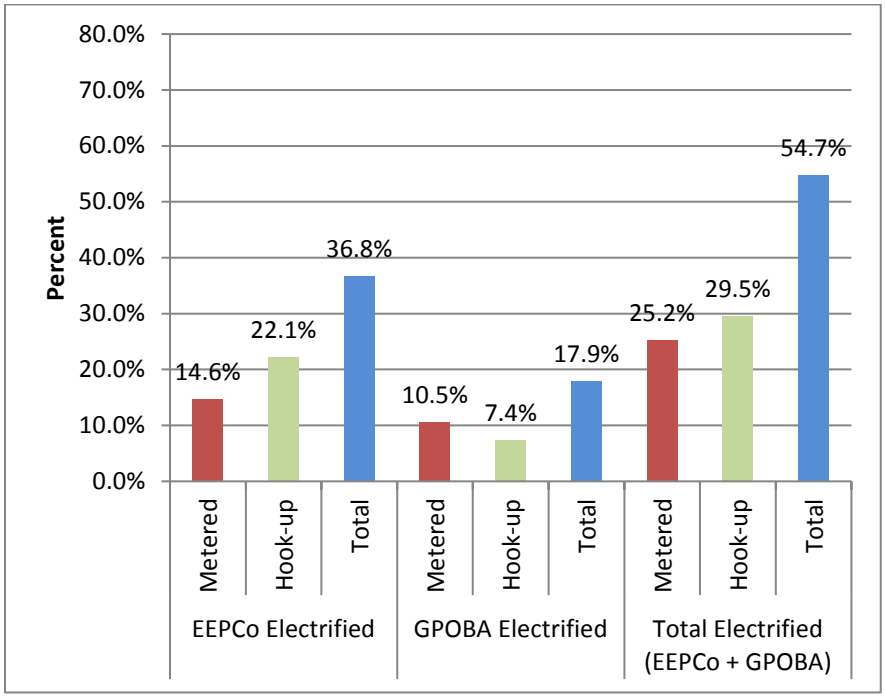
Popularity of Indirect Household Connections

The remarkably high numbers of new indirect household connections can be directly attributed to the expansion of service to the villages and towns covered under the GPOBA program. Indirect electricity connections to households with a formal meter were attractive for a variety of reasons related mainly to ease of access and service. Some households had lost hope of being able to obtain a direct connection serviced by EEPCo, and thus turned to getting electricity from a neighboring household. Despite such problems as dangerous household wiring, many of the poorest households could get immediate service by using a neighbor's legal (metered) connection. Some survey respondents mentioned that they took an indirect connection in order to avoid EEPCo's formal requirements of obtaining a metered connection (e.g., having a land ownership certificate) and delays, which sometimes dragged on for months. Households that benefited the most from indirect electricity connections were families living in non-concrete houses—usually the poorest customers in the villages. An indirect connection was their only available option since EEPCo's regulations prevented non-concrete houses from receiving a connection for safety reasons.

Taking an indirect household connection was not a matter of reducing monthly costs, however, highlighting these households' willingness to pay for electricity. Generally, such households paid higher prices for electricity through fixed charges for lights and appliances. But they avoided having to pay the upfront fees to initiate service. Indirectly connected households paid about US$0.26–$0.52 per bulb a month. Depending on the hours of use, this was $0.10–$0.30 more per kWh than the amount paid by directly connected households. Payments were more expensive for households in neighborhoods with few official direct (metered) connections, and were most modest in areas with many official connections. Most indirectly connected households could use such electricity for lighting, charging their mobile phones, and listening to the radio, all of which was negotiated with the household that had the officially metered connection.

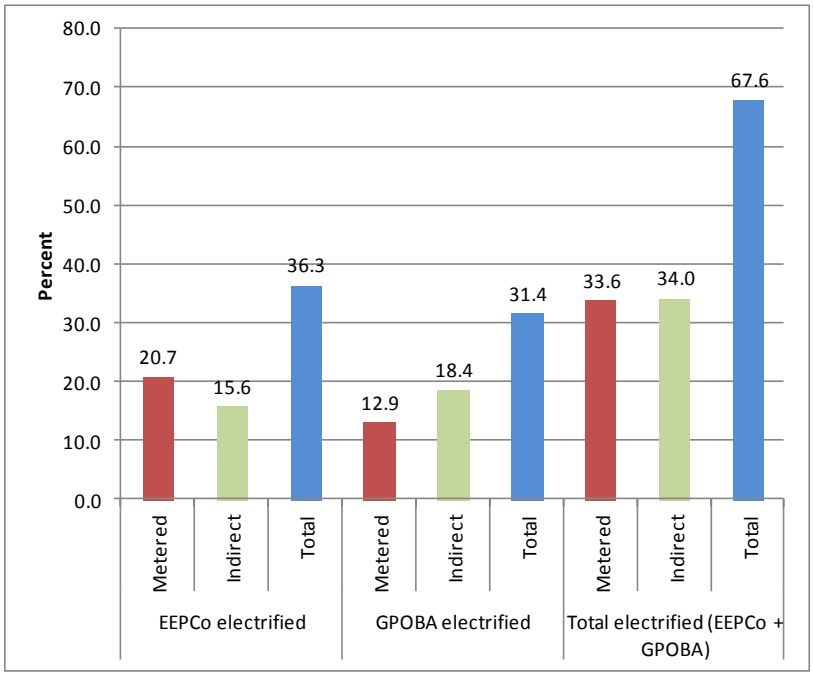
According to the final impact evaluation survey in 2014, the number of households connected directly to an EEPCo meter, including those with the GPOBA subsidy, were actually fewer in number than those obtaining electricity indirectly from other households. The connection rates for meterd and indirectly connected households were quite similar. The total cumulative direct and indirect connections for a village averaged about 55 percent in 2011 (figure 3.2), climbing to over 67 percent by 2014 (figure 3.3). Thus, for rural communities provided with electricity service, the electrification rate increased about 12 percent between 2011 and 2014. Also, due to indirect connections, the effective number of rural connections was more than double that reported by EEPCo. It is worth emphasizing that all indirect connections were found to be connected to households with meters; thus, the officially metered electricity consumption involved little electricity theft.

Figure 3.2 Metered and Indirect EEPCo and GPOBA Household Connections, 2011–12



Source: Ethiopia Baseline Study 2011–12.

Figure 3.3 Metered and Indirect EEPCo and GPOBA Household Connections, 2014



Source: Ethiopia Impact Evaluation Survey 2014.

Figure 3.4 Poor Installation Procedures for Indirect Electricity Connections in Ethiopia

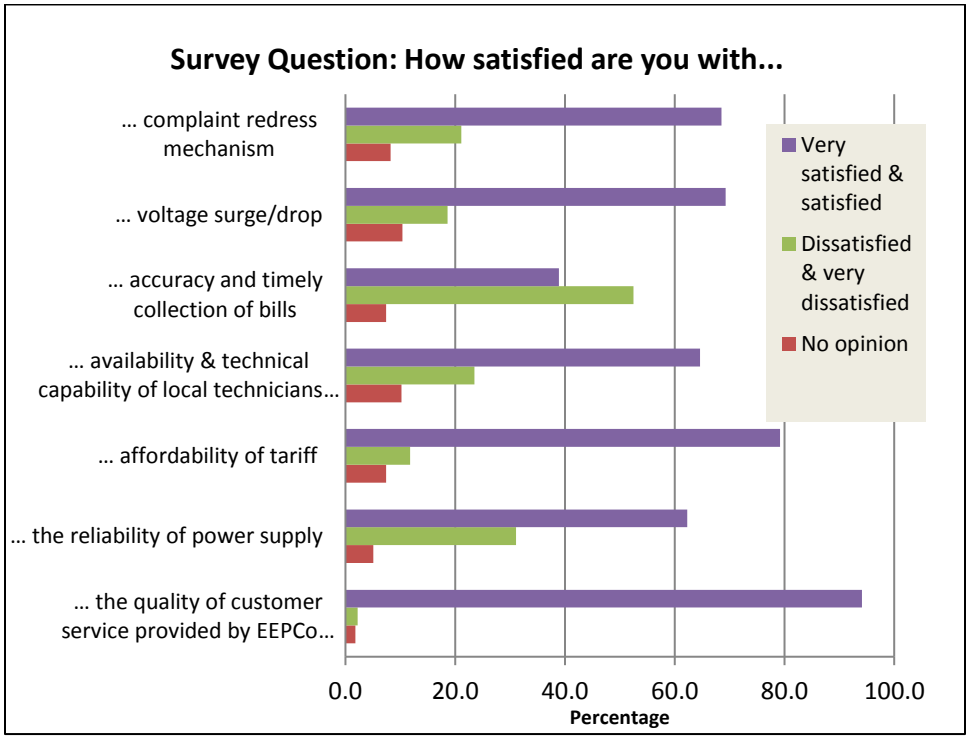
Source: INTEGRATION Environment & Energy and MEGEN Power Ltd 2014.
Note: The photo on the left illustrates octopus wiring, a dangerous practice typical of the poor installations among hook-up households. Unfortunately, this practice is common under the GPOBA program. The photo on the right shows a dangerously low-hanging electricity line in Gogeti, SNNPR.

Along with the benefits of indirect household connections, there were drawbacks. The main ones were poor technical household installations, dangerous wiring, and an uncontrolled number of indirect connections to a single meter. In one case, 12 households were indirectly connected to a single household with a metered connection. In another, the wires connecting the households were hanging dangerously low (figure 3.4). Poles that could be easily toppled carried wires from one household to another. Thus, even though indirect connections were convenient, many were based on poor installation practices. Also, even slight delays in bill payment could sometimes lead to an arbitrary cutoff of service.

Customer Satisfaction with EEPCo Electricity Service

Households participating in the GPOBA program experienced lower initial connection costs as a result of the scheme's grant funding, which spread out payments over time. After installation, however, those connections were serviced by EEPCO. Therefore, differences between GPOBA and EEPCo households were only marginal in terms of customer satisfaction with electricity service provision.

Figure 3.5 Customer Satisfaction with EEPCo Service Provision



Source: Ethiopia Impact Evaluation Survey 2014.
Note: There were 489 households with new electricity connections, including both GPOBA participants and non-participants. All household were serviced by EEPCo.

Overall, customers were satisfied with the services provided by EEPCo. About 95 percent of the households surveyed indicated they were very or somewhat satisfied with the service provided by the utility company. Nearly 80 percent of households thought the electricity tariff was quite affordable (figure 3.5). These positive sentiments, expressed during a difficult period characterized by significant power reliability issues, may have reflected people's satisfaction with having electricity service in their community for the first time, as opposed to their prior use of kerosene and candles for lighting. The survey indicated that people overall were quite happy to obtain an electricity connection.

The main customer complaints were power outages, delayed meter installation and bill collection, and unclear billing and payment procedures (figure 3.5). Many towns experienced service interruptions. Frequent power outages—lasting from 30 minutes up to an entire day—resulted in dissatisfaction with electricity service. Households pointed out that voltage fluctuations had caused considerable damage to electrical equipment (e.g., bulbs, radios, TVs, and mobile phone chargers). According to participants in focus group discussions (FGDs), village water supply had become dependent on electricity. With power cuts, both the household use of electricity and the water supply became problematic. Power cuts also reduced the income of rural businesses with electricity. In one town, where a group of youth had organized a bakery and pastry business, frequent power outages prevented the group from producing the necessary volume of baked goods, resulting in the new business facing bankruptcy.

Because many villages and towns were scattered in remote areas, EEPCo had difficulty reaching villages for proper meter reading, which encouraged the practice of estimating meter readings. This meant that households often paid estimated bills and feared the uncertainty of billing amounts, particularly since indirect connections could sometimes push their bills into a higher tariff regime. Many customers were unhappy with the inability of EEPCo's staff to provide satisfactory explanations about their electric bills.

Conclusion

The GPOBA program was quite successful in providing new incentives for households to adopt electricity. No doubt, the Ethiopian government's 2009 moratorium on new household electricity connections adversely impacted the rate of rural electrification that could have been achieved by the late 2000s. The 2007 envisioned goal of reaching 1 million people was not achieved. Even so, the program connected an increasing number of households over its two-year duration.

The surprising finding for both the GPOBA and EEPCo expansion programs was the high number of new households that were indirectly connecting to the grid system through their neighbors. The main reasons for the high number of indirectly connected households were (i) low-quality housing materials not in compliance with EEPCo regulations, which excluded many poor

households from participation and (ii) a meter shortage caused by EEPCo's sole-sourcing of meter production and delays in GPOBA program rollout.

For every new metered connection, more than one additional household was adopting electricity by extending a wire and connecting informally to a neighboring house. This was not electricity theft because the electricity used went through the neighbor's household meter. Indirectly connected households paid metered households a fixed fee, based on the number of appliances used. Many indirectly connected households would have been willing to adopt a formal metered connection if it had been easily available, especially since they had to pay their neighbor a higher price for electricity. These average monthly bills, which quickly added up, could have paid for an official connection.

Generally, households were quite satisfied with the electricity service they received under both the GPOBA scheme and the EEPCo expansion plan. The main problems were related to frequent power cuts, unclear billing procedures, and poor-quality line extensions for indirect connections. The next chapter examines how electricity changed the pattern of household energy use in rural Ethiopia.

4. Patterns of Household Energy Use

Much research has been conducted over the past several decades on the changes in energy-use behavior that occur after households adopt electricity for the first time. Electricity adoption will have an impact on the other fuels households use in their daily lives (Modi et al. 2006; O'Sullivan and Barnes 2006; World Bank 2002, 2007b, 2011b). In some cases, households will make a direct substitution of electricity for other types of energy. In other cases, electricity will permit them to use existing sources of energy in alternate ways for cooking and other household activities. Electricity generally replaces kerosene for household lighting unless electricity service is unreliable during evening hours. New appliances, including televisions and radios, will increase access to mass media and will connect isolated rural areas to the rest of the region and country. This chapter explores the impact of electricity adoption on households in the five study regions of rural Ethiopia by examining changes in their energy-use and expenditure patterns.

Usage Before and After Electricity Adoption

The impact evaluation survey for the Ethiopia study regions found that electricity adoption generally led to many changes in household energy-use patterns. Virtually all households that adopted electricity used it for lighting, adopting either compact fluorescent lamps (CFLs) or incandescent lamps (table 4.1). Households without electricity rarely used these types of appliances for lighting, meaning that their previous primary lighting fuels (i.e., kerosene and candles) were used far less once electricity was adopted.

Batteries are generally an expensive form of electricity, costing US$20–40 per kWh. Given the much cheaper cost of electricity, households were found to switch to plug-in radios and televisions once they adopted electricity. Among households with electricity, 45 percent owned radios or cassette players. For those without electricity, only 23 percent owned these types of appliances, which presumably were battery-run models.

Table 4.1 Appliance Use of Rural Households by Electricity Status, 2014

Type of appliance	Households with electricity (%)	Households without electricity (%)
Lighting		
Incandescent lamps	72	4
CFLs	52	0
Communication		
Mobile phones	71	17
Radios or cassette players	45	23
Televisions	30	1

Source: Ethiopia Impact Evaluation Survey 2014.

After households adopted electricity, most did not use it for cooking. Interestingly, however, the better-quality lighting from electricity led to some changes in cooking patterns, as discussed below.

Household Lighting

In the Ethiopia survey regions, households without electricity traditionally used hurricane lanterns or kerosene wick lamps made of used cans as their primary lighting source. For households that adopted electricity, candles often served as a backup lighting source. Flashlights also served as a form of backup lighting, and were used when people left their homes during evening hours. Households with electricity used various types of lights, including fluorescent tubes, incandescent light bulbs, and energy-saving CFL bulbs.

Based on a survey recall question, 9 out of 10 respondents in households with electricity remembered using kerosene as their primary lighting source.[6] However, after electricity arrived in the households, only about 1 in 4 households continued using kerosene for lighting. Candles were a significant source of lighting both before and after households adopted electricity, and were the main source of backup lighting for households with electricity (table 4.2).

[6] The recall question was "What are the three most frequently used energy sources (for lighting) in your household before and after electrification."

Table 4.2 Household Lighting Before and After Electricity Adoption, 2014

	Status of household electrification			
Main fuel used for household lighting[a]	EEPCo connection (%)	GPOBA connection (%)	Households without electricity (%)	Nearby villages without electricity (%)
Electricity				
Before grid	0	1	0	0
After grid	100	100	n.a.	n.a.
Generator				
Before grid	2	0	1	0
After grid	1	0	n.a.	n.a.
Kerosene				
Before grid	88	86	79	85
After grid	22	27	n.a.	n.a.
Batteries				
Before grid	47	57	45	70
After grid	30	37	n.a.	n.a.
Candles				
Before grid	43	40	35	10
After grid	36	43	n.a.	n.a.
Wood				
Before grid	45	45	48	47
After grid	20	17	n.a.	n.a.

Source: Ethiopia Impact Evaluation Survey 2014.
Note: n.a. = not applicable (i.e., household did not have an electricity connection).
a. Figures are for the top three fuels used by the surveyed households for lighting.

Prior to electrification, households required a fuel that combined both lighting and heating for cooking activities. It appears that about one-quarter of households with a new electricity connection no longer used wood for these purposes as they had done before electrification. Also, households that used charcoal as a cooking fuel required some additional form of high-quality lighting since charcoal emits little light. Better lighting was now made possible by electricity.

As part of the GPOBA scheme, households were to be provided two free CFLs. Unfortunately, this program component suffered from the untimely delivery of CFLs to EEPCo's local offices and insufficient communication on the utility's responsibilities under the program. Only about 30 percent of households indicated they received CFLs under the GPOBA program, and only about half of the GPOBA households ended up using them (table 4.3).

Table 4.3 Percentage of Households Using Incandescent Bulbs and CFLs for Lighting

Household type	Incandescent bulb	CFLs	CFLs replaced with incandescents
EEPCo	68.7	56.7	n.a.[a]
GPOBA	73.6	47.6	33.6
Total	71.4	51.7	n.a.[a]

Source: Ethiopia Impact Evaluation Survey 2014.
Note: Some households with CFLs replaced them after several months of use.
a. n.a. = not applicable.

The use of CFLs also suffered due to voltage fluctuations in the rural grids. Under low voltage, the lamps sometimes would not start up and, due to extreme voltage fluctuations, sometimes failed. As a result, the CFLs were unpopular, even among the households that received them for free. After a short period of time, about one-third of the households that were given the CFLs decided not to use them. Those households generally replaced the CFLs with incandescent bulbs, which were readily available in the village and cheaper than CFLs.

Table 4.4 Potential Annual Energy Consumption and Expenditures for Household Lighting, 2014

Households with electricity	CFLs	Incandescent bulbs	Savings due to CFLs
Actual annual energy consumption (kWh)			
All households with lamps	4,657	51,355	46,698
Kilowatt-hour (kWh) per household	37	263	226
All GPOBA households (265)	9,795	69,790	59,995
GPOBA households with CFLs (35)	1,196	13,198	12,001
Actual annual expenditures (US$)			
All households with lamps	122	1,351	1,229
Expenditure per household	0.97	6.93	5.96
Actual expenditure, including replacing CFLs	31	347	315
Possible annual expenditures (US$)			
Possible annual expenditure if all eligible households used CFLs (US$)	257	1,836	1,579

Source: Ethiopia Impact Evaluation Survey 2014.
Note: The results for actual annual expenditures are based on those households that received CFLs under the GPOBA program. Possible annual expenditures assume that all households eligible for the CFLs actually received them.

