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Connection Charges and Electricity Access in Sub-Saharan Africa

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Abstract

Sub-Saharan Africa trails other regions in providing access to electricity for poor urban and rural residents. This poor performance can be linked to various factors, including political interference in utility policy, higher investment costs and lower profitability of extending service to rural areas. But a major obstacle to wider access is the high charges consumers must pay to connect to the electricity network. The connection charges in Sub-Saharan Africa are among the highest in the world, which has resulted in low rates of electrification in many countries. This paper reviews ways to improve electrification rates by addressing the issue of high connection charges. Essential to the success of such efforts is concurrent political commitment to identify, examine, and implement various low-cost electrification approaches and financing solutions as part of a broad plan to improve access. Electricity companies can lower their connection-related costs, and thus consumer charges, by using a variety of low-cost technologies and materials in distribution networks and household connections; making bulk purchases of materials; and adjusting technical standards to reflect the lower loads of households that use a minimum amount of electricity. Strategies for lowering connection charges may also include spreading charges over a reasonable period, rolling them into monthly service payments, subsidizing connections, or amortizing them through loans. Lowering connection charges is not the only step, but it is an essential part of any strategy for addressing the electricity access gap between rich and poor households in Sub-Saharan Africa, a gap that denies millions of poor Africans the benefits of electricity.

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Connection Charges and Electricity Access in Sub-Saharan Africa

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This paper was written for the African Electrification Initiative (AEI), the objective of which is to create and sustain a living body of practical knowledge and an active network of Sub-Saharan African practitioners who work on the design and implementation of rural, peri-urban, and urban on-grid and off-grid electrification programs. These practitioners include individuals who work for electrification agencies and funds, government ministries, regulators, and state, community, or privately owned utilities. Funding for this paper was provided under the Africa Renewable Energy Access Grants Program(AFREA) ,ESMAP, and GPOBA.

Since the paper examines one of the key barriers to electricity access in Sub-Saharan Africa—that is, high connection charges, which have not been specifically addressed by the energy literature—it constitutes an important contribution of the AEI to the Sustainable Energy for All. The team gratefully acknowledges the support from Meike van Ginneken, Lucio Monari (Sector Managers, Africa Energy Practice), Vivien Foster, (Sector Manager, Sustainable Energy Unit) and Carmen Nonay (Program Manager, GPOBA). Special thanks are given for guidance and contribution by Chrishanta Ratnayake, Jie Tang, Bobak Rezaian, Sudeshna Ghosh Banerjee, Xiaoping Wang, and Leopold Sedogo. The authors benefited of research support from Arsh Sharma.

Introduction

Sub-Saharan Africa trails other regions in the breadth of common access to electricity for household use. Anticipated population growth is expected to widen that gap (IEA 2010a, 2010b). Several factors contribute to the access deficit across the subcontinent (Zomers 2001). Conservative utilities have stuck to traditional policies that emphasized service to urban areas, in large part because providing service in urban areas is more profitable than extending it to remote and sparsely populated rural areas. In many cases, plans to extend electrification to rural areas have been subjected to political pressure that often prevents the utility from charging a cost-recovery tariff and amassing the investment capital needed to extend service, leaving it in a chronically weak financial position. Another reason for the slow rate of access expansion is the poor targeting of subsidies, which allows wealthier customers to enjoy subsidies they do not need (Komives and others 2005; Foster and Briceño-Garmendia 2010).

Even in urban areas where the cost of extending service to new customers is comparatively low, companies have provided service to households wealthy enough to pay the connection charge for electricity service "in full" and "in advance." Presently, utilities lack incentives to expand electricity into areas where customers cannot afford up-front connection charges and where low load factors result in returns on investment that are too low to justify the substantial costs of extending the service.

The unfortunate reality in many Sub-Saharan African countries is that even when distribution lines are provided to increase access—whether because of a political commitment on the part of the government, an investment decision by the utility, or the availability of financing from donors—the percentage of consumers who are able to connect to the network remains extremely low. In many of these countries, the initial rates of connection in villages newly added to the electrical grid are as low as 10 to 20 percent of possible connections, and that number increases only very slowly over time.

Electricity Connection Assumptions and Methods

To explore the role that connection charges play in electrification rates, this paper first examines patterns of access to electricity in Sub-Saharan Africa and reviews current practices in connection charges. Several new programs in the region and elsewhere in the world are then reviewed, focusing on how the pace of electrification can be accelerated when the barrier of high connection charges is lowered. Finally, the conclusion provides recommendations for policy makers on how to ensure wider access to electricity in Sub-Saharan Africa.

The data on connection charges were collected from utilities, regulatory agencies, and World Bank staff and project documents over the period 2011–13. Connection charges generally reflect the lowest rating offered by the utility or power distributor for a house with

a few lights and plug points.[2] The main source of data on electricity access is the International Energy Agency's *World Energy Outlook 2011*. Country updates on electricity access were included where available.

A word about terminology is in order here. The term "connection charge" is used in the industry (and in this paper) to denote the fee charged to a consumer to connect to an established distribution network. The cost related to connection charge usually covers the estimated costs of materials, labor, and transport needed to make the connection from the nearest pole of the distribution system, along with the costs of inspection of the consumer's premises and, in some instances, a relatively small one-time application fee. By contrast, "cost of connection" or "connection cost," as often used in energy literature, usually refers to the total expense (to the utility and the consumer) of providing new electricity supplies. Different authors include various cost components in their treatment of connection costs depending on the scope of their analysis. Typically such connection costs consist of the service connection expenses from the nearest distribution line post to the consumer's main circuit breaker (that is, the connection charge) along with the cost of upstream development of the power grid to serve an area. In general, the key item of the related upstream cost is that of the distribution system (medium voltage) expansion. It can also include, depending on the scope of the analysis, further upstream development costs needed in the transmission and generation systems as well as the downstream cost of internal wiring of the consumer's house. Only a few utilities collect contributions from prospective consumers before setting up a distribution network. Such contributions are normally in addition to the connection charge. Usually the connection charges and internal wiring cost are paid by the households.

Although this paper focuses on connection charges to consumers, rather than on the other costs of developing distribution systems, the cost-effective development of distribution systems is also key to the success of rural electrification programs (see appendix 3 for more information).

Access to Electricity in Sub-Saharan Africa: A Status Report

About 1.3 billion people around the globe lack access to electricity (IEA 2010a, 2010b), and the majority of them reside in rural areas. Sub-Saharan Africa alone accounts for almost 45 percent of that number (table 1). Across the subcontinent, fewer than one-third of households have electricity. In most parts of the world, urban electrification rates exceed 90 percent, but less than 60 percent of the urban population in Sub-Saharan Africa has

[2] Connection charges and