Theoretically, the use of CFLs instead of incandescent bulbs had great potential for saving both energy and money, while providing consumers more lighting. Assuming that the GPOBA households had used their 1.84 CFLs (11 W each) for five hours per day, each household would have saved up to 226 kWh per household each year. At the prevailing EEPCo domestic tariff, this

would have represented an annual financial savings of about US$7 per household. Thus, if all GPOBA households had actually received the two free CFLs and used them, the energy savings of the GPOBA households alone would have been nearly 60,000 kWh per year (table 4.4).

Unfortunately, the savings potential of the CFLs was not realized. Contrary to the original plan, only about 48 percent of GPOBA participant households received two CFL bulbs as part of the scheme's connection package. In addition, only about one-quarter of the households receiving the CFLs decided to replace them with new CFLs once they wore out. Even the limited number of households using CFLs suffered from frequent power outages and service interruptions. In effect, only one-fifth of the projected savings of 60,000 kWh per year was achieved by the CFL program component.

Cooking

A common misperception is that electricity adoption will significantly change household cooking practices in developing countries. The reality is that people have been using firewood for cooking for thousands of years. In most countries, the advent of electricity does not significantly change customary cooking practices. Like rural communities in many other developing countries, Ethiopia's rural villages and towns were found to use firewood to meet much of their daily cooking needs both before and after adopting electricity (table 4.5). Firewood is often collected from the local environment, requiring no cash expenditure.

Table 4.5 Cooking Before and After Electrification in Rural Ethiopia, 2014

	Status of household electrification			
Main fuel used for household cooking	EEPCo connection (%)	GPOBA connection (%)	Households without electricity (%)	Nearby village without electricity (%)
Electricity				
Before grid	0	1	0	0
After grid	16	9	n.a.	n.a.
Kerosene				
Before grid	15	15	15	5
After grid	11	11	n.a.	n.a.
Wood				
Before grid	95	88	91	73
After grid	85	85	n.a.	n.a.
Other fuels				
Before grid	18	20	15	30
After grid	17	19	n.a.	n.a.

Source: Ethiopia Impact Evaluation Survey 2014.
Note: n.a. = not applicable (i.e., households did not have an electricity connection).

However, owing to the low price of electricity in Ethiopia at just US$0.02 per kWh—among the lowest rates in Sub-Saharan Africa—some rural households in the five study regions (about 1 in 10 households) adopted the *injera mitad* (electric hotplate for cooking traditional breads), which has impacted their cooking patterns. But due to unreliable power supply, the households that purchased this cooking appliance have complained of not being able to use it regularly. Once the power-supply situation improves, more households may switch to cooking certain items using electricity, given the country's low domestic electricity tariff.

Summing up, the main cooking patterns did not change in the study regions after electrification, which is consistent with findings elsewhere. Wood is still used by 9 out of 10 households in rural Ethiopia both before and after electrification. In addition, the survey found that 11–19 percent of households use kerosene or other fuels (e.g., agricultural waste products) for cooking.

Television and Radio

Communication is an important benefit of rural electrification programs. In rural areas without electricity, most communication is local, with the exception of communication using battery-powered radios. In many developing countries, cell phones are also becoming a mainstay of rural communications. Radios and cell phones do not require much electricity; but the monthly expense for batteries, depending on their use, can be substantial. Electricity provided by batteries is quite expensive, sometimes reaching US$40 per kWh.

In rural Ethiopia, few households in the surveyed villages and towns owned televisions prior to electrification; however, many had radios. Out of the 760 households surveyed, only 15 had a television set, while nearly 150 owned a radio. The radios were almost exclusively powered by dry-cell batteries. The televisions, which required a bit more power, were powered by generators, 12-V car batteries, or photovoltaic (PV) solar home systems (SHSs).

The pattern of television ownership changed dramatically after electricity adoption. Once households had a grid connection, a significant number immediately purchased a television set. For households receiving electricity through other EEPCo programs, nearly half adopted a television (table 4.6). For GPOBA-participant households, the television adoption rate was closer to one-third.

Table 4.6 Television Ownership Before and After Electricity Adoption, 2014

	Status of household electrification			
Main fuel used for TV	EEPCo connection (%)	GPOBA connection (%)	Households without electricity (%)	Nearby village without electricity (%)
Electricity				
Before grid	2	0	0	0
After grid	47	33	n.a.	n.a.
Batteries (12-V PV system, dry cell)				
Before grid	0	2	0	0
After grid	1	0	n.a.	n.a.

Source: Ethiopia Impact Evaluation Survey 2014.
Notes: n.a. = not applicable (i.e., households did not have an electricity connection). Four households had electricity powered by a generator before electrification and none after electrification. Two households used a 12-V battery before electrification and none afterwards.

It should be kept in mind that GPOBA households have only had electricity for about two years, and most have had service for a year or less. With time, it is expected that increasingly more households will adopt televisions, as has been common in other developing countries. Thus, one major change in communication that occurs in Ethiopia as a result of rural electrification is an increase in information and entertainment through the availability of television.

Table 4.7 Radio Ownership Before and After Electrification, 2014

	Status of household electrification			
Main fuel used for radio	EEPCo connection (%)	GPOBA connection (%)	Households without electricity (%)	Nearby village without electricity (%)
Grid electricity				
Before grid	1	1	0	0
After grid	54	55	n.a.	n.a.
Battery				
Before grid	50	55	41	33
After grid	29	30	n.a.	n.a.
Generator, 12-V car battery, or PV solar home system (SHS)				
Before grid	2	0	0	0
After grid	1	0	n.a.	n.a.

Source: Ethiopia Impact Evaluation Survey 2014.
Note: n.a. = not applicable (i.e., households did not have an electricity connection). Four households had electricity powered by a generator before electrification and none after electrification. Two households used a 12-V battery before electrification and none afterwards.

Prior to electrification, about one-half of households had radios powered by dry-cell batteries. Even for households that did not adopt electricity under the GPOBA project or EEPCo programs, more than one-third still used this type of radio (table 4.7). With the advent of electricity, the proportion of households using dry-cell powered radios dropped from about one-half to less than one-third. Also, some new households that did not have radios in the past purchased plug-in radios after they adopted electricity. Among the households that adopted electricity, the number with a radio was about half of those with electricity service.

In other countries, the adoption of television has sometimes led to a decline in the number of radio users. The higher quality and unique nature of television has a tendency to replace the time spent listening to radio. This has not yet happened in Ethiopia, as both televisions and radios have increased in number. However, as increasingly more people purchase televisions, a modest decline in radio listening might be expected in future years. The impact of the availability of entertainment, news, and other types of communication made possible by television often extends beyond the family that owns the television set to include neighbors and relatives that often stop by to watch favorite programs.

Consumption and Expenditures

Access to electricity provides new opportunities for communication, social activities, and productive uses. Good lighting means that households can socialize in the evening. Information flow is improved through having television and radio. The possibility of charging mobile phones or perhaps accessing the Internet can link rural households to the world outside of their villages. However, this new demand for better living conditions can also lead to increased household cash expenditures. In this section, we examine the impact of rural electrification on household energy expenditures.[7]

Monthly Household Income and Energy Expenditure

The monthly income and expenditures reported in this study are probably somewhat low. The main sources of income and expenditure were captured in the impact evaluation survey, meaning that some minor sources of household income were omitted. As might be expected, the yearly household income in rural Ethiopia is slightly higher than expenditures (table 4.8). Those households that had electricity for a longer period of time (EEPCo households) had higher incomes than more recent electricity adopters (GPOBA households). Likewise, all households with electricity had higher incomes and expenditures than those without electricity. No doubt, this was

[7] During the impact evaluation survey, some difficulties occurred in gathering correct electricity consumption data from households. The main reasons were corrupt or broken meters and irregular collection of electricity bills, along with informal household connections. However, the information provided suggests the approximate levels of household electricity used in the survey areas.

a self-selecting process. Households with higher incomes can better afford an electricity connection and the monthly charges for adopting electricity.

Table 4.8 Income of Households with and without Electricity in Ethiopia, 2014

Electrification status	Yearly household income (US$)	Yearly household expenditure (US$)
EEPCo connection	918	814
GPOBA connection	932	675
Households without electricity[a]	681	601
Nearby village without electricity	844	651
Average	851	694

Source: Ethiopia Impact Evaluation Survey 2014.
Note: Exchange rate is 1 US dollar = 19 Birr.
a. Households without electricity are in villages with electricity.

Both household incomes and expenditures rose between the 2011 and 2014 surveys. Given the short period between the surveys, these increases should not be attributed to the impact of electricity, and are more likely due to inflation. The survey figures are not adjusted for inflation, and the rising cost of living played a significant part in increasing household energy expenditure. Also, a high percentage of GPOBA households were selling electricity to their neighbors who could not obtain direct metered connections. These additional charges to households would show up as reported income and expenditure for those households that had adopted electricity. Furthermore, at the time of the survey, there was an increase in ground-transport costs to rural areas for commercial fuels (e.g., kerosene, firewood, and charcoal), which significantly increased the delivered costs of such energy sources.[8]

Despite the survey issues and recent high rates of inflation in Ethiopia, the final survey results are fairly consistent with other worldwide energy surveys. The overall findings are that purchased energy accounts for an average of about 20 percent of household income (table 4.9).

[8] In this section, the study focuses on the impact evaluation survey carried out at one point in time.

Table 4.9 Expenditures on Energy in Ethiopia, 2014

Fuel	EEPCo households	GPOBA households	Households without electricity[a]	Nearby village without electricity
Energy expenditures ($ per month)				
Electricity	2.2	1.3	0.0	0.0
Kerosene	2.2	1.6	2.6	1.8
Dry-cell batteries	1.1	1.2	1.2	1.3
Candles	0.9	1.0	1.1	0.6
Firewood	8.8	10.3	7.3	6.3
Charcoal	8.0	7.5	10.2	6.8
Mean total expenditure/ $ per month	16.9	15.8	14.1	9.7
Income and expenditures				
Mean annual energy expenditure ($)	202	189	169	117
Expenditures on energy (%)	25	28	28	18
Income spent on energy (%)	22	20	25	14
Income spent on electricity (%)	2.9	1.7	0	0

Source: Ethiopia Impact Evaluation Survey 2014.
Note: Exchange rate is 1 U.S. dollar = 19 Birr.
a. Households without electricity are in villages with electricity.

In villages without electricity, the household income spent on energy is a bit lower, probably because such households collect more fuels for cooking and are slightly poorer than those in villages with electricity. The high percentage of income spent on energy is partly because the survey measure of income is in cash; however, in rural areas, much income is in-kind, which is not measured by the survey. Farmers sell a small portion of the grain they produce in the local market. If this were included, the percent of income spent on energy would be somewhat lower. In contrast to income, commercial energy sources all involve cash expenditures.

Electricity

Electricity from the grid is quite affordable for rural households, accounting for just 2–3 percent of all expenditures and only about 10 percent of all energy expenditures (table 4.9).[9] These findings agree with other international household energy studies, which indicate that households spend 2–5 percent of their income on electricity. As households in rural Ethiopia transition to

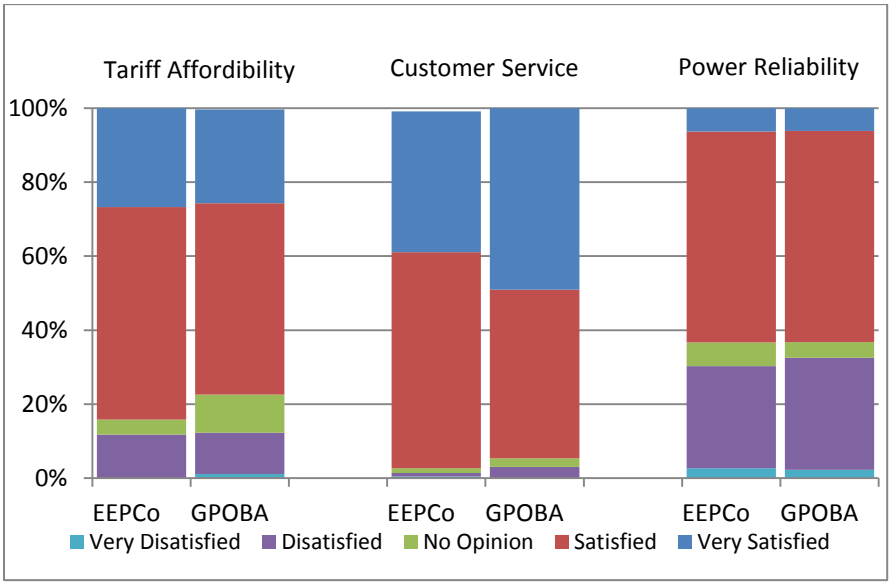
[9] Electricity consumption data was available for only 21.8 percent of the 107 households surveyed because many surveyed households had an inaccurate meter or were lacking bills.

electricity, their other energy expenses do not decline by much. It would have been expected that kerosene for lighting would be significantly reduced. But kerosene was used in similar amounts by households with and without electricity. Perhaps the kerosene saved from lighting in households with electricity was repurposed for cooking, as well as used as a backup power supply.

For electricity, the GPOBA households spent about US$1.30 on their average monthly electricity consumption of about 12 kWh per month. The EEPCo households used an average of 15 kWh and paid about $2.20 per month. These results were confirmed by the baseline survey for all households, which indicated the average monthly expenditure for electricity was about $2.60 per month.[10]

Households in rural Ethiopia generally considered that the price of electricity was affordable. This was not unexpected since, by international standards, Ethiopia's electricity price is extremely low, at about US$0.02 per kWh. More than 80 percent of households with electricity considered the price of electricity as reasonable, while only slightly more than 10 percent thought it was priced too high (figure 4.1). When asked how much they would be willing to pay for a reliable supply of electricity, households responded they would be willing to pay $2.20 per month, which is quite similar to the amount already being paid by EEPCo households but much higher than the $1.30 expenditure of GPOBA-participant households. Thus, there may be room to increase the price of electricity among poor households that are not extremely poor.

Figure 4.1 Opinions Toward Tariff Affordability, Customer Service and Power Reliability, 2014



Source: Ethiopia Impact Evaluation Survey 2014.

[10] Average monthly consumption is for all GPOBA customers, including institutional and commercial (heavy-weight) consumers (Sources: GPOBA Task 1B Database, EEPCo Central Marketing Department, IT Unit).

Households were generally satisfied with EEPCo's customer service and tariff affordability; however, power reliability did not fare as well (figure 4.1). More than 90 percent of the households surveyed indicated they were satisfied with customer service, and over 60 percent said they were satisfied with tariff affordability. But less than 10 percent were very satisfied with power reliability, meaning that 30 percent were either dissatisfied or very dissatisfied. Typically, during a country's first years of rural electrification, most households indicate they are satisfied with electricity service, mainly because they are making comparisons with their situation before electricity arrived in their communities; therefore, satisfaction with service reflects customers' happiness in having been able to adopt electricity service. Having 30 percent of households with new electricity service dissatisfied with power reliability is quite a large percentage.

Kerosene

Kerosene is an important fuel in rural Ethiopia, used either for lighting or cooking. It is commonly sold in small plastic containers, called "Fanta-bottles," containing about 330 ml. In Ethiopia, the average price of such containers of kerosene is about US$0.40–0.60 (8–12 Birr). People in rural Ethiopia are aware that kerosene lamps are polluting. About 70 percent of the surveyed households affirmed that kerosene lamps had a bad odor and gave off poor light.

The household consumption of kerosene in Ethiopia is fairly low compared to other countries. The amount of kerosene consumed by rural households is about 2 liters per month (table 4.10). One explanation for the low level of kerosene use is the way it is priced in communities. People purchasing smaller amounts are usually charged a higher price. In the study villages, the average price per liter was slightly more than US$1 (23 Birr), but the price for 1 liter varied considerably between $1 and $2, depending on local availability within the village. In more remote areas, many households complained about the high price of kerosene. Forty-five percent of the surveyed households stated that kerosene is not readily available in their village and is quite highly priced.

Table 4.10 Overview of Monthly Expenditure/Consumption of Kerosene, 2014

Household type	Total monthly energy expenditure (US$)	Monthly expenditure on kerosene (US$)	Kerosene as share of total energy (%)	Average kerosene consumption (liters)
Total	15.2	2.1	14.1	1.9

Source: Ethiopia Impact Evaluation Survey 2014.

One explanation for the increased kerosene expenditure is the way it is priced in the communities. People purchasing smaller amounts are usually charged a higher price. In the study villages, the average price per liter was slightly more than US$1 (23 Birr), but the price for 1 liter varied quite a bit between $1 and $2, depending on local availability within the village. Many households that lived in more remote areas complained about the high price of kerosene. Forty-five percent of the surveyed households stated that kerosene is not easily available in the village and that it is quite highly priced.

Batteries and Candles

Batteries and candles are an alternative to electricity for lighting. About 65 percent of the households studied used batteries for lighting or radios. These households purchased an average of three batteries per month, spending about US$1.20. Candles were used for lighting or as backup fuel in case of power outages. Candle-using households typically used 4–6 candles per month, spending about US$1.00 on average. Due to the irregularity of electricity service, many households with electricity found it necessary to continue using candles and batteries as backup fuels in amounts not much less than those spent by households without electricity. As documented in other developing countries (e.g., Banerjee et al. 2015), improvement in the power supply, no doubt, would mean more people using electric radios and lighting and thus would result in a significant decrease in the use of batteries and candles.

Firewood, Charcoal, and Gas

For cooking, the surveyed households typically used firewood, charcoal, or gas. Firewood, used by two-thirds of the surveyed households, was the most important household energy expenditure. Households either collected it from nearby common-access land or bought it in the local market. Firewood was sold in bundles and donkey loads (equivalent to about 60 kg of wood) or truck loads. The majority of households indicated they typically purchased 4 bundles or 2 donkey loads per month. The average price for 1 donkey load was US$3.00–$5.50. For households that used firewood, the estimated average monthly expenditure on wood was about $8.00.

The use of charcoal for cooking or heating was found to be less common than firewood, and its availability in the rural markets was somewhat limited. Even so, about 25 percent of the surveyed households used charcoal. Charcoal cannot be collected from the local woodlands; instead, all of it is purchased in the commercial market. As a result, households that used charcoal spent an average of about US$8.00 per month on this fuel. It should be emphasized that this amounts dwarfs that spent on electricity. Finally, the use of bottled gas was uncommon in rural areas of Ethiopia.

Conclusion

The promotion of electricity in rural areas of Ethiopia has had a significant impact on how households use energy. Predictably, the largest shift in energy use involved household lighting. Households that adopted electricity were extremely satisfied with the improvements in household lighting made possible by electricity. They perceived that kerosene did not provide enough light. Also, most households indicated that kerosene use was somewhat polluting. After adopting electricity, households generally used fewer batteries, somewhat less kerosene, and less wood for lighting. A surprising number of households indicated that they had television. The use of plug-in radios also became popular after electricity arrived in communities in rural Ethiopia.

Electricity is also quite affordable in rural Ethiopia, comprising only 2–3 percent of total income, a figure fairly typical of many developing countries. However, rural households in Ethiopia have many other energy expenditures, especially those related to cooking. Purchased energy accounts for up to 20 percent of household income. Also surprising was that some households with new electricity service use it for some cooking, most likely because of the extremely low price of electricity in Ethiopia. Electricity's affordability, combined with its significant impact on rural households, means that rural electrification is an important development program for the country. Given electricity's low price and household impact, it is little wonder that some households that could not obtain an official meter from EEPCo adopted electricity indirectly by connecting to a neighbor with an official meter.

The major benefits of electricity for households in rural Ethiopia were household lighting, communication, and, to a more limited degree, cooking. In order to further examine changes in energy use, the next chapter takes a closer look at the more general welfare benefits of electricity for people living in rural Ethiopia, including education, health, and changes in family social interactions.

5. Impact on Household Quality of Life

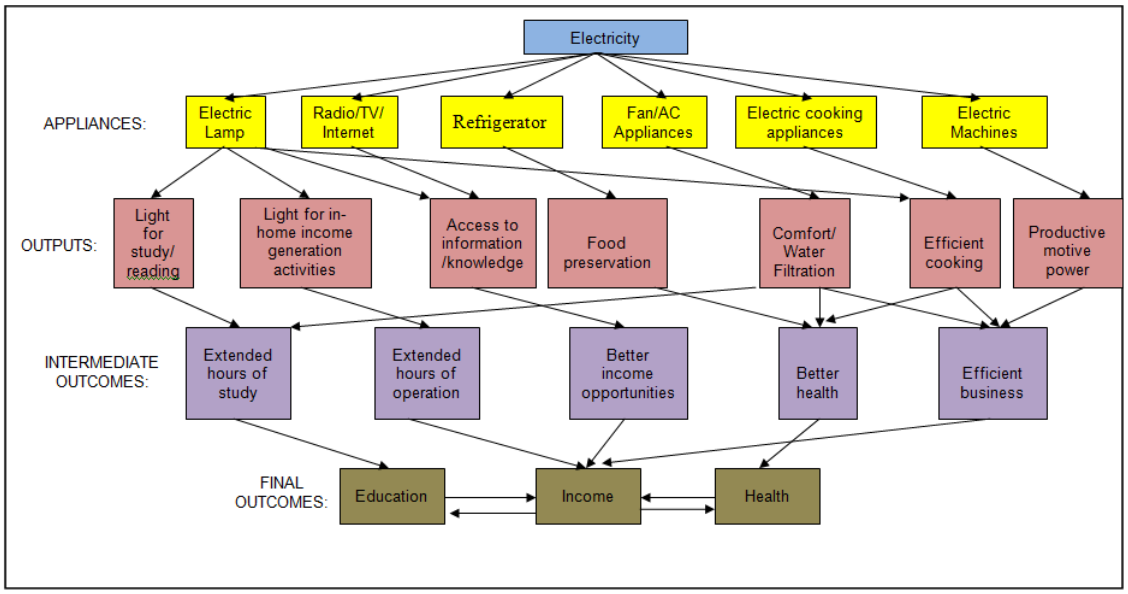
The adoption of electricity is important for improving rural households' quality of life. The use of electricity not only is substituted for less efficient fuels, but also establishes a resource that quickly changes life in rural households. Electricity provides better access to information, more avenues of communication, enhancement of social activities, and increased productivity. Televisions, radios, and cell phones all link rural households to the world outside. At the same time, electricity increases the demand for new or improved electrical equipment. In social terms, women and children benefit the most from rural electrification. Rural households use electricity initially for lighting, which allows for evening reading and study for schoolgoing children.

Electricity and Appliance Ownership

Electricity is a necessary but insufficient condition for development. The welfare benefits from rural electrification invariably result from the use of some type of appliance or machine. Thus, it is necessary to trace some of the pathways of electricity and its eventual social and economic impacts. For example, electricity provides improved household lighting (Nieuwenhout et al. 1998), which immediately increases children's study hours (Barakat et al. 2002; World Bank 2002; Unnayan Shamannay 1996); this, in turn, improves school attendance and higher education for children. Community or street lighting provides higher levels of community illumination during evening hours, but the real benefit is a greater sense of security. Figure 5.1 illustrates the probable pathways leading to welfare impacts for households and individuals. These pathways are complex, and no doubt there are others that have an impact on socioeconomic development.[11]

[11] This section is based on Khandker, Barnes, and Samad (2012a).

Figure 5.1 Pathways of Rural Electrification's Development Impact



Source: Khandker, Barnes, and Samad 2012a.

The adoption of grid electricity first means having access to a reliable and inexpensive electricity supply. Consumers soon begin buying a variety of electric appliances, including light bulbs, radios, television sets, space coolers/heaters, cooking devices, and other small machines. The next step is that these appliances produce results, such as more light, which allows more study or home production, more access to information and entertainment, more comfort, better food preservation, more efficient cooking, and finally more motive power for productive uses (World Bank 2002; IEG 2008). At times, households use small cooking devices, such as hotplates or electric coils, for heating water. In the case of rural Ethiopia, people sometimes cook with the electric *injera mitad* (hot plate for cooking traditional flatbread). In addition, in some instances, electric lighting and small grinders allow people to prepare food more efficiently, thus freeing up their time for other activities (World Bank 2004).

The use of such appliances, in turn, can create intermediate outputs, such as extended study time, longer hours of operation for home businesses, better business knowledge, better health, and more efficient business operation. These intermediate outputs can lead to final development outcomes, such as improved education, health, and income. In the case of education, for example, children's increased study time due to electric lighting results in better performance at school; in the long run, this leads to higher educational attainment and ultimately higher income. A fairly large body of literature, beginning with Mincer (1974), discusses the returns to education. Similarly, the productive uses of electricity have been the subject of many studies. The main findings are that complementary conditions, such as active markets and available credit, are

necessary to realize the full benefits of rural electrification (Cabraal, Barnes, and Agarwal 2005; Asaduzzaman, Barnes, and Khandker 2009).

Even small businesses can take advantage of electric lighting and appliances. The use of electricity in small retail shops or food stores can mean longer business hours and refrigeration. Conceptually at least, the pathways of electricity's impact on both outputs and outcomes can lead to gains in household income and productivity. This chapter focuses on appliance ownership, people's perception of improvement in energy services, use of electricity in small businesses, improvements in education, and other impacts of rural electrification.

Electric Appliance Ownership

Electricity offers new opportunities for households, including improved quality of household lighting, enhanced flow of information, and better communication. In order to realize such benefits, households purchase appliances. The availability of electricity enables households to purchase a wide array of appliance types. Of course, households will be limited by their income, but even the poorest ones value the purchase of new appliances.

In the Ethiopia study, most GPOBA households had enjoyed electricity for only one or two years at most, and EEPCo households had not had electricity for much longer. It is well established that households accumulate new appliances over time. After expending income to purchase appliances in a first wave, they save money and plan for later purchases. Results of the impact evaluation survey thus provide a snapshot of this first round of purchasing household appliances in rural Ethiopia.

While chapter 4 examined the use of household energy for lighting, cooking, and communication, here we examine the adoption of electric appliances that produce better development outcomes (table 5.1). We know that 100 percent of the households with electricity in this study have incandescent lamps or compact fluorescent lamps (CFLs). The GPOBA intervention has stressed the use of CFLs by aiming to provide all households adopting a connection under the program two free CFLs. Despite the logistical problems in providing these lamps, more than half of GPOBA-participant households had CFLs. More surprising, 48 percent of EEPCo households also had CFLs (table 5.1). Perhaps due to significant voltage fluctuations in the service areas, both EEPCo and GPOBA households had a high level of incandescent lamps. For households without grid electricity, a small number had electric lamps that used either batteries or solar home systems (SHSs) for lighting.

Table 5.1 Rural Household Investments in Appliances, 2014

Appliance type	EEPCo households (%)	GPOBA households (%)	Households without electricity (%)	Nearby village without electricity (%)
Lighting				
Incandescent lamps	69	74	5	0
CFLs	57	48	0	0
Communication				
Mobile phones	73	70	18	15
Radios or cassette players	46	45	24	18
Televisions	33	28	1	0
Other appliances				
Refrigerators	6	3	0	0
Hair dryer or clippers	1	1	0	0
Water boiling kettles	1	0	0	0
Injera mitad	5	4	0	0
Space heaters	2	1	0	0
Total households = 760	224	265	211	60

Source: Ethiopia Impact Evaluation Survey 2014.
Note: Households without electricity are in villages with electricity. Some households in this category have electricity from other sources, such as batteries or PV solar home systems (SHSs). Communication equipment can run on batteries.

Many households with electricity appreciated the impact that rural electrification has on communication. About three-quarters of rural households with electricity had mobile phones, as did approximately one-fifth of households without electricity, who often charged their phones at charging stations or in neighbors' homes. Radios and cassette players were also popular in homes with electricity. Nearly half of homes with electricity had plug-in radios, compared to one-quarter of homes without electricity (table 5.1). No doubt, those without electricity used expensive batteries to power their radios. More surprisingly, one-third of households purchased a television set shortly after connecting to electricity, attesting to television's popularity for obtaining news and entertainment. In contrast, television sets were seldom found in households without electricity.

Predictably, most other appliances had not yet been purchased, given the short amount of time that the surveyed households had had electricity. Surprisingly, however, the electric injera mitad had been purchased by about 5 percent of rural households with electricity (figure 5.2). This hotplate draws quite a bit of power, costing about US$100. A similar percentage of rural households had bought refrigerators. Purchase of these two appliances could have a profound impact on household cooking practices in rural Ethiopia.

Figure 5.2 Woman with Newly Purchased Electric Injera Mitad, 2013

Source: Ethiopia survey team members 2013.
Note: The *injera mitad* is a hotplate for cooking the main bread consumed in Ethiopian villages.

Table 5.2 Rural Household Purchases of New Electric Appliances during Last 12 Months, 2014

Appliance type	EEPCo households	GPOBA households	Households without electricity[a]	Nearby village without electricity
Households making new investments (%)	45	44	5	0
Total investments (US$)	96	70	2	0
Total households = 760	224	265	211	60

Source: Ethiopia Impact Evaluation Survey 2014.
a. Households without electricity are in villages with electricity; some households in this category may have electricity from other sources (e.g., batteries, PV solar home systems [SHSs], or indirect connections).

The purchase of household appliances requires cash. About half of the surveyed households with electricity had purchased appliances during the past 12 months. Nearly 50 percent of households with electricity had made a new appliance purchase in the past year. Among those surveyed, the average amount spent on new appliances during the past year was US$96 for EEPCo households and $70 for GPOBA households (table 5.2). The lesser amount spent by GPOBA households can probably be explained by their somewhat lower income levels, compared to those that had connected during the first round of connections for the community prior to the GPOBA

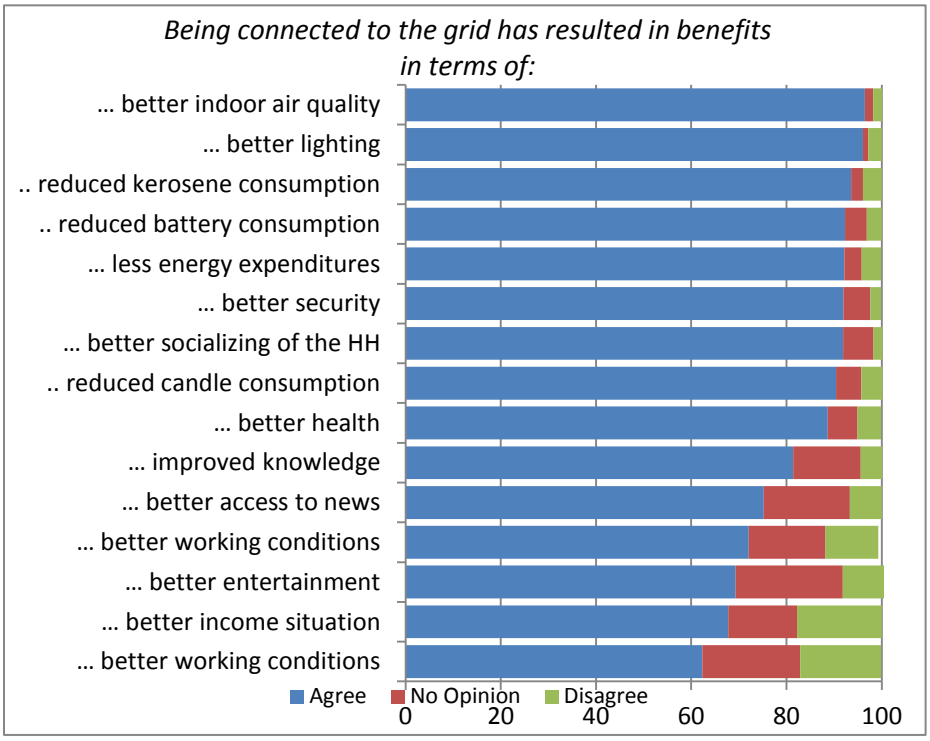
program. The amount of money spent by households was wide-ranging, from less than $10 to as much as $800.

While remittances and loans from friends and relatives might explain how the high level of appliance purchases was made during the study period, the availability of electricity made this new wave of appliance purchasing possible, underscoring the need for rural electrification programs to think beyond provision of wires and poles. That is, thinking must extend beyond the necessary conditions for development to those appliances that provide the development benefits resulting from rural electrification. The impact of the rural electrification program might be greater if a microcredit program allowed households to spread out payments for electric appliances. This is not to say that subsidies are necessary for promoting household appliances. Rather, the financing of appliances, like the financing of initial household connections, could perhaps be supported by microfinance institutions (MFIs).

Household Opinions on Electricity Benefits

Households with electricity in rural Ethiopia have a quite favorable opinion of the benefits of rural electrification. When households were asked to agree or disagree with the statement "being connected to the grid has resulted in benefits in terms of better lighting," more than 95 percent agreed and few disagreed (figure 5.3).

Figure 5.3 Attitudes Toward Outcomes by Households with Electricity



Source: Ethiopia Impact Evaluation Survey 2014.

Taken alone, this result was not surprising; however, households' perception of benefit did not stop at lighting. They believed that electricity was responsible for better indoor air quality, reduced kerosene consumption, and generally less expenses for energy. In addition, they felt more secure and perceived their health to be better, perhaps due to the better indoor air quality.

Opinions on electricity benefits were also favorable in terms of attitudes toward economic opportunities. More than 60 percent of households agreed that "being connected to the grid has resulted in benefits in terms of better income and working conditions." However, opinions toward working conditions were less positive than those related to the quality of life within households. This is not unexpected since it generally takes longer for economic development to have an impact on quality of life, compared to the purchase of household appliances. This is not to say that electricity will not eventually benefit the local business community in rural Ethiopia. But new jobs and economic opportunities cannot be expected to develop overnight, and generally require longer periods of time to have a full impact.[12]

Social Impact of Electricity

Until a severe storm affects power supply lines, most people in developed countries do not consider the importance of electricity in their lives. This is not the case for those in rural areas of such developing countries as Ethiopia, where the vast majority of people have never had electricity. This fact was a major advantage for assessing the social impact of rural electrification. Because this impact evaluation study was conducted only a few years after households adopted electricity for the first time, the memories of living without power were fresh in their minds.

This section examines the opinions of people in rural Ethiopia about life before and after the arrival of electricity. These include opinions about how having electricity has changed their time use and living patterns, improved their children's education, and made them feel safer and more secure.

Changes in Living Patterns

With better lighting, communication, and entertainment, family members no doubt changed their time-use patterns, especially during evening hours. Survey questions were asked about the "two main activities" of household members (men, women, boys, and girls) before and after adopting electricity. Focusing on the two main activities of household members during evening hours revealed patterns of social change resulting from the rural electrification program.

In households without electricity, the main evening activities for men involved discussions with family members and tending to cattle (table 5.3). More than one-quarter of men indicated

[12] This issue is more fully addressed in chapters 6 and 7.

they go to sleep early in the evening. After adopting electricity, men still tended cattle; however, because they did not have to go to sleep early, they were able to do other activities. The main change was that television viewing increased from about zero before electrification to about one-quarter after adopting service (about the same percentage as those owning a television set). No doubt, more households will view television in the future as sets become more common in villages and towns with electricity. Family discussion time also increased significantly for men, perhaps due to the availability of better lighting. Also, men tended to listen to the radio a bit more after electricity was adopted.

Table 5.3 Top Evening Activities of Men and Women Before and After Electrification, 2014

	Men (%)				Women (%)			
	Before electricity		After electricity		Before electricity		After electricity	
Household activity	EEPCo	GPOBA	EEPCo	GPOBA	EEPCo	GPOBA	EEPCo	GPOBA
Family discussion	18	12	25	27	7	4	12	14
Eat dinner	7	6	4	6	2	2	2	3
Tend cattle	30	28	22	23	1	0	1	1
Radio listening	12	8	14	13	1	0	6	4
Sleep early	28	41	6	8	12	10	2	1
Domestic work	1	0	1	3	84	89	78	88
Watch TV	1	1	35	30	1	0	23	14
Help children study	1	2	8	9	0	1	2	4
Own study	2	1	2	1	0	0	0	0
Households answering	138	162	157	170	193	234	188	227
Number of households	224	265	224	265	224	265	224	265

Source: Ethiopia Impact Evaluation Survey 2014.
Note: The question asked only for the top two main activities of households before and after electrification. The % figures are only for households answering the question; the others were treated as missing values.

The main activities of women before having electricity differed markedly from those of men. Interestingly, the changes due to adopting electricity were quite similar. Overall, women's main activity was domestic work, including cooking. Like men, their living patterns changed after adopting electricity. Women also did not go to sleep as early as before. They also did less domestic housework, freeing up time for activities that were quite similar to those of men. More women in households that adopted electricity watched television and participated in family discussions. Thus, the main change overall for adult men and women in rural households that adopted electricity related to communication. Better lighting allowed households to stay up longer and participate in family discussions. For those that had televisions, virtually all men and women watched it as a main activity in the evening.

The focus group discussions (FGDs) conducted as part of the household survey revealed that the adoption of electricity reduced the amount of travel time necessary for purchasing kerosene

and charging mobile phones. For households without electricity, the charging of mobile phones is difficult and time consuming. Shops and nearby households in the villages offer mobile charging services for a fee. Once households adopted electricity, phone charging was done less expensively in the home.

In households that had not yet received electricity, the living patterns of children and adults differed. The main difference was that children studied after dark by the weak light provided by kerosene lanterns (table 5.4). Between one-quarter and one-third of children in the surveyed households without electricity studied in the evening. Otherwise, they participated in family discussions and went to sleep early in the evening.

Table 5.4 Top Evening Activities of Boys and Girls Before and After Electrification, 2014

	Boys (%)				Girls (%)			
	Before electricity		After electricity		Before electricity		After electricity	
Household activity	EEPCo	GPOBA	EEPCo	GPOBA	EEPCo	GPOBA	EEPCo	GPOBA
Family discussion	14	13	9	9	6	10	6	5
Eating dinner	4	6	2	2	2	3	2	1
Tending cattle	11	3	8	2	0	0	0	0
Radio listening	3	4	6	3	1	1	4	2
Sleep early	14	21	1	2	12	17	0	1
Domestic work	4	4	4	2	35	33	26	24
Watch TV	0	0	18	21	1	0	12	11
Own study	71	60	85	88	62	52	80	78
Households answering	145	156	158	170	144	153	160	165
Number of households	224	265	224	265	224	265	224	265

Source: Ethiopia Impact Evaluation Survey 2014.
Note: The question asked only for the top two main activities of households before and after electrification. The % figures are only for households answering the question; the others were treated as missing values.

Once a household adopted electricity, evening study time increased by about 15–20 percent for both boys and girls, reaching well over half of all households with electricity. More boys and girls watched television in the evening, but the number was only about 10 percent, compared to more than 20 percent for adults. Thus, television does not appear to substitute for study time. The number of boys and girls that fell asleep early declined significantly for households that adopted electricity. For girls, the increase in study time may also have been caused by a decline in time spent doing domestic work during evening hours.

The FGDs confirmed the changes observed in the household survey. According to the FGDs, the adoption of electricity encourages households to buy televisions or radios. Television offers useful information that can enhance the productivity of inputs used in household production, leading to increased income. Family members gain knowledge and awareness of events and

activities that are socially beneficial. Furthermore, women may gain awareness of reproductive health issues, which can empower them in household decision-making. Such changes are expected to contribute to the improved welfare of all household members. FGD participants also wondered whether electricity would bring new services to their communities, including the opening of business establishments.

Better Education

That more children are able to study once a household adopts electricity means that it is important for children's education. The improvement in children's education, in turn, is important for their future income as they reach adulthood and for the country overall, which will benefit from a more educated population.

Electricity's estimated benefits for education have been well documented for developed countries and, to a lesser extent, for developing countries. Intuitively, one knows that education can lead to higher streams of future income over an individual's lifetime. Such intuition was formalized in Mincer's classic model for analyzing the income returns of education, which established that additional education leads to higher incomes (Mincer 1974). Education is more like an investment than a consumer good. This study does not estimate the future potential gains from education, but it does analyze the change in student study patterns that result from their households adopting electricity.

There is accumulated evidence on the strong positive relationship between rural electrification and education. In Bhutan, for example, a household survey conducted in 2010 found that rural electrification increased children's evening study time by 10 minutes and grade completion by three-quarters of a year (Kumar and Rauniyar 2011). In Brazil, a recent study on county-level electrification (made possible by a hydropower dam) suggests that countries achieving full electrification see a 22 percent drop in illiteracy, a 19 percent reduction in the population with less than four years of education, and an increase of 1.2 years in schooling completion (Lipscomb, Mobarak, and Barham 2013).

Building on this evidence, some recent studies using advanced statistical techniques have established the causality between electrification and educational outcomes by controlling for the possibility that those with higher levels of education are more likely to adopt electricity (Khandker, Barnes, and Samad 2012a, 2012b, 2013). In Bangladesh, both boys and girls in households with electricity spent more time studying and had higher levels of grades completed in school. Also, it does not appear that the source of electricity mattered, as children from households with decentralized sources of electricity in Bangladesh (SHSs) and Nepal (community micro-hydro systems) also studied longer than those living in households without any form of electricity. The implication is that electrification indeed contributes to better education.

The opinion of recent household adopters of electricity in Ethiopia mirrors the findings of numerous studies in other developing countries indicating that rural electrification has positive impacts on both the number of hours children study and their participation in school. In fact, according to the FGDs and survey questionnaire, households adopting electricity in rural Ethiopia have high hopes for their children's education. About 95 percent of those households with electricity think that electricity will improve the educational possibilities of their children (table 5.5). Even the surveyed households without electricity had a positive view of the relationship between rural electrification and education.

Table 5.5 Household Opinion of Electricity's Impact on Improvement in Children's Education, 2014

Household opinion	EEPCo households (%)	GPOBA households (%)	Households without electricity (%)[a]	Nearby village without electricity (%)[a]
Has electrification resulted in improvement in children's education?				
Yes	95	94	n.a.	n.a.
No	5	6	n.a.	n.a.
Total	100	100	n.a.	n.a.
Missing/no children in household (%)	17	23	n.a.	n.a.
Total households	224	265	211	60

Source: Ethiopia Impact Evaluation Survey 2014.
Note: The survey question was "Where do children usually do their homework for school (at home, elsewhere, etc.)?"
a. n.a. = not applicable.

The optimism of households with electricity was borne out by changes in the location and hours of children's study. Households still without electricity or those who could recall life before electricity reported that between one-fifth and one-third of children studied outdoors to take advantage of daylight for reading (table 5.6). After households adopted electricity, many more children were able to study indoors. After electricity adoption, about four-fifths of children studied at home, while the number studying outside dropped to zero. Thus, the survey confirms that the study environment for children living in homes with electricity improves as a result of improved household lighting.

Table 5.6 Children's Location of Homework Before and After Electrification, 2014

Homework location	EEPCo households (%)	GPOBA households (%)	Households without electricity (%)[a]	Nearby village without electricity (%)[a]
Before electrification				
Home	44	38	37	32
School	2	4	5	7
Outdoors	34	34	16	20
Neighbor	1	1	0	8
No answer/no children	19	23	42	33
After electrification				
Home	83	76	n.a.	n.a.
School	0	1	n.a.	n.a.
Outdoors	0	0	n.a.	n.a.
Neighbor	0	0	n.a.	n.a.
No answer/no children	17	23	n.a.	n.a.
Total (%)	100	100	100	100
Total households = 760	224	265	211	60

Source: Ethiopia Impact Evaluation Survey 2014.
Note: The survey question was "Where do children usually do their homework for school (at home, elsewhere, etc.)?"
a. na = not applicable.

Not only did the place of study change in households with electricity, children's evening study time increased (table 5.7). For households who could recall life before having electricity and those still without it, children studied approximately two hours per night. After adopting electricity, children tended to study a full extra hour (three hours per night). This difference is likely to impact not only current school performance, but also the likelihood that children will stay in school. Better prepared students are often perceived positively by teachers. Other international studies have confirmed that school attendance increases with the adoption of electricity by rural households.

Table 5.7 Children's Study Hours Before and After Electrification, 2014

Children's study time after dark	EEPCo households	GPOBA households	Households without electricity[a]	Nearby village without electricity[a]
Before electrification (hours per night)	2.0	1.9	1.8	2.2
After electrification (hours per night)	3.0	3.0	n.a.	n.a.
Households (number)	185	211	121	44
Missing/no children in household (%)	17	20	43	27
Total households	224	265	211	60

Source: Ethiopia Impact Evaluation Survey 2014.
Note: The survey question was "How many hours do children study at night (after it gets dark) on average?"
a. n.a. = not applicable.

It should not be overlooked that the quality of primary and secondary schools might also be enhanced after electricity reaches a village or town. Schools can be equipped with computers, copy and printing machines, multimedia equipment, and other services. In some urban villages, educational television programs have been offered as a result of the town having power service.

Having electricity for children's study time has some possible negative consequences. FDG participants worried that direct satellite television and cinemas may impact children's educational performance by taking time away from study. These worries were not substantiated by the survey, which documented an increase in children's study time and television viewing as their main activities in the evening, which resulted from doing less household work and going to bed later. Therefore, the findings that electricity has a positive impact on children's education in rural Ethiopia are buttressed by other international evidence, as well as the impact evaluation survey of children's study hours. Adult household members are in close to unanimous agreement that electricity has a positive impact on children's education.

Health and Safety

In general, households in rural Ethiopia think that rural electrification improves health and safety. In most developing countries, cooking smoke is thought to have the greatest impact on household health. In contrast, households in rural Ethiopia were more aware of the health problems caused by smoke from kerosene household lamps, including eye and throat irritation. In most countries, improved lighting is much appreciated for improving safety, especially if towns and villages have street lights. In Ethiopia, street lighting was not included in most villages under the program; however, many beneficiary households had a lamp installed outside the house.

The FGDs identified lighting as the main reason that health and safety improved in rural households with electricity. Replacing the dim light of smoky kerosene lamps with non-polluting

electric lights was perceived to reduce indoor air pollution (IAP).[13] With better-quality lighting, it was possible for women to spend less time cleaning. Electricity also improved the efficiency of cooking during evening hours. The FGD participants agreed that women and young children in households with electricity had fewer respiratory and related illnesses. Also, the use of electric lights reduced fire hazards caused by kerosene lamps.

Table 5.8 Lighting Opinions for Households with and without Electricity, 2014

Household opinion	EEPCo households (%)	GPOBA households (%)	Households without electricity (%)	Nearby village without electricity (%)
Lighting is quite adequate in my home.				
Agree	89	85	3	0
Disagree	11	15	97	100
Missing	0	0	0	0
The usage of kerosene for lighting is without any problem.				
Agree	32	25	31	45
Disagree	67	75	65	52
Missing	1	0	4	3
Total households = 760	224	265	211	60

Source: Ethiopia Impact Evaluation Survey 2014.
Note: The categories "strongly disagree" and "disagree" were combined to form "disagree." Similarly, the categories "strongly agree" and "agree" were combined to form "agree."

When the surveyed households were asked about lighting in their homes, their responses clearly reflected their opinion about the superiority of electricity (table 5.8). Nearly 90 percent of the households with electricity agreed with the statement "Lighting is quite adequate in my home." For those households without electricity, who no doubt were dependent on kerosene, less than 5 percent thought they had adequate light in their homes to meet their needs. In fact, respondents in villages without electricity unanimously agreed that non-electricity lighting sources were inadequate for their needs.

For those households with electricity, a set of questions was asked on the benefits of electricity from the grid (table 5.9). These households were also asked to agree or disagree with the statement "Being connected to the grid has caused benefits in terms of better lighting, reduced kerosene consumption, and better security and health." On average, the households had strong positive feelings about the benefits of electricity from the grid. This included both the households

[13] The use of kerosene lamps is receiving greater international attention among those involved in IAP research.

connected by EEPCo and those under the GPOBA program. More than 90 percent of households considered electricity to be related to better indoor air quality, better lighting, reduced kerosene consumption, and the use of fewer candles. In addition, households held the opinion that electricity would lead to better security and health of family members.

Table 5.9 Opinions of Households with Electricity on Health and Security, 2014

Survey question	EEPCo and GPOBA household opinion		
Being connected to the grid has caused benefits in terms of:	Agree (%)	No opinion (%)	Disagree (%)
… better indoor air quality	97	2	2
… better lighting	96	1	3
.. reduced kerosene consumption	94	3	4
… better security	92	6	2
.. reduced candle consumption	90	5	5
… better health	89	6	5

Source: Ethiopia Impact Evaluation Survey 2014.
Note: The responses for EEPCo and GPOBA households gave quite similar results, so the categories were combined.

One unusual finding from the FGDs was that those areas with street lights were more attractive for both formal and informal taxi service. Some taxis began operating in areas that were lighted with electricity. Before village electrification, taxi and *Bajaj* drivers were not willing to come to the villages without electricity, probably because they feared various security problems. Now they offer their service till late in the evening.

It should be cautioned that the opinions about the benefits of electricity may have been a bit inflated due to the recent adoption of service. Compared to spending evenings in darkness or by the dull light of a kerosene lamp, those who adopted electricity may have exaggerated its benefits. However, the households with electricity in rural Ethiopia were able to clearly identify the benefits of electricity, and, in the years to come, will come to think of it as a normal part of their everyday life.

Conclusion

The social benefits of rural electrification include changes in living patterns, improved education, possibly better health, and better home security. At least this is the opinion of the households that have adopted electricity under the GPOBA and EEPCo programs. The goal of the GPOBA program was to make it possible for households that could not afford the cost of a connection to be able to obtain the benefits of rural electrification right away, and then pay for those benefits over time.

When asked who benefited most from the GPOBA program, more than 80 percent of village respondents indicated that it was poor households. This spurred a higher rate of connections in villages under the GPOBA program, paralleled by a wave of electricity appliance purchases—mainly additional household lights, plug-in radios, and televisions. Probably due to the low price of electricity, some households were even purchasing hotplates and injera mitads for cooking bread. According to the opinions of those questioned, these appliances, in turn, had an impact on a household's quality of life, including improved reading and education, improved comfort, and better health.

The overall improvement in the quality of life for people living in rural areas depends on the number of people actually adopting electricity. The GPOBA scheme's goal of making connections more affordable was much appreciated by most participating households. One survey respondent stated that "the rich can pay the whole amount, and we are benefited by long-term payments." Another said that, due to the GPOBA program, his household could get electricity "like a rich household."

Some might question why households who could afford to buy a television set could not afford to pay for an electricity connection. The reality is that household savings are quite meager in rural areas of Ethiopia, and only one-third of households in the study regions purchased a television set. For some households, being able to spread out connection payments over time helped to make the TV purchase affordable. Televisions were watched not only by the families that purchased them, but also by their neighbors and relatives. This suggests that such programs as the Ethiopia GPOBA project perhaps should be extended beyond electricity adoption to include the purchase of important appliances in order to maximize the development benefit of rural electrification.

In this chapter, the social benefits of rural electrification have been analyzed and proven to be extensive. However, electricity can also be used in productive enterprises. The next chapter examines the financial and economic benefits of rural electrification in Ethiopia in the context of household enterprises and business development.

6. Productive Use of Electricity

People often equate the productive use of power with machinery. While driveshaft power is certainly important, myriad other uses of electricity can provide economic benefits for businesses in rural areas. High-quality lighting can lead to longer business hours and therefore higher income. The use of refrigeration in small rural restaurants and food shops can be important for preserving food and maintaining a healthy environment. The production of home artisan goods can provide women with additional income to support their families. Thus, the productive use of electricity is not limited to machinery.

This chapter reviews the impact of electricity for home production, small businesses, and larger enterprises in rural Ethiopia. The next section examines small-scale businesses, most of which are conducted inside or alongside homes. Subsequent sections investigate somewhat larger rural businesses with locations separate from the home.

Household Production and Small Business

International experience has shown that rural electrification can stimulate many new household businesses in rural areas. Without complementary programs, however, the creation of new household production or related businesses is modest at best (Barnes 2014; Asaduzzaman, Barnes, and Khandker 2009; Barakat et. al. 2002; Cabraal, Barnes, and Agarwal 2005; Dinkelman 2011; Meier et al. 2010; World Bank 2002). After all, not every household has the personal initiative or financing necessary to start a business. Also, businesses tend to be quite modest endeavors (e.g., local food vendors, kiosks, teahouses, and crafts production). In many countries, the majority of business owners are women who produce and sell home goods.

Although rural Ethiopia has had electricity for only a few short years, many home-based businesses and independent stores have sprung up in villages and towns with electricity. The number of home-based businesses or those providing additional household income from outside the home totals about 6 percent of EEPCo or GPOBA households (table 6.1). The additional household income provided by these electricity-using businesses was in a range of US$25–$34 per month, or about $1 per day, which is typical for home-based businesses around the world. While this amount of money may not seem like much, it can make the difference between a household

living in or out of poverty. For other developing countries, about 10–20 percent of rural households have additional business opportunity. Not unexpectedly, these figures are comparatively higher, reflecting the much longer period that communities in these countries have had electricity (World Bank 2002, 2008b). Given that rural communities covered in the Ethiopia impact evaluation survey had only had electricity for a little over three years, it is likely that the 6 percent figure will grow in the coming years.

Table 6.1 Household Businesses Using Electricity, 2014

Households with additional business opportunity	EEPCo households	GPOBA households	Households without electricity	Nearby village without electricity
Households with business (no.)	13	15	5	0
Households with business (%)	6	6	2	0
Total (no.)	224	265	211	60

Source: Ethiopia Impact Evaluation Survey 2014.
Note: Missing values were assumed to have zero new businesses as a result of adopting electricity.

Many of the new small businesses are taking advantage of improved lighting. Only about 11 of the 33 households with new businesses have purchased new equipment for a business activity. Of these, five households indicated they had added on to their house, four purchased a refrigerator, two purchased a pool table, one purchased equipment for a tea business, and another bought a grain mill. The value of the new investments ranged from only US$11 to more than $1,000 for the purchasing households. Nearly half of the businesses started as a result of rural electrification; they were not due to any special equipment, but did take advantage of better-quality lighting provided by electricity.

Many households in villages and towns with electricity had ideas about a future business. In fact, about half of the households under the GPOBA and EEPCo programs had considered starting a new business. The most common business concepts were small shops, food vending, hair salons, woodworking shops, and cafes (table 6.2). Most of these households were thinking about the future, but did not yet have the means to start such businesses. This is in stark contrast to people living in households and nearby villages without electricity, who had not even started to think about starting a new business. Clearly, having electricity service in a village opens up a range of business possibilities for rural households.

Table 6.2 Rural Households' Ideas for Future Businesses, 2014

Business type	EEPCo households	GPOBA households	Households without electricity	Nearby village without electricity
Shops	16	18	7	0
Selling food	9	24	6	0
Milling services	11	19	7	0
Hair salons	15	10	7	0
Woodworking	9	13	8	1
Cafe and bars	7	10	4	0
Metal work	11	8	1	0
Small businesses	7	5	2	0
Sale of soft drinks	6	5	1	0
Sale of electric appliances	5	4	2	0
Other businesses	3	0	0	0
Households with business ideas	105	130	50	1
Households not responding[a]	119	135	161	59
Total households	224	265	211	60

Source: Ethiopia Impact Evaluation Survey 2014.
a. Households not responding were assumed to have not been asked the question (because they were not living in communities with electricity) or had no business ideas.

Business owners participating in focus group discussions (FGDs) appreciated that electricity facilitated the attraction of more customers and that customers generally stayed longer in their food shops and cafes. Customers would eat, drink, and watch television in the cafes, thus improving sales and income for the business owner (figure 6.1). According to the survey, women gained income by running small kiosks or shops with electricity that sold local food and drinks. Most of these businesses did not use electricity directly to prepare food, but the value of better lighting and sometimes television would attract customers.

For charging mobile phones, the rural electrification program had the effect of moving charging services from shops into people's homes. Prior to the rural electrification program, most people with mobile phones had to travel many miles to charging stations outside of the village. After the rural electrification program, households with electricity started charging their neighbors' mobile phones to earn extra money. This arrangement was also convenient for their neighbors without electricity, saving them time and travel expenses.

Figure 6.1 Customers in a Shop that Sells Local Drinks

Source: Ethiopia Survey Assessment Team 2013.

One type of home business—indirect electricity connections—was a direct result of problems with the rural electrification program. As previously indicated, many homes without electricity in villages and towns with power service took advantage of connecting to service by stringing lines to their neighbors' homes. Households with an indirect connection paid a higher price for electricity, based on fixed monthly fees for the appliances in their homes. For example, in the Benishangul-Gumuz (BSG) region, a female-headed household charged a fixed monthly fee of US$0.75 per bulb to neighbors without electricity. As a result, after paying EEPCo for electricity, she made a small profit of about $3 per month. Thus, the inefficiency of the program in installing meters had resulted in new businesses for "electricity entrepreneurs" charging higher prices for electricity with no connection charge. This was not a unique case as every household with a legitimate meter spawned about one addition household with an informal connection.

Private Businesses

As part of the survey, local administrators were asked about the impact of village electrification on private business establishments in their communities. The objective of this assessment was to estimate the proportion of businesses with electricity and to examine whether village electrification had played a catalytic role in the establishment or significant upgrading of private businesses.

This section investigates the impact of rural electrification for business development on a somewhat larger scale than the household level. The communities included in this assessment all had electricity with no control villages. Thus, this section should be treated as a descriptive analysis of business development for villages and towns with electricity.

Description of Businesses

The business survey was conducted in the same villages and towns as those in the household impact evaluation study. The 22 villages and towns in the study represented both rural and semi-urban areas; thus, the majority of businesses were small service firms (e.g., local liquor shops, kiosks, retail shops, tea rooms, barber shops, grain mills, restaurants, and bakeries). In addition, there were a small number of woodworking and metalworking shops. In all, there were 2,557 private business enterprises in the 22 towns and villages with electricity (table 6.3).

Table 6.3 Total Number of Businesses, Number of Businesses per Village, and Percent of Electrified Businesses by Region

	Number			Percent of private businesses with electricity
Region	Villages surveyed	Total private businesses	Private businesses per village	
Tigray	6	321	54	98
Amhara	4	938	235	97
BSG	3	92	31	54
Oromia	6	889	148	79
SNNPR	3	317	106	73
All regions	22	2,557	116	83

Source: Ethiopia Administrator Assessment 2013.

The majority of the study villages and towns were provided with electricity under the Universal Electricity Access Program, of which GPOBA is a part. Nearly all businesses in this study gained access to electricity only after the Universal Electricity Access Program came to their village. The few exceptions were some towns with municipal mini-grids that may have existed prior to the national grid program. Therefore, more than four-fifths of private businesses had electricity provided by EEPCo or through indirect electricity connections.

One would expect close to 100 percent use of electricity by private business enterprises, given that electricity plays a crucial role in improving business productivity and profitability. Business owners also expressed an ability and willingness to pay for electricity service. Business owners and local administrators explained that the reason 17 percent of private businesses were without electricity was that they could not obtain a connection from EEPCo due to the shortage of electricity meters and other necessary materials, and these explanations were confirmed by EEPCo's district managers. This situation illustrates the significant role that quality of electricity service provided by the power company plays in both household and business adoption of electricity, which can impact the level of productive use in a community.

Table 6.4 Total Businesses in the Survey Villages with Electricity, 2014

Region	Amhara	Oromia	Tigray	SNNPR	BSG	All regions (average)
Villages surveyed (no.)	4	6	6	3	3	22
Total businesses (no.)	938	889	321	317	92	2,557
Businesses per village studied (no.)	235	148	54	106	31	116
Private businesses per surveyed village by region (no,)						
Local liquor shops	78	67	20	37	10	44
Kiosks	58	6	14	0	1	16
Mobile phone-charging shops	24	20	6	9	2	13
Tea/coffee houses	17	11	4	10	4	9
Small shops	3	17	0	9	7	7
Barber shops	7	8	1	4	1	4
Grain milling service	6	7	1	3	2	4
Local restaurant	3	6	2	3	0	3
Bakery	5	0	2	3	3	2
Carpentry/woodworking	5	2	0	1	0	2
Commercial injera baking	6	1	1	2	0	2
Other	25	6	4	25	2	10
Total	235	148	54	106	31	116

Source: Ethiopia Administrator Assessment 2014.
Note: This is an overlapping but not identical list compared to table 6.3 on households deriving income from businesses with electricity. The villages and towns are the same as those for the household survey, except that the two control villages without electricity were excluded from the analysis. The figures for all regions are the average per region, except as otherwise noted.

Many rural electrification programs in Sub-Saharan Africa are just now reaching small towns, and Ethiopia is no exception. Thus, the average number of businesses per surveyed village or town is quite high, at 116. But this average tends to hide many important differences among the five study regions. The highest number of private businesses per village or town were reported for Amhara (235), followed by Oromia (148) and SNNPR (106), with lower numbers in Tigray (54) and BSG (31) (table 6.4).

Residential homes and business establishments generally are not separate entities. Such small businesses do not pay a separate tariff because, for the most part, they are either housed on the premises or in extensions added to existing residences. Homes with private businesses often are the first to adopt electricity from the grid. Businesses are not only a high-end electricity market niche; they also informally help to expand the reach of electricity within rural villages and towns

by serving local customers. Thus, the distinction between business and household rural electrification in rural Ethiopia is quite blurred.[14]

The productive uses of electricity in rural Ethiopia are quite varied. Small businesses serve a variety of consumer needs. However, certain business activities stand out, including cell phone charging, sale of cold drinks, grain milling and woodworking. Of course, lighting helps these and many other businesses, including cafes, restaurants, and barber shops.

Because of the short time that the villages and towns have had electricity, few businesses are engaged in manufacturing, and they are small in scale. This pattern is similar to that of many other developing countries; that is, with development, many villages and towns begin specializing in agricultural production, while others become growth centers with commercial services that cater to the surrounding villages. Nevertheless, the survey revealed some interesting examples of businesses using electricity for manufacturing applications, including woodworking and metalworking.

Cell Phone Charging

Information and communication technologies, including cell phones, have made considerable inroads in rural Ethiopia. The impact evaluation survey indicates that cell phone ownership had reached 1.4 cell phones per household. Before village and town electrification, all cell phone charging in the five GPOBA study regions had to be done in the nearest town with electricity, usually located about 10–20 km away. After electrification, mobile phone charging constituted a major business opportunity. For example, in Ura village, a general retail shop established after village electrification recognized the business opportunity to charge cell phones for households that had not yet connected to electricity service (figure 6.2). The shop charges about eight cell phones per day for a fee of US$0.10 per two-hour charging session, equivalent to an additional $25 in monthly income.

[14] This aspect of rural electrification requires more attention from the electricity authorities.

Figure 6.2 Cell Phone Charging Provides New Income Stream for Local Businesses

Source: Ethiopia Survey Assessment Team 2013.
Note: In the lower-left corner, a wooden board used for charging cell phones is visible among other goods sold in the village retail shop. The photo on the right shows multiple sockets affixed to this innovative charging board.

The commercial electricity tariff is quite low, at US$0.04–0.06 per kWh, depending on level of electricity use.[15] This low rate, combined with the little energy required to charge mobile phones, has made cell phone charging a profitable business. Of course, this business opportunity will decline once greater numbers of households adopt electricity.

In each surveyed village with electricity, an average of 13 shops provide cell-phone charging service. Customers are those without electricity—including households with indirect connections—from both the same village and nearby ones without service. Households with indirect connections generally are not allowed to use electrical devices for services other than household lighting. Therefore, once villages are provided with new electricity service, cell phone charging can become a significant income stream for businesses and households with a sanctioned meter.

Sale of Cold Drinks

Refrigeration and cooling of beverages became a significant business after a village was connected to the grid system. Though some selling of beverages may have occurred before the use of refrigerators, electricity has made it possible to expand the existing beverage market, as well as offer new products (figure 6.3).

[15] The lowest tariff rate of US$0.02 per kWh is for households that use little electricity; for households that use higher levels of electricity, the tariff rate is $0.04–0.06 per kWh.

Figure 6.3 Refrigerator and Non-Alcoholic Beverages on Display in a Shop in Ura Village

Source: Ethiopia Survey Assessment Team 2013.

One of the new products, locally known as *jelati*, is a frozen mixture of water, sugar, and flavoring. Licked like an ice-cream cone, these flavored ice cubes are a favorite refreshment among children. Jelati is usually sold to customers who visit a store; but one innovative shop owner subcontracted children to sell his product throughout the village.

According to one shop owner, market demand for beverages has grown by several times since the arrival of electricity service in his village. He had been selling beverages before electrification, but after purchasing a new refrigerator, sale of cold beverages increased significantly. He further stated that customers prefer cold beverages, particularly during the hot season. Also, electric lighting enables his shop to stay open for longer hours in the evening. He plays music in his shop so that it is both convenient and entertaining for customers to purchase their supplies or enjoy their cold beverages.

Grain Milling Service

The village FGDs identified electric grain milling as one of the most significant achievements of village electrification (figure 6.4). The introduction of grain milling service benefited women's lives in important ways. In rural Ethiopia, women and girls are responsible for food processing (i.e., from milling to cooking and serving food). Before village electrification, they had two options for transforming grain into flour. One was to manually grind the grain themselves, and the other was to transport it to the nearest diesel-run grinding mill. The latter option, often using loaded donkeys as pack animals, involved drudgery and was time-consuming; also, diesel engines for milling grain were about 30 percent more expensive than those using electricity.

Figure 6.4 Village Grain Mill with New Electricity Supply

Source: Ethiopia Survey Assessment Team 2013.
Note: Pictured on the left are women queuing up to have grain milled. The photo on the right demonstrates the use of the milling machine.

In some rural villages without donkeys, women and girls even had to travel 15–20 km carrying 20–30 kg of grain on their backs. According to villagers, the introduction of electricity-driven mills has relieved village women and girls of the drudgery involved in transporting grain for milling or milling it themselves. Also, there were health and safety risks associated with traveling to grain milling services located in distant communities. The FGD participants believed that having electric grain milling service in their villages saved them a considerable amount of time and effort, which could be used for leisure, family welfare, and other productive activities.

Sawmilling and Woodworking

Wasgebeta, a newly electrified village in SNNPR, located about 20 km west of the zonal capital of Hosaena, is rich in timber resources. Prior to having electricity service, all of Wasgebeta's timber was exported to Hosaena for processing and the manufacture of furniture, meaning that all of the village's inhabitants had to depend on Hosaena for their furniture. Once electricity arrived in the village, several new businesses involving sawmilling and woodworking developed (figure 6.5).

Figure 6.5 Sawmilling Workshop in Wasgebeta Village, SNNPR

Source: Ethiopia Survey Assessment Team 2013.

Additional businesses were developed in Wasgebeta after electricity. These included tea rooms, local liquor shops, and restaurants. Some existing shops were improved and expanded, giving the village a new face. An owner of a small sawmilling shop commented, "When electricity came to our village, it did not come alone. Rather, it came along with all sorts of opportunities, of which I grabbed one."

Complementary Electricity Services

In newly connected villages, electricity plays a vital role in catalyzing development. Beyond better household lighting, electricity unlocks a range of new social and economic opportunities. This is not to suggest that electricity is a panacea for all development problems facing a village. Realizing new opportunities to the fullest extent possible requires more than just providing a village with electricity. In rural Ethiopia, the GPOBA survey results confirm that complementary services are quite important for enhancing the program's impact.

Table 6.5 Electricity-Related Services Lacking in Study Villages and Towns, 2013

Service lacking (%)	EEPCo households	GPOBA households	Households without electricity	Nearby village without electricity[a]
Street lighting	58	68	73	45
Place to purchase new appliances	55	55	31	n.a.
Power reliability	5	7	5	n.a.
Electricity technicians	7	6	2	n.a.
Grain mill in village	2	5	7	24
Place to purchase CFLs	4	2	0	n.a.
Power for grain mill	3	2	5	n.a.
Nearby electricity poles	3	2	2	12
Responding households (no.)	215	252	170	42
Non-responding households (no.)	9	13	41	18
Total households (no.)	224	265	211	60

Source: Ethiopia Administrator Assessment 2013.
Note: The survey question was "What energy/electricity-related services and/or goods do you think are missing most in your village?"
a. In this column, cells with n.a. = not applicable.

When asked "What kind of problems in order of importance has the household had with the connection in the last six months?," the two main problems cited by electricity customers were lack of street lighting and a place to purchase new appliances (table 6.5). Surprisingly, most households did not cite power reliability as a significant issue. To a limited degree, households were of the opinion that more electricians needed to be available in the villages. Such problems should lessen once a community has had electricity for a number of years.

Many important complementary support services could facilitate the benefits of electricity for those that have recently been connected to the grid system. There is a need for local electricians to help with electronics installation, indoor wiring, and maintenance and repair. Clearly, households would like to have street lights for local safety and local appliance shops where new appliances would be available for them to purchase as needed. These would include refrigerators, satellite dishes, TV sets, commercial phone-charging equipment, equipment for barber shops and hair dressing, and electric *injera mitads*.

For business development, innovative financing mechanisms, such as those involving microfinance institutions (MFIs), need to be promoted at the village level so that loans for working capital can be extended for newly emerging businesses. The adequacy of power reliability, which is also important for businesses, was not among the highest concerns of the EEPCo and GPOBA communities. These and other services are necessary for businesses, but electricity is also

important for public institutions in the communities. This aspect of the impact of rural electrification is examined in the next section.

Public Services and Institutions

Despite their bureaucratic slowness, public institutions—from schools and public health clinics to agricultural offices and the postal service—perform critical tasks for society. The importance of public institutions was clearly demonstrated in the five GPOBA study regions of rural Ethiopia. In the 22 villages and towns with electricity, the number of public offices totaled 314, or about 14 per community. Religious institutions were the most numerous, comprising 24 percent or nearly 4 per village (table 6.6). Strictly speaking, these are not public institutions; however, they are important for the community.

Table 6.6 Public Institutions in the Study Region Villages and Towns, 2013

Institution type	Tigray	Amhara	BSG	Oromia	SNNPR	All regions	Percent
Religious (churches and mosques)	6	23	6	23	16	74	23.6
Kebele administrative office	6	4	3	6	3	22	7.0
Primary school	6	4	2	5	3	20	6.4
Health post	6	2	3	5	3	19	6.1
Potable water supply	6	4	2	4	3	19	6.1
Police station	5	4	3	4	3	19	6.1
Heath center /clinic	1	11	1	2	2	17	5.4
Farmer training center	4	3	2	4	3	16	5.1
Teacher/extension agent residences	4	4	3	3	2	16	5.1
Agricultural office	4	2	3	3	3	15	4.8
Veterinarian services	2	3	3	4	3	15	4.8
Agricultural cooperatives	4	3	2	2	3	14	4.5
Secondary school	0	2	1	5	1	9	2.9
Prison (correctional facilities)	0	0	3	3	2	8	2.5
Women's center	0	3	2	1	1	7	2.2
Rural financial intermediaries (MFIs)	1	2	2	0	2	7	2.2
Pre-school (kindergarten)	1	1	1	2	0	5	1.6
TVET centers	0	1	0	0	0	1	0.3
Other	0	3	3	2	3	11	3.5
All public institutions and services	56	79	45	78	56	314	100.0
Average number of institutions per kebele	9.3	19.8	15.0	13.0	18.7	14.3	

Source: Ethiopia Administrator Assessment 2013.
Note: MFIs = microfinance institutions; TVET = technical vocational education and training.

The other public institutions were quite diverse, ranging from administrative offices and police stations to potable water supply centers and schools. The regions covered also had farmer training centers, teacher/extension agent residences, and health centers/clinics. The services offered by these public institutions were diverse, ranging from peacekeeping to providing farmers information for better agricultural production.

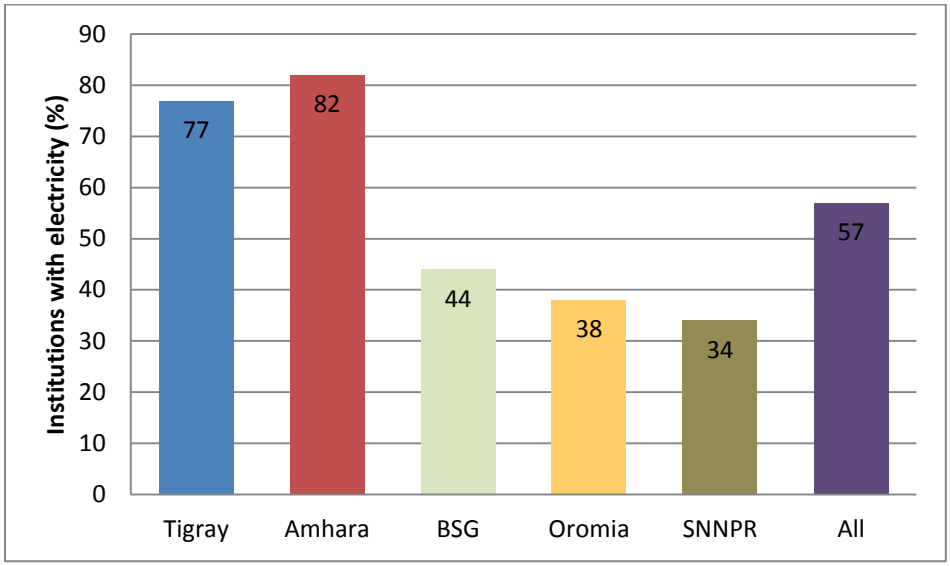
Given the importance of electricity for enhancing the services provided by public institutions,[16] EEPCo's district managers worked with the rural electrification project to ensure that expansion of the national grid system took the location of public institutions into account. Because public offices were included in rural electrification planning, more than half of the public institutions and social services in the surveyed areas adopted electricity, either through an official meter or an indirect connection from a nearby institution with power service.

Even so, only about one-half of public institutions in the surveyed villages and towns have adopted electricity, which is low compared to private businesses, more than four-fifths of which have power service. The main reason for the low rate of electrification among public institutions in rural areas is a lack of finances to cover connection costs and electricity expenses. Unlike rural businesses, public institutions are not rewarded for their additional productivity due to electricity because most public services are free of charge. For private businesses, electricity increases income and thus makes electricity affordable. By contrast, public institutions must get by on the same amount of public subsidy whether or not they decide to have electricity.

Electrification rates for public institutions varied widely between study regions, as well as between sites within regions. The highest rates were found in Amhara (82 percent) and Tigray (77 percent), followed by BSG (44 percent), Oromia (38 percent), and SNNPR (34 percent) (figure 6.6). Even higher variations in adoption rates were observed within regions. Serawat and Shebta villages had 100 percent adoption rates, while Gamera and Kuen had rates of only 55 percent and 30 percent, respectively. The lowest rates of electrification, at less than 24 percent, were observed in Lalisa Yesus, Bertasami, Gogeti, and Aroji Serdo villages.

[16] For example, electricity in health centers allows for the preservation of vaccines and other medicines. In schools, electricity provides better-quality lighting and powers appliances used for educational instruction.

Figure 6.6 Public Institutions with Electricity by Study Region



Source: Ethiopia Rural Electrification Survey 2014.

At present, the majority of public institutions and social service facilities are using electricity mainly for lighting. However, electricity could bring a whole gamut of services to villages beyond lighting, such as powering medical equipment, refrigeration, communication devices, equipment for vocational education and training (VET) instruction, and street lighting.

Figure 6.7 Electric Health Devices in Bambasi Health Station, 2013

Source: Ethiopia Survey Assessment Team 2013.
Note: Photos (left to right): electronic microscope, sterilizer, drug dispensary, and refrigerator for medicine.

The Bambasi Health Station in the BSG region is among the few public institutions in the surveyed villages and towns that have started using electricity for more than just lighting. There electricity is not only being used to refrigerate medicine; it is also provides an array of other important services, including powering basic medical equipment (e.g., microscopes, sterilizers, and various small-scale laboratory equipment) (figure 6.7).

After Bambasi village was provided with electricity service, the health facility was able to provide a higher level of services, including desperately needed maternity care. According to Bambasi Health Station staff, the new electricity service not only brought the community better-quality health services. It also meant that people with serious illnesses would not have to travel far (45 km) to reach more qualified health facilities, as they had done in the past.

One should recall that this survey was completed only about two-three years after communities had first been provided with electricity service. As previously mentioned, it takes a longer period of time for the impact of electricity to fully mature. Now that the basic electricity infrastructure is in place, socioeconomic impacts will expand over time. In the coming years, public institutions will adopt more electricity devices, including telecommunications equipment and computers. At this point, it is important to provide complementary services for the rural electrification program. Development is an incremental process, but the possibilities of development are enhanced by the provision of new electricity service to rural villages and towns.

The burden of paying for electricity used for public services should not fall on the power company. Rather, the government is responsible for electricity service and should treat it like any other budget item. It should provide the public institutions financing for adopting electricity; this, in turn, will result in the utility company having a more attractive revenue stream from the community, enabling it to provide better overall electricity service.

Conclusion

This chapter has shown that the benefits of electrification for the development of household businesses, private companies, and public institutions are pervasive in rural Ethiopia. As a result of having electricity, households engage in home-based production and sometimes even add on to their homes to sell groceries or other retail goods. Existing small businesses immediately adopt electricity, which permits them to stay open for longer hours and display their goods in an attractive manner. Some even buy additional appliances (e.g., refrigerators and cooking devices) to better serve their customers. Businesses are also established because of new opportunities created by the availability of electricity in villages and towns. Most rural businesses are small in scale, but they provide a wider range of community services and generate income for their owners.

Many public institutions in the surveyed villages and towns have adopted electricity to improve their services for the community. Unfortunately, about half of them still cannot afford electricity due to the expense. This is an issue that might be addressed by local governments as they gain more experience with having electricity in their towns and villages. To conclude, electricity not only has significant social impacts for households; it also plays an important role in the economic development of communities.

7. Policies to Improve Ethiopia's Rural Electrification Program

The Global Partnership on Output-Based Aid (GPOBA) component of the World Bank–sponsored Electricity Access Rural Expansion Project (Phase 2) has been extremely important for providing poor and lower-middle-income households in rural Ethiopia incentives for adopting electricity. The GPOBA program accomplished this by allowing households to pay off connection charges over a five-year period. GPOBA program grants covered the interest on those loans so that households only had to pay the loan principal, arranged through EEPCO, the national power utility. When participant households were asked why they might recommend the program to others, most cited lower cost and saving money as important benefits. One family indicated it could save money by having electric lights and avoiding kerosene expenses. Another indicated that being able to pay over time would help them use money for other purposes. They also believed they could enjoy the benefits of electricity like "those that are rich." Most of the negative comments about the program centered on problems attributed to EEPCo electricity distribution. These included intermittent power supply, unavailability of meters for those applying for a connection, and infrequent electricity bills.

The goal of the GPOBA intervention was to make the benefits of rural electrification available to a much larger proportion of Ethiopia's rural population than was being reached by EEPCo through the national grid rollout program. Under this regular expansion program, the connection charge was unaffordable for most poor and lower-middle-income households, many of whom faced prohibitive requirements for housing materials and bureaucratic hassles, which may have discouraged them from obtaining service. As a result, many households indirectly adopted electricity from a neighbor with a sanctioned meter. Others simply did not adopt electricity. The consumer survey revealed that people in rural areas are quite willing to pay for electricity, even at higher unofficial rates paid to their neighbors. Unfortunately, in villages with electricity, many barriers still block poorer households' ability to obtain a connection.

It should be kept in mind that, while connection rate programs are quite important, they are only one part of an overall sector strategy to promote rural electrification (Barnes 2007). The success of rural electrification also depends on other important sector issues, which cannot be

ignored. These might include having a dedicated institution or division of the electricity company implement rural electrification programs. In Ethiopia's case, the rural electrification program is implemented more generally by EEPCo as a state-owned enterprise. Under the Universal Electricity Access Program implemented by EEPCo, the Ethiopian government financed 80 percent of connection costs, with the remainder funded by EEPCo. Other issues include appropriate pricing policies and financial incentives for the electricity company to service rural customers. Community support, proper planning, promoting productive uses of electricity, and having lower-cost system designs are also vital for a rural electrification program to thrive.

This chapter examines the impact of the GPOBA intervention on electricity connection rates in rural Ethiopia and the socioeconomic benefits that resulted from rural households having electricity. Also, it recommends policies that can result in higher connection rates for those living in villages with electricity, as well as higher welfare impacts for households that adopt electricity. Before turning to these issues, the next section highlights the project's major achievements and challenges.

GPOBA Program Achievements and Challenges

Generally, the GPOBA program can be considered a success. Participant households were quite appreciative that they could spread their initial payments out over time. Some families even indicated that, by not having to spend cash upfront for a household connection, they were able to purchase new appliances. It is expected that such purchases, over time, will increase the welfare benefits of having electrification for rural households.

The GPOBA scheme achieved high numbers of total connections. The GPOBA program was quite successful, given the challenging sector context in which the utility operated. During the short time it was active (2011–13), the program dispensed financing of connections through EEPCo. In the surveyed areas, the share of GPOBA households reached nearly four-fifths of all EEPCo connections, amounting to about two-fifths of all households in those communities.[17] Beyond the GPOBA connection intervention, much work is needed to ensure universal adoption of electricity once a village or town has power service. As the surveys revealed, there is pent-up demand for having a metered connection owing to a meter shortage, which has curtailed the ability of many households to officially adopt electricity service.

GPOBA subsidies were well directed. During the first 18 months after a village or town received electricity service—when many of the better-off households adopted electricity—GPOBA financing was not available. Delaying its availability allowed many more poor and lower-

[17] One should also note that including indirect household connections would significantly increase these figures.

middle-income households to take advantage of the interest-rate subsidy for loans, which allowed them to spread out connection charges over five years.

Program effectiveness varied widely by region. In Oromia, more than two-thirds of households adopted electricity, compared to less than one-tenth in Amhara. Altogether, nearly 100,000 households—close to half a million people—adopted electricity under the GPOBA program. About one-half of these were households with indirect connections, many of which lacked concrete houses and are among the poorest people in these rural areas. For officially metered connections during the 2011–13 period, three-quarters of the 57,000 families provided with electricity (43,000 families) took advantage of the GPOBA program.

The GPOBA subsidy expanded electricity coverage. The GPOBA intervention helped EEPCo to shift the focus of its regular grid expansion program toward poor households. The increased participation of poor and lower-middle-income households was quite remarkable, given the many program delays caused by EEPCo.

As previously discussed, the original project objectives were not reached due to the 2007–10 government moratorium on new connections, power supply problems, and a shortage of meters. As mentioned, the latter problem was caused, in part, by using a sole-source local contractor that could not deliver on time. In addition, the surveyed households indicated that EEPCo offices often did not provide bills on time. Some households feared having to pay large estimated bills after months of not having received a proper bill.

Many households have taken indirect connections from their neighbors. The biggest surprise from the surveys and focus group discussions (FGDs) was that many households were taking an indirect (metered) connection from their neighbors since, for safety reasons, EEPCo's policy did not allow houses made of substandard, non-concrete materials to obtain a connection. The indirect household connections were not electricity theft because the electricity ran through another household's electricity meter. The problems were that households paid a higher monthly price for electricity than metered households and much of the wiring was poorly done and, in some cases, dangerous.

The CFL program requires modification. The goal of the compact fluorescent lamp (CFL) program within the GPOBA project was a good one. CFLs use less electricity for lighting than traditional incandescent lamps, which can make lighting more affordable for poor rural households. According to the survey, however, many customers were dissatisfied with the CFLs due to low voltage levels, which, in some cases, prevented the CFLs from even starting up; thus, no light was provided. Such problems could be solved by using an electronic ballast that corrects for voltage fluctuations; though somewhat more expensive, this option might be considered for future programs. Moreover, if internal wiring and lighting components are included in subsidy programs, an effective information campaign should be carried out.

Electricity-sector problems reduced the impact of the GPOBA scheme. One of the greatest challenges for the GPOBA program was caused by Ethiopia's power situation. Just as the Electricity Access Rural Expansion Project (Phase 2) was beginning, the Ethiopian government directed EEPCo to halt all new connections due to a drought-related power shortage. As a result, the GPOBA program and other World Bank–sponsored access projects were delayed for more than two years. When the GPOBA program finally resumed in early 2011, priority was given to filling the significant backlog of orders (about 0.5 million) for customers who paid the full connection charges. Thus, EEPCo connections under the GPOBA grant were not started until June 2011.

The monitoring and verification (M&V) and impact evaluation surveys indicated that information about the GPOBA project flowed poorly to EEPCO's field offices. Local EEPCo offices often lacked even basic knowledge about the program. In some cases, households that had already applied for an EEPCo connection later switched to applying through the GPOBA program, perceiving that the implementation process would be faster. This suggests that some better-off households, frustrated with the slow speed of EEPCo, tried to qualify for the loan, more for the purpose of obtaining a faster, rather than a more affordable, connection.

Impact of Electricity on Rural Households

This study found that the impact of electricity on Ethiopia's rural areas is similar to that found in many other developing countries (Barnes 2014). After adopting electricity, households enjoyed better lighting. Households that adopted electricity used more appliances, watched television, and worked and socialized more in the evening. In contrast, households without electricity tended to listen to battery-powered radios, participate less in family discussions, and generally go to sleep early. Schoolgoing children in households that adopted electricity changed their study location from outdoors to indoors and studied for longer periods of time. The impact of electricity was also quite extensive for rural businesses. Contrary to conventional thinking that electricity must be used in machines and power tools to provide productive-use benefits, this study confirmed that business lighting is an often unheralded productive use of electricity. The impact of rural electrification was quite similar for GPOBA-participant households and those connected through EEPCo's regular expansion program.

Electricity adoption improves household lighting. The adoption of electricity for household lighting drastically reduced households' use of kerosene lamps. Households that adopted electricity kept some kerosene lamps as a mobile form of lighting and as a backup lighting source, along with candles. Interestingly, kerosene use did not decline in the rural Ethiopian homes with electricity, probably because it was being used more as a cooking fuel in the evening. Some households in the survey believed they had reduced their lighting costs after adopting electricity. Besides improving reading and socializing possibilities, electric lighting may make it possible to prepare meals in the evening. Some better-off households in the survey region adopted electric

injera mitads, which are convenient for preparing traditional bread. All of these factors might mean a reduction in wood and charcoal used for cooking.

Women benefited from electricity. In many households, women used lighting during the evening hours to produce crafts that they could sell for extra income. Most communities had a grain mill, which was considered quite important for women. Instead of grinding grain by hand, women could now bring it to an electric-powered mill, where it would be processed into flour. This saved the women a significant amount of time in food preparation. Also, electricity improved community health services that were particularly important for women and kept them from having to travel long distances for health checkups, especially during pregnancy. In addition, some women were able to help their children study in the evening.

Better household lighting improved children's education. Evidence from the surveys and FGDs indicated that having better-quality lighting in the home means that children can study longer during evening hours. Without electricity, most study time for both boys and girls was outdoors or by the dim light of a kerosene lamp. Based on recall questions, households that adopted electricity indicated that, compared to the earlier time without electricity, children's study location moved from outdoors to indoors and their study time increased by about an hour per night (table 5.7). The time elapsed since receiving electricity was just one or two years; thus, households could accurately recall conditions before they adopted electricity. This additional study time might well impact these children's educational performance, making it less likely that they drop out of school (Khandker, Barnes, and Samad 2012a, 2012b, 2013).

Mobile phone charging at home saved time. Many people in developing countries now own mobile phones, and rural residents in Ethiopia are no exception. Before adopting electricity, households had to take their cell phones to charging stations often located miles away from their homes. After adopting electricity, the phones could be charged at home, which eliminated travel time and expense. Households that had not yet adopted electricity also benefited from having a nearby neighbor or store that could charge their phones (figure 6.2).

Televisions and radios improved communication and entertainment. Television sets were purchased by about 4 out of 10 households with electricity. Watching television became a main activity during evening hours. TV provides news and entertainment for rural people, integrating them into the nation and even the world. In areas without electricity, the expense of batteries to power televisions was prohibitive. After a community had electricity, television became an inexpensive form of entertainment. In comparison to televisions, the number of plug-in radios increased significantly in rural households, but listening to them increased only slightly, perhaps because of the increase in television viewership. Also, households with electricity adopted numerous plug-in radios, which reduced their battery expenses.

Rural businesses improved services due to electricity. Nearly all existing rural businesses adopted electricity once it became available in the community. Lighting was the main benefit, with only a few businesses using electricity for food preparation, cooking, and refrigeration. Businesses used electric lighting for a variety of purposes, including displaying merchandise, lighting premises, and illuminating signs. With electric lights, businesses could stay open longer during the evening hours.

The impact of rural electrification was quite similar for GPOBA-participant and EEPCo households adopting electricity. The main difference between a GPOBA and EEPCo connection was that the GPOBA connection was paid for over time rather than upfront at the time of connection (the GPOBA households also received two free CFLs). Once a household adopted electricity, it was serviced by EEPCo. Thus, most changes in household behavior due to electricity were the same, regardless of whether service was adopted through EEPCo or the GPOBA program.

However, the GPOBA program had a higher welfare impact than the EEPCo program because it reached more households and accelerated appliance adoption. Many households that took advantage of the five-year connection loan under the GPOBA scheme would not otherwise have been able to adopt electricity service. Thus, in villages with new electricity service, the GPOBA program accelerated the rate of electricity adoption. Nearly 100,000 households, including 40,000 official and 60,000 indirect connections, were able to enjoy the benefits of rural electrification sooner rather than later. Finally, the FGDs and impact evaluation suggest that, due to spreading out connection costs over time, GPOBA households did not have to defer the purchase of electric appliances due to cash shortages. This, in turn, would deepen the impact of electrification in rural Ethiopia.

Policies to Improve Connection Rates and Impact

One paradox of rural electrification is that high rates of electricity adoption, along with good pricing policies, are necessary to make programs financially sustainable over the long term. A general rule of thumb on subsidies is to have cost-covering fees that are fair to both customers and the electricity company and to provide financial assistance to new customers desiring to adopt electricity. This can be done through providing loans for disbursement of subsidies for household connection costs or recovery of connection charges through tariffs. Lowering the upfront cost for customers will free up customer cash to purchase appliances, which means a higher level of benefits for the connecting households and a better revenue stream for the electricity company resulting from higher electricity use.

This means that high adoption rates result in better prospects for the financial viability of the electricity companies. The converse is also true. Programs with low initial adoption rates, typical of those found in Sub-Saharan Africa, make it much harder for the electric utility to have the necessary revenue to maintain lines and provide quality service. Thus, it is in the financial

interest of the utility companies to strive for high electricity adoption rates and encourage the purchase of appliances by households in rural areas.

In Ethiopia, the rural electrification program is still in its initial stages. The monitoring and verification (M&V) and impact evaluation surveys identified key policy issues to encourage greater adoption of electricity and better overall policies for the rural electrification program.

Recommended Policies

Raise the overall price of electricity to reflect the cost of service after taking into account any capital cost subsidies for extending service to rural areas. Also, incorporate other best practices into the distribution sector to promote rural electrification. Ethiopia's low electricity prices cause problems for rural electrification as a business. The electricity price for rural households is extremely low, making it difficult for EEPCo to recover its costs. The price for those consuming 50 kW or less per month is about US$0.02 per kWh. Even at the level of 400 kWh, the price of electricity is only $0.03 per kWh. This means that the rural electrification program loses money on every new customer. Consumers have little incentive to conserve electricity, and EEPCo has little incentive to provide the necessary operation and maintenance for rural lines. In the future, this will likely cause a decline in the quality of service.

Have simple and effective mechanisms for targeting the poor. In this GPOBA program, targeting was achieved by combining geographic criteria with self-selection methods. The targeting was consistent with the Ethiopian government's policy of providing equity and broad geographical coverage for its rural electrification access program.

Facilitate house wiring in both standard and substandard housing. One major issue identified in this study was EEPCo's policy of connecting only those homes made of concrete, which frustrated many poorer households who were ineligible for electricity service. They, in turn, decided to string wires to a neighboring house with a legitimate meter. Most of the problems involving indirect household connections could be avoided by developing standard waterproof ready boards for installation in houses constructed of substandard materials.

Officially connect households with indirect electricity connections. Ethiopia's electrification rates could be higher if more attention were paid to finding ways to service poor households. Switching from indirect to officially metered connections would mean lower electricity prices for such households; in turn, they would consume and pay for more electricity, which might help to improve the utility's financial condition.

Provide credit, encourage appliance adoption, and promote intersectoral synergies. The GPOBA scheme could probably be extended beyond wires. Given the expense of putting up poles and transformers and stringing wires, the investment could be optimized by implementing complementary programs that encourage greater use of electricity. This might include ensuring

that electric appliances are available for local purchase. Also, many of the world's most successful rural electrification programs include close cooperation between ministries and agencies that provide other types of development assistance, including education, agriculture, and rural development. Promoting such intersectoral synergies would not only improve the impact of rural electrification; it would also increase the financial benefits for EEPCo due to higher levels of electricity use.

Focus on women-headed households. In most countries, women-headed households are generally among their poorest groups. In the five rural regions of Ethiopia covered by this study, women-headed households comprised just over 15 percent of the population. These households often cannot afford the upfront costs of electricity; at the same time, they are quite responsible about paying their bills.

The Power to the People program developed in Lao PDR, which is quite similar to the GPOBA intervention in Ethiopia, had one key difference: It focused efforts on providing assistance to women-headed households (World Bank 2008a, 2011a, 2013b). A key underlying concept was to keep targeted households' monthly expenditures—for both repayment of the interest-free credit and electricity consumption—at the same level as their expenditures before grid electrification for vastly inferior traditional energy (e.g., batteries, diesel lamps, and candles). It was projected that the monthly savings in household energy expenditure would be enough to allow households to repay the connection cost in three years. A similar gender-focused program for rural Ethiopia could be integrated into EEPCo's standard operating procedures.

Make meters more readily available to prevent delays in providing customers with service. The survey found that a shortage of electricity meters had led to delays in signing up new customers. This issue could be easily resolved by diversifying the sourcing of meter supplies and allowing them to be imported. Inexpensive and reliable meters are readily available from other countries.

Decentralize and lower the cost of bill collection. Generally, the best practice is to have the electricity company develop low-cost ways to collect bills. This might include making payments possible at local banks or public institutions or through local contacts in the community, such as village leaders; one advantage of the latter option is that village leaders could serve as a contact point between EEPCo and the community for reporting power outages and other distribution problems. More technical options might include the use of load limiters or prepaid meters.

Provide better-quality CFLs or other, more efficient lighting options. The two free CFLs provided under the GPOBA program were not fully appreciated by the GPOBA-participant households. According to the survey and FGDs, the CFLs provided did not work well under the low-voltage conditions found in most villages and towns. Future programs need to include lighting

options that function well under periodic low-voltage conditions. Providing more efficient lighting options, such as better-quality CFLs or light-emitting diodes (LEDs), would not only be important for households newly adopting electricity; this could also be part of a broader campaign to promote energy-efficient appliances in rural Ethiopia.

Provide technical assistance and loans for businesses. Many successful rural electrification programs encourage business development by providing new business loans and assistance on how to set up businesses that can take advantage of electricity. This can be done through raising awareness of the possible productive uses of electricity, facilitating credit for small businesses, providing technical assistance on the requirements of running small businesses, and making sure that appliances or tools common to small businesses are available in the community (Brüderle, Attigah, and Bodenbender 2011; Finucane et al. 2012). Households in rural Ethiopia seemed eager to start a new business. According to the impact evaluation survey, they had many new business ideas, ranging from retail shops to beauty salons and cafes. In addition, assistance could be given to promote electricity-driven appliances that would make life easier for people in rural areas. In some countries, promoting the availability of electric appliances accompanies the extension of electricity to new rural communities. Such complementary programs would increase the utility's revenue stream and have a greater socioeconomic impact in rural communities.

Connect public institutions. Only about half of the public institutions in the villages and towns with new service have adopted electricity. Once a community has electricity, additional funds should be provided for government-financed public institutions to adopt electricity. Public services are generally important for the whole community, especially the poor. With better lighting and communication and office equipment, such public institutions with electricity should be better able to serve rural populations. However, the responsibility of subsidizing the electricity used by public institutions should not be placed on the electric utility company. Rather, the government should consider it as a normal budget cost of providing public services. The electricity used by the public institutions can provide the utility a stable source of revenue for serving rural areas.

Meeting the Challenge of Implementation

To deal with the challenges of rural electrification, it might be necessary to set up a specialized institution within the power company (Barnes 2007). The best electricity programs around the work have dealt with the issues involved in rural electrification by setting up specialized institutions either within or external to the main utility. Successful programs have also featured a firm government commitment to the program, along with a clear plan for system expansion that avoids political influence (Barns 2011). In addition, for most successful programs, the electrification rate was high enough to allow the distribution companies to obtain revenue for system expansion by pursuing customers rather than government subsidies. Furthermore, many traditional distribution companies have adopted single-phase and other low-cost distribution

methods. If geography permits, single wire earth return (SWER) systems can drastically reduce distribution costs. They also lower the initial barriers to adopting electricity and stress community involvement early in the program.

To summarize, with better electricity pricing policies, combined with policies to ease both connection and house-wiring expenses, the number of people in villages and towns with new service would expand significantly. This would also mean that the utility would gain significant revenue streams from rural electrification. This, in turn, would allow for greater investments in customer service and sufficient investments in operation and maintenance of rural systems to avoid many of the problems caused by power outages. Rural customers would then perceive themselves as valued customers and, over time, would invest in more appliances. By implementing these innovations together, Ethiopia would be taking important steps to solve its challenges of rural electrification.

Conclusion

The impact of household electricity adoption in rural Ethiopia is extremely high and remarkably similar to that of programs elsewhere in the developing world in the initial stages of promoting rural electrification. In Ethiopia, rural businesses adopt electricity immediately after electricity arrives in their village or town. With electric lighting, schoolgoing children can study in the safety of their homes in the evening, which no doubt results in better classroom performance. Also, household members can socialize and participate in family discussions during evening hours. With an electric grain-processing mill in the village, women are spared time-consuming drudgery. Also, cell phones can be charged locally rather than miles from home. In addition, households that purchase televisions have access to inexpensive news and entertainment. The main problem for Ethiopia, like most countries in Sub-Saharan Africa, is that it lags in the process of extending electricity to its rural people.

Even with these substantial gains, the development impact of Ethiopia's rural electrification program could be much greater. One main area in need of attention involves raising the extremely low price of electricity and planning the system rollout to include communities with the highest potential for electricity growth. Another main area to address is ensuring that the electricity provided to rural towns and villages has the highest possible impact for rural households. This means cooperating with other rural development agencies through coordination of complementary programs and promoting credit and technical assistance to raise the level of program impact. Addressing these areas will ensure that the utility has a higher revenue stream and therefore incentive to provide customers better service and connect more rural households. It will also ensure that the program has a higher level of socioeconomic impact for Ethiopia.

The GPOBA program played a vital role in accelerating rural households' access to these benefits of electrification. The connection rates of villages participating in the GPOBA program

were higher than those under EEPCo's regular connection program. Despite the intervention's success, obstacles remain in achieving rural electrification rates typical of other countries in the developing world. According to the impact evaluation survey, the main reasons people have not yet adopted electricity include frequent power outages, lack of local regional offices or businesses for bill paying, infrequency of receiving consumer electric bills, lack of an adequate meter supply to connect those applying for service, and EEPCo's policy of not connecting non-concrete houses. Finally, there were delays in EEPCo program implementation resulting from problems faced by the electricity sector in bringing new generation online.

Connection-rate programs are an important component of strategies for rural electrification. However, they are not a panacea for all that ails the power companies in Sub-Saharan Africa. In addition to low-connection costs, the success of rural electrification depends on a deep institutional commitment by the government and electricity companies to provide service to the poor. The electric utilities need to have appropriate pricing and financial incentives to properly serve rural areas. Low-cost system designs for rural areas and sound planning for the grid system rollout are important for keeping rural electricity prices low. It is also important to gain community support for rural electrification. Strategies to achieve this would include low levels of system outages, timely and good billing practices that make certain bills are easy to understand and pay. Complementary programs to encourage greater use of electricity would include providing credit for new businesses and incentives for households to adopt efficient electric appliances. In short, output-based aid (OBA) and other programs designed to lower connection costs are an important component of an overall rural electrification strategy.

Many countries in Sub-Saharan Africa have rural electrification rates that remain quite low. The reasons for these low-connection rates vary by country. In many, the power companies have not yet grappled with the need to have a dedicated team in place and a strategy that differs from those used in more densely populated urban areas, which today account for their main electricity customers. The emphasis on lowering connection costs is a good start for demonstrating that people desire and will adopt electricity with the appropriate incentives. This, in turn, will have large benefits for the country well above the investment cost of the electricity companies.

The Ethiopia GPOBA program was an important first step in focusing the state electricity company on providing service to some of the country's poorest regions; but certainly it is not the last step. Providing electricity to rural areas is a long-term investment. The future of rural electrification in Ethiopia depends on the ability of the government and the power company to make a serious commitment to adopting the principles of successful programs and working together to provide electricity for all of Ethiopia's people. Tackling the problems encountered will not be an easy task. It is imperative that the solutions identified do not harm the electricity company and that it be given appropriate incentives to serve rural areas. Once this is accomplished, the electricity provided to rural areas will have a high level of benefits for Ethiopia.

Annex 1. Programs to Lower Connection Costs in Sub-Saharan Africa

There is little doubt that having reasonable charges for obtaining access to electricity, combined with consumption tariffs that allow the utility to recover its costs, is a worthwhile endeavor. Financing options to make household connections affordable, combined with low-cost electrification technologies and effective procurement practices that help to reduce the cost of connection service, are prerequisites for accelerating access expansion. Scaling up electricity access also requires strong political support and specialized institutions.

Sub-Saharan Africa has many available options for helping to make connection charges affordable to consumers. Choosing the best one will depend on the specific conditions found in individual countries. Over the past decade, some of the newer subsidy programs have been based on output-based aid (OBA) and results-based financing (RBF), meaning that subsidy payments are disbursed based on pre-agreed and independently verified outputs, such as functional household connections, billing cycles, and distribution of energy-efficient lights, such as compact fluorescent lamps (CFLs).

In **Senegal**, for example, the Rural Electrification Priority Program aims to increase new customer connections by providing OBA subsidies to private electricity concessionaires that agree to finance the related investment. The subsidies target poor and remote communities within the concession area (de Gouvello and Kumar 2007). In those communities, the average cost of providing a connection, inclusive of upstream network development, is estimated at US$725, and the average subsidy provided to competitively selected private operators is $286 per connection. The difference, accounting for 60 percent of the project costs, is borne by the private operator. Office National de l'Electricite, one of the selected concessionaires, is committed to increasing both the overall number of connections and the proportion of connections using renewable energy. The private operator recovers the capital costs of connection, internal wiring, and CFLs through a monthly bill, which, by removing the barrier of high upfront charges, is expected to make electricity adoption more affordable to poor households (Golumbeanu and Barnes 2013).

The connection charge is recovered in the customer's electricity bill over a period of 120 months, at 15 percent interest. The private operator is obligated to complete the internal installations for the first three customer-service levels. For the fourth level of customer service, this rule is optional. Customers must pay an affordable sum of money upfront before being connected. This sum can be paid at once or in three installments. Because of the installment option, customers' monthly bills may have two components: energy consumption costs and monthly repayment of the initial connection charge.

In **Liberia**, **Kenya**, and **Uganda**, the World Bank is implementing Global Partnership on Output-Based Aid (GPOBA) grants to reduce the burden of connection charges by encouraging utilities to connect poor people who otherwise could not afford the full cost of a grid connection. In Monrovia, the program subsidizes part of the overall cost of US$950 for providing a connection (inclusive of upstream development). In the slums of Kenya, a subsidy is provided to lower the $300 connection charge. Subsidy disbursement schemes vary by country, but all are linked to verified household connections; that is, the subsidy is disbursed only after a certain number of households have obtained connections. Though in the early stages of development, such initiatives bode well for the future of electrification in Sub-Saharan Africa.

Côte d'Ivoire has set up a revolving fund that allows customers to finance 90 percent of their connection charges with interest-free loans over a maximum period of two years (World Bank 2009a). In **Botswana**, the government offers rural customers loans for 95 percent of the utility's standard connection charge (US$615).[18] The loan is payable over 15 years at the prime interest rate. Connection and installation services include smart meters with prepayment cards for electricity consumption. The high connection charge in Botswana reflects high costs that could probably be reduced by using lower-cost system designs. Meanwhile, offering loans to help new customers pay for connection charges is a step in the right direction. Some subsidies to the interest rate may be justified.

In **Kenya**, several financing schemes offered by the Kenya Power and Lighting Company (KPLC) are helping to expand access and ensure the utility's financial viability (World Bank 2010b). Under one program, the KPLC has initiated a partnership with Equity Bank to offer "Stima" loans for connection charges to all customers living within 600 m of a transformer. Customers pay 30 percent of the charge upfront, with the balance payable over three years at an annual interest rate of 15 percent. Under the Rural Electrification Deferred Payment Plan, financed by the Ministry of Energy, customers pay 30 percent of the connection charge upfront and the balance over 10 months. A third program, based on a revolving fund and administered by the KPLC, is open to all customers and requires a 20 percent upfront payment, with the balance due

[18] This is the Botswana Power Corporation's standard connection cost for customers within 500 m of transformer coverage.

over one or two years. A 2 percent administration fee is charged on the 80 percent balance. Finally, for customers living outside a 600 m radius of a distribution point, the KPLC offers a group program called *Umeme Pamoja.* This program enables people otherwise ineligible for individual connections (except at a great cost) to finance the transformer and low-voltage network. The cost of extending power to such households is divided equally among the affected customers, making it more affordable overall.[19]

In **South Africa**, the government considers electrification a social service. Typically, the South African government provides capital subsidies for electrification directly from the national budget (Dinkelman 2011). Customers have also been asked to make modest financial contributions. A program in Cape Town allows households that cannot afford to pay the US$24 connection charge as a lump sum to discharge it over time on prepaid meters, through which customers pay for the electricity they use. For each dollar of electricity used, the customer pays an additional $0.14 until the connection charge is paid in full (AEI 2009).

In **Zambia**, the power utility benefits from a World Bank–funded program to reduce connection charges (World Bank 2008b). Under the project, a government subsidy of about US$120 covers 75 percent of the cost of a basic household connection. The utility receives the subsidy in the form of materials and equipment used to connect a certain number of low-income households. In the initiative's pilot areas, the number of households requesting a connection doubled from the previous volume of requests.

Experience in **Ghana** shows that low connection charges encourage local populations to participate in rural electrification (EUEI-PDF 2008). Only about 23 percent of Ghana's rural population has electricity. Even so, the country has one of the subcontinent's highest rates of rural electrification, and is set to make even further progress. In 1989, the government launched the National Electrification Scheme (NES), whose goal has been to connect all communities of more than 500 people to the national grid by 2020. External funding has been provided by a consortium of institutional and bilateral donors under the auspices of the World Bank.

Complementing the NES is the Self-Help Electrification Programme, a rolling (three-to-five year) electrification program. Under this program, communities not scheduled for immediate connection to the national grid, located within 20 km of an existing medium-tension electricity line, help the electricity operator lower its cost by erecting low-voltage distribution poles and thus ensuring that at least 30 percent of households in the community are wired and ready to be serviced as soon as the electricity supply becomes available. The community accomplishes this work through a village electrification committee, responsible for mobilizing funds, establishing rights-of-way, and helping people to wire their homes. In 2000, a plan was devised to provide credit for

[19] These programs cover the connection charge, plus the cost of extending the system to supply the affected group of consumers.

productive and income-generating uses of electricity. More recently, this credit facility has been used to help pay for household wiring.

Rwanda shows how a capital subsidy policy, combined with low-cost electrification technologies and improved procurement practices, can be translated into significant access results (World Bank 2009b, 2013c). The Rwanda Electricity Corporation (RECO) has been able to lower its costs through bulk purchases of hardware for local installations, including bundled low-voltage cables, distribution transformers, poles, prepayment meters, brackets, and other connection materials. In addition, RECO has used less costly, but experienced, local labor for installation services. Lower costs, combined with a capital subsidy, have allowed for a doubling of the number of connected households in the targeted urban and periurban areas over the 2010–11 period. This low-cost electrification project was the result of cooperation between RECO and the Tunisian electricity company (Cecelski et al. 2005). Worldwide many successful programs have lowered their electricity distribution costs by implementing low-cost strategies to service rural areas (World Bank 2000a, 2000b, 2006; NRECA International 2000, 2011, 2012a, 2012b; Karhammar et al. 2006).

Annex 2. Electricity Access and Study Methodology

Ethiopia's low level of electrification meant that this study had to pay particular attention to the methodology used to measure the impact of rural electrification. This was particularly important, given the measurement challenges of assessing changes over the short two-year program period. This annex describes the methodology used to assess the impact of the GPOBA intervention.

Overview

To measure the impact of electricity, this study relied on a mix of quantitative and qualitative approaches (INTEGRATION Environment & Energy and MEGEN Power Ltd 2014). To monitor progress on connecting households, an independent monitoring and verification (M&V) survey, required for funds disbursement, was used to verify payments to households that adopted electricity and installation of EEPCo connections. As part of this study component, baseline surveys were conducted in November 2011, June 2012, and July–August 2013. The delay of the baseline survey meant that examining changes over time would not be possible as part of the analysis strategy. Therefore, in this report, more weight has been given to the impact evaluation survey conducted after the project.

Concurrent with the M&V survey, the study implemented a socioeconomic impact evaluation to explore the impact of the GPOBA intervention on household connection rates, particularly the affordability of connection costs. The evaluation study used several approaches. For example, an impact evaluation survey, including a household questionnaire, was conducted at project startup (2011) and after project completion (2013–14) (annex 3). This survey covered a total of 760 households with and without electricity. While a larger sample (e.g., 2,000–3,000) would have been more robust, the differences between households with and without electricity were quite notable, even with the limited sample size. This formal statistical approach was complemented by structured informant interviews with key village and EEPCo officials and focus group discussions (FGDs) on project impact, with a focus on gender issues. Because of the compressed timeline for completing the GPOBA program and the overlapping time frames

between the baseline and impact evaluation surveys, the findings presented in this report are based on the final cross-sectional impact evaluation survey.

Sample Stratification and Village Selection

The survey sample is highly stratified. Ethiopia's overall rural electrification rate is only about 10 percent, compared to 60 percent for the sampled households. An explicit strategy of comparing households with and without electricity was used to assess the differences between them. A modified matched-pair sample design was used, meaning that households with and without electricity were randomly selected within income groups so that there were similar numbers for the overall survey and within distinct income classes (table A2.1). This approach eliminated much of the bias that would have occurred using a random sample since higher income households adopt electricity at a higher rate than lower income ones.[20] The modified matched-pair sample design made it possible to compare similar households with and without electricity. Also, the number of households was rather low for conducting a formal impact evaluation survey.

Table A2.1 Household Electrification Status by Income Class for Matched-Pair Sample in Ethiopia Impact Assessment Survey, 2014

	Household type (%)				Total (%)
Income class	EEPCo	GPOBA	No electricity	Village without electricity	Average
Low	16	19	28	28	22
Medium low	20	18	17	7	17
Middle	21	25	26	22	24
Medium high	24	18	18	25	20
High	19	20	11	18	17
Total	100	100	100	100	100

Source: Ethiopia Impact Assessment Survey 2014.
Note: Figures represent % of sample by electrification status.

No doubt, significance tests for the variables would have indicated some type of positive or negative association for those households with and without electricity. But given the sample design, this approach might have been somewhat misleading due to stratification procedures that became necessary during the sample selection. Therefore, the survey results are reported as differences between groups of quite similar households with and without electricity. Since the socioeconomic characteristics of the sampled households are comparable, the main difference

[20] If a random sample had been used, only 10 percent of households with electricity would have turned up in the sample, making comparisons difficult due to the low number of sampled households.

between the two groups is that one has electricity and the other does not. Thus, the difference in means, if any, is likely to result from rural electrification. Because of this random matched-pair type of sample design, caution should be used in extending these results to rural Ethiopia.

Selection of Priority Districts and Villages

The selection of households started with the list of newly connected households, but was modified according to on-the-ground realities. Based on the household lists received from EEPCo and results of the M&V survey, the study team identified what it called EEPCo priority districts: those districts with a high number of villages with electricity, defined as having at least 30 households with electricity service.

Within EEPCo priority districts, villages were selected after consulting with district offices, confirming that the EEPCo lists in those districts were up-to-date. Villages were evaluated and prioritized based on their proximity to the EEPCo office, road conditions, and minimum number of new connections. Project M&V data was used to prepare the list of villages for selection for the impact evaluation survey. Twenty-two villages were selected from this list, complemented by the selection of two nearby villages without electricity, for a total of 24 villages.

Household Stratification and Selection

After villages were selected, households were chosen based on certain characteristics, grouped into three electricity connection categories: (i) GPOBA households, (ii) EEPCo households, and (iii) households without electricity. Households without electricity were selected from both villages with electricity and nearby villages without electricity. One selection criterion was that at least 10 households had to be chosen from each of the three electricity connection categories. Within each category, the sample selection was based on such household criteria as presence of adult household members, accessibility of the property, proximity of household location, and economic diversity of households (rich, middle class, or poor). An attempt was made to ensure that households within each strata were selected according to similar socioeconomic backgrounds; however, this was not entirely possible in all villages.

Survey Instruments

The complementary survey activities yielded more consistent information for the impact assessment. A village electricity market survey and gender impact assessment, along with the household socioeconomic survey, were cross-validated. Village-level FGDs were held with women, village elders, community leaders, *kebele* chairmen,[21] teachers, and business people. Key informant interviews were conducted with local politicians and officials in district-level electricity

[21] A *kebele*, similar to a ward, is the smallest administrative unit in Ethiopia.

offices. The gender-centered FGDs each comprised 6–9 women of diverse ages, educational backgrounds, occupations, and wealth status; these women represented both GPOBA and non-GPOBA households with and without electricity.[22]

The household survey activities received valuable assistance from EEPCo's respective regional offices in Addis Ababa and its district offices in the respective administrative regions and zones. EEPCo district offices provided important local information about the location, accessibility, and electrification status of villages within their respective jurisdictions. They also provided local EEPCo technicians to accompany the field survey teams to the villages, which greatly helped in identifying GPOBA households without influencing the selection of households for interviews.

As originally planned, the GPOBA program was to conduct a baseline survey to gather information from the study group before project startup, with the first impact assessment to be conducted 1–1.5 years later. However, because of the delay in program implementation, the first baseline survey was carried out within months of project startup. The impact evaluation completed at the end of the project allowed for a comparison of households that had gained 1–2 years of experience using electricity. About 25,000 household connections out of a total of 40,000 were completed between June 2011 and May 2012 under the GPOBA program. The impact evaluation sample contained households that had electricity 1–3 years. Most of the earlier connections were EEPCo-classified households, while a majority of the later ones were under the GPOBA program.

Sample Design

The sample frame for the assessment was based on lists from EEPCo, showing the total number of newly connected households in the project area (a total of 21,792 households), covering both GPOBA and non-GPOBA households. From these lists, the study sample of 760 households was drawn, representing 24 villages and towns (including 2 control villages) from 14 administrative zones in the 5 regions (table A2.2).[23] Within each region, the sample group was stratified by household type (whether electricity was provided under the GPOBA scheme or EEPCo's normal expansion program). The control groups included households without electricity in the selected villages with electricity and households in nearby villages without electricity.

[22] GPOBA households receive loans for which the interest rate is paid through grants and the loan principal is repaid by the participant households in monthly installments over time. GPOBA households also receive two free CFLs. Non-GPOBA households are connected to the grid system through EEPCo's normal practice. Both GPOBA and EEPCo households are connected and serviced by EEPCo.

[23] Details on the sample-selection technique are provided in INTEGRATION Environment & Energy and MEGEN Power Ltd (2014).

Table A2.2 Regional Sample Distribution for Ethiopia Impact Evaluation

Region	GPOBA households with electricity	EEPCo households with electricity	Households without electricity	Households in nearby villages without electricity	Total
Oromia	43	83	55	30	211
Amhara	42	40	42		124
SNNPR	43	42	24		109
Tigray	61	70	67	30	228
BSG	35	30	23		88
Total households	224	265	211	60	760

Source: Ethiopia Impact Evaluation Survey 2014.

During the M&V program phase, it was discovered that the lists provided by EEPCo were not up-to-date. Some households, listed as newly connected, had no electricity connection; others not listed were found to have an indirect connection (chapter 3). For the impact evaluation, this meant that many households had to be reclassified, with some purposively selected based on their household characteristics. For this reason, a random matched-pair sampling design (similar to propensity-score matching), rather than a classic random sampling of households, was used.

Because the M&V survey was conducted continuously over the compressed program period, the impact evaluation survey team was able to prepare the sample frame based on that information. The baseline and impact evaluation surveys were conducted too close together to conduct a panel analysis; thus, the final impact evaluation survey comparing households with and without electricity proved to be the best way to analyze the impact of rural electrification on development. Within villages, an equal number of households from various socioeconomic strata were randomly matched according to socioeconomic characteristics; thus, the comparison of simple means was a valid measure of difference between the main household groups.[24]

Treatment of Indirect Connections

Through the M&V survey, it was discovered that many households had indirect electricity connections (i.e., they used electricity passing through their neighbors' officially sanctioned meters) (chapter 3). However, there was no evidence of meter tampering. Households with indirect connections paid neighboring households with metered connections a fixed monthly fee. Thus, the electricity measured by the neighboring households' meters accounted for both direct and indirect household connections. The impact survey sample for the GPOBA and EEPCo households included both direct and indirect connections. Because households with indirect

[24] Statistical inference has been avoided in this study in order to present the results in a way that is accessible to a wider group of readers. Most of the comparisons between groups are simple differences in means.

connections comprised a significant number of households with electricity in the villages, the study classified them as EEPCo or GPOBA connections (table A2.3).

Table A2.3 Sampled Households with and without Meters, 2014

Household type	Households with metered connections (no.)	Households with indirect connections (no.)	Total households in category (no.)
EEPCo (with electricity)	119	105	224
GPOBA (with electricity)	155	110	265
Without electricity in village with electricity	0		211
In nearby village without electricity	0		60
Total	274	225	760

Source: Ethiopia Impact Evaluation Survey 2014.

Summing Up

The sampling procedure began by selecting districts with high concentrations of new electricity connections under the GPOBA program. Next, villages were selected, based on their having a sufficient number of households with electricity. Finally, households were selected from the villages. The village samples were required to include 10 EEPCo connections, 10 GPOBA connections, and 10 households without electricity. They were also stratified according to such considerations as accessibility and social class. As mentioned, households with indirect connections were considered either GPOBA or EEPCo connections, depending on the source of the direct (metered) connection. In addition, two nearby villages without electricity controlled for assessing the differences between households without electricity in villages that already had power and those in villages without electricity service.

Annex 3. Household Questionnaire

I) IDENTIFICATION:

Questionnaire number ☐☐☐☐ *(to be filled out by supervisor)*

No.	Question	Answers
1.	Name of head of household:	
2.	Type of household:	☐ Electrified (other programs) (1) ☐ GPOBA (2) ☐ Control group (4) ☐ Non-electrified (3)
A	➔ *If GPOBA household* GPOBA customer contract no.:	☐☐☐☐☐☐ *(will be filled out by the supervisor)*
B	Identification of household: Was the household already interviewed during BLS 1 or 2?	!!!!!!!! IMPORTANT !!!!!!!!!!!! ☐ "Old" household *(surveyed during BLS 1/2)* ☐ "New" household *(only surveyed for the impact assessment)*
C	Interviewer name	
D	Date of interview	**Date:** _ _**-** _ _ **-20**_ _ **(GC)** *[dd-mm-yyyy]*
E	Kebele/village name	☐ rural ☐ urban
F	Woreda/district	
G	Zone	
H	Region	

I	"EEPCo District"	
3. Name, gender, and family status of person interviewed		3.1 Name of interviewee:_____ 3.2 Gender: 1. Male ☐ 2. Female ☐ 3.3 Head of household 1. yes ☐ 2. no ☐
4. How many **people** belong to the household (including the person interviewed)?		4.1 **Adults** male ☐ female ☐ = total ☐☐ 4.2 **Children** male ☐ female ☐ = total ☐☐ *(up to 13 years)* 4.3 **Total number of people** ☐☐

II. SOCIO-ECONOMIC CHARACTERISTICS:

5. A) Please complete the following tables for all family members who are <u>currently</u> living in the family:

No	5.1 **First Name** *(Write name of head of household in row A and spouse in B, followed by other members)*	5.2 **Sex** 1 M 2 F	5.3 **Age in complete years**	5.4 **Relation to head** 1 Head of household 2 Spouse 3 Son 4 Son-in-law 5 Daughter 6 Daughter-in-law 7 Grandchild 8 Parent 9 Parent-in-law 10 Other	5.5 **For those of school age:** **7-15 years** Attending school? 1 Yes 2 No	5.6 **Highest level of education completed** 1. Illiterate (no schooling) 2. Literate (non-formal education) 3. Primary 4. Secondary 5. Vocational 6. University 7. Religious	5.7 For those over 15 years **<u>Main</u> occupation**: 1. Farmer 2. Pastoralist 3. Seasonal worker 4. Daily laborer 5. Enterprise worker 6. Student 7. Civil servant 8. Self-employed 9. Retired 10. Unemployed 11. Housewife 12. Other	5.8 Do you have additional occupations? **<u>Additional</u> occupation**: 1. Farmer 2. Pastoralist 3. Seasonal worker 4. Daily laborer 5. Enterprise worker 6. Student 7. Civil servant 8. Self-employed 9. Retired 10. No additional occupation 11. Housewife 12. Other

A								
B								
C								
D								
E								
F								
G								
H								
I								
J								

B) Please complete the following tables for all family members who are currently earning an income:

(Please ask annual amount and sources of income, as per types 1–9 listed in the table below, for each income-earning member of the household)

No.	5.9 **First Name** *(Write name of head of household in row A and spouse in B, followed by other members)*	5.10 **Source (1) of cash income from which the member of the household earns money from** 1. Salary/wages 2. Farming 3. Small/petty trading business (e.g., kiosk, shop) 4. Craft/handicraft work 5. Casual labor 6. Remittances 7. Social security benefits (like National Safety-Net Program) 8. Pensions/grants 9. No source of income	5.11 **Additional source (2) of cash income from which the member of the household earns money from** 1. Salary/wages 2. Farming 3. Small/petty trading business (e.g., kiosk, shop) 4. Craft/handicraft work 5. Casual labor 6. Remittances 7. Social security benefits (like National Safety-Net Program) 8. Pensions/grants 9. No source of income	5.12 **How much do they earn per <u>YEAR</u>** **(net income) in Birr?** *(write 0 Birr if there is no Income)*

A				Birr
B				Birr
C				Birr
D				Birr
E				Birr
F				Birr
G				Birr
			5.13 **TOTAL yearly income**	**BIRR/year**

6. What are the **5 most important services/ goods** that your **household** is in need of (i.e., that your household needs in greater quantities and/or for a lower cost/price) **to improve your household's standard of living**?	**Goods/Services** 1. Electricity 2. Shelter (a decent house) 3. Water supply 4. Irrigation 5. Education 6. Health/medical care 7. Transport possibilities 8. Separate kitchen	**Goods/Services Cont'd** 9. Clothes for different purposes 10. Electrical appliances 11. Equipment/machines for producing goods or providing services for sale 12. Domestic animals 13. Saving account/access to credit 14. Enough agricultural land 15. Other (specify)_____ _____
Indicate order of importance (1. the most important, 2. the second most important, 3. the third most important, etc.)	1. _____ 2. _____ 3. _____ 4. _____ 5. _____	

III. ENERGY APPLIANCES, OWNERSHIP, CONSUMPTION, AND EXPENDITURE:

7. How many of the following electrical appliances does your household own/use?	**Number of household appliances**	
	1. Incandescent bulb ☐ 2. CFL ☐ 3. radio/cassette ☐ 4. TV/satellite dish ☐ 5. refrigerator ☐ 6. Grooming equipment ☐ (Electric hair dryer/electric hair tongs, electric hair clipper, electric razor)	7. cell phone ☐ 8. kettle ☐ 9. Injera mitad ☐ 10. iron ☐ 11. heater ☐ 12. fan ☐

8. Please strongly agree, agree, disagree, or strongly disagree with the following statements. *(please tick ☑ only one answer per question)*	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
8.1 Lighting is quite adequate in my home.				
8.2 We have adequate entertainment in our household through radio and/or television (satellite dish).				
8.3 We have adequate access to communication, e.g., through landline/mobile phones.				
(only, if household owns mobile phones) ➔ 8.4 We can easily charge our mobile phones.				
8.5 Kerosene/candles are easily available in our village.				
8.6 The usage of kerosene for lighting is without any problem.				
8.7 Firewood is easily available in our village.				
8.8 Coal/charcoal is easily available in our village.				
8.9 In our village it is possible to connect a household to the national grid without difficulty.				

9. What (energy/electricity-related) **services** and/or **goods** do you think are missing most in your **village**? *(Access to markets for energy equipment, appliances, fuels, lighting of public places/main street in your village, …)*	1. _____ 2. _____ 3. _____

10. Household consumption and expenditures for energy/fuel

(How many/much…does the household use/pay per month?)

Energy sources/fuels	Consumption per month	Price per unit	Expenditure per month
Electricity	*(10.1)* ___ _____kWh/month	*(10.2)* _____ Birr	*(10.3)* _____Birr/m
Kerosene	*(10.4)* _____litre/month	*(10.5)* _____ Birr	*(10.6)* _____Birr/m
Batteries	*(10.7)* _____pieces/month	*(10.8)* _____ Birr	*(10.9)* _____Birr/m
Candles	*(10.10)* _____pieces/month	*(10.11)* _____ Birr	*(10.12)* _____Birr/m
Firewood	*10.13)* units/month ☐ ➔ ***please indicate unit*** ☐ a) bundle b) donkey load c) truck load d) other_____	*(10.14)* _____Birr	*(10.15)* _____Birr/m *self collected (free)*
Charcoal	*(10.16)* _____bags/month ***9.2.6.2 ➔ please indicate weight*** _____ kg bags	*(10.17)* _____ Birr	*(10.18)* _____Birr/m

Gas	*(10.19)* ____bottles/month ➔ ***please indicate weight*** _____ kg bottles	*(10.20)* _____ Birr	*(10.21)*_____Birr/m
Other fuel/energy	*(10.22)* (___)/month	*(10.23)*_____ Birr	*(10.24)*_____Birr/m

11. What are your household's total <u>energy expenditures</u> for the above listed items per year? *(to be filled out by supervisor)*	**Total energy expenditure** _____Birr/**month**

12. Do you think the current electricity tariff is …	☐ a) under-priced ☐ b) fairly priced ☐ c) over-priced
13. How much are you willing to pay over the period of a month if you could get a <u>24-hour/reliable/stable</u> electricity supply?	_____ **Birr/month**

14. Please give us your best estimate of the total monthly expenditures of your household ➔(<u>include all kinds of expenditures</u>)	**<u>TOTAL</u>_____Birr/month** nutrition: education: house rent: transport: health:

IV. IMPACT OF ELECTRIFICATION:

15. What are the three most frequently used energy sources in your household before and after electrification of the household/village for the following end use (please rank):

1) grid net 2) generator 3) kerosene 4) batteries 5) 12VDC 6) wood 7) candles 8) solar PV 9) other sources

A = most frequently used; B = 2nd most frequently used; C = 3rd most frequently used (energy source)

Household end use *(only for household/customer own use)* **!!!!!**	**Before electrification** *(ask all households)*	**After electrification** *(ask only for EEPCo and GPOBA households)*	**Notes**
Lighting	*(15.1)* A B C	*(15.2)* A B C	*(15.3)*
TV/satellite dish	*(15.4)* A B C	*(15.5)* A B C	*(15.6)*
Radio	*(15.7)* A B C	*(15.8)* A B C	*(15.9)*
Cooking/baking	*(15.10)* A B C	*(15.11)* A B C	*(15.12)*
Mobile phone charging	*(15.13)* A B C	*(15.14)* A B C	*(15.15)*
15.A/B ➔ If household performs any income-generating activities (e.g., charging cell phones for a fee, running a kiosk/restaurant/liquor shop, handicraft activities, baking injera on a commercial basis, etc.). **Please identify income-generating activities and identify the three most frequently used energy sources in the household/shop before and after electrification of the household/village.**			
Productive use (income-generating activities) A)_____	*(15.A.1)* A B C	*(15.A.2)* A B C	*(15.A.3)*
Productive use (income-generating activities) B) _____	*(15.B.1)* A B C	*(15.B.2)* A B C	*(15.B.3)*

16. What do household members usually do between after it gets dark and bedtime? (evening activities)

16.1 Household members	16.2 Before electrification	16.3 After electrification
16.1.1 Father	a) b)	a) b)
16.1.2 Mother	a) b)	a) b)
16.1.3 Boys	a) b)	a) b)
16.1.4 Girls	a) b)	a) b)

17. Has the time household members usually go to bed changed after the household/village was electrified?

1. Yes ☐ 2. No ☐

(17.1) ➔ If yes, do you now go to bed:

a) same than before ☐ or

b) later than before ☐

(17.2) ➔ if later than before, please estimated the <u>average additional waking</u> hours: _____hours/night.

➔ Question 18 to 21: *Only for households with school-aged children*

	Before household electrification	After household electrification
18. Where do children do usually their homework for school (at home, elsewhere, etc.)?	(18.1) Place for homework _____	(18.2) Place for homework _____
19. During what times of the day or night do children do their homework for school?	(19.1) a) In the morning ☐ b) In the afternoon ☐ c) In the evening ☐ *(after it gets dark)*	(19.2) a) In the morning ☐ b) In the afternoon ☐ c) In the evening ☐ *(after it gets dark)*

20. How many hours do children study at night (after it gets dark) on average?	(20.1) _____ hrs/day	(20.2) _____ hrs/day
21. Has the electrification of your household resulted in any improvements for your children's education?	1 Yes ☐ 2 No ☐ (21.1) ➔ If yes, what kind of improvements?_____ _____ _____	
22. Has the electrification of the village enabled any adult education in the evening?	1 Yes ☐ 2 No ☐ (22.1) ➔ If yes, in what ways has it enabled adult education? _____ _____	

23. Has your household made any investments within the last 12 month as a result of the electrification of your household/village? *(e.g., radio, satellite dish, TV, fridge, mobile phone, stock for kiosk, electric Mitad, electric hot plate, etc.)*	1 Yes ☐ 2 No ☐ (23.1) ➔ If yes, what kind of investments? a)_____ b)_____ c) _____ (23.2) Total amount of investment: _____Birr

24. Does anyone in your household participate in any additional economic (productive use) activities due to the electrification of the household? ➔ **If yes,** **What type of business is it?**	1. Yes ☐ 2. No ☐ (24.1) **Who?** ☐ *(day time)* 1 man 2 woman 3 both (24.2) business women _____ TIME day/night (24.3) business men_____ (24.4) business both _____ ➔ 24.5 Have you made any additional investment for productive use? Yes ☐ No ☐ ➔ 24.6 If yes, what equipment have you bought and how much did it cost? _____ _____ Birr
25. Does anyone in your household earn an additional income because of the electrification of the household/village? *(e.g., sell bulbs or other electrical equipment in kiosk, charging phones, doing handicraft work, etc.)*	1. Yes ☐ 2. No ☐ (25.1) ➔ **If yes:** How much do you earn additionally per month? _____ Birr
26. Do you have an idea for the future of how you could use electricity to produce goods or services for sale to generate a cash income?	_____ _____ _____ _____

➔ Only for GPOBA households and households with grid connection !!!

27. Being connected to the grid has caused benefits in terms of ….	*Please strongly agree, agree, disagree, or strongly disagree with the following statements, or indicate if you are unsure (have no opinion) (please tick ☑ only one answers per question)*				
	Strongly agree	**Agree**	**No opinion**	**Disagree**	**Strongly disagree**
27.1… better lighting					
27.2 … better income situation					
27.3 … better health					
27.4 … better indoor air quality					
27.5 … less energy expenditures					
27.6 … reduced kerosene consumption					
27.7 reduced batterie consumption					
27.8 … reduced candle consumption					
27.9 … better working conditions					
27.10 … better entertainment					
27.11 … better access to news					
27.12 ... better socializing of the HH					
27.13 … better security					
27.14 … improved knowledge on critical issues like health, education, etc, through increased access to TV/radio					

28. What do you think are the three main benefits in order of importance for **your village** from having been electrified?	1_____ 2_____ 3_____
29. What do you think are the three main benefits in order of importance **for your household** from having been connected to the grid?	1 _____ 2 _____ 3 _____
30. What **kinds of problems** (if any) in order of importance has the household had with the connection in the last six months? *(e.g., accident [electric shock], power interruption, lack of timely maintenance, etc.)*	1 _____ 2 _____ 3 _____

31. How satisfied are you with …	Very satisfied	Somewhat satisfied	No opinion	Dissatisfied	Very dissatisfied
31.1 … the quality of customer service provided by EEPCo when getting connected	☐	☐	☐	☐ Why?	☐ Why?
31.2 … the reliability of power supply	☐	☐	☐	☐ Why?	☐ Why?
31.3 … affordability of tariff	☐	☐	☐	☐ Why?	☐ Why?
31.4 …availability & technical capability of local technicians for power supply system repair/ maintenance, internal wiring, etc.	☐	☐	☐	☐ Why?	☐ Why?
31.5 …accuracy and timely collection of bills	☐	☐	☐	☐ Why?	☐ Why?
31.6 …voltage surge/drop	☐	☐	☐	☐ Why?	☐ Why?
31.7 …complaint redress mechanism	☐	☐	☐	☐ Why?	☐ Why?

➔ ➔ **Only <u>for GPOBA households</u>**

32. Does your household still have the two free CFLs that were given together with the GPOBA household connection? ➔**If no…** (32.1) Has the household replaced or sold the CFLs? ➔ **If replaced…** (32.2) The household replaced the CFLs by… (32.3) How did you dispose your used/broken CFLs?	1. Yes ☐ 2. No ☐ 3. Household was not given two CFLs to begin with ☐ Replaced CFLs ☐ Sold CFLs ☐ ☐ CFL ☐ Incandescent bulb ☐ Fluorescent lamp _____ _____ _____
33. Would you recommend the GPOBA connection to your friends/relatives or other people? ➔**If yes** (33.1) What are the most important features of GPOBA that you would highlight to your friends/relatives to encourage them to get a GPOBA connection?	1. Yes ☐ 2. No ☐ _____ _____ _____
34. In your opinion, which social group do you think has benefited most from the GPOBA electrification program in your village and how? 1) The poor (explain how) 2) Middle income (explain how) 3) Non-poor (explain how)	☐ _____ _____ _____
35. In your opinion, what should be done to improve desirable impacts of the GPOBA electrification program in the future and to reach and benefit more households in your area?	_____ _____ _____ _____
36. Do you think saving electric energy is important for your household? (36.1) ➔If yes, tell me strategies you have used to save energy?	1. Yes ☐ 2. No ☐ _____ _____ _____

37. Give me the three most important provisions/measures that either should not have been made/taken at all, or should have been made/ taken in a different way under the GPOBA program.

_____

_____

Additional comments, suggestions:

_____

_____

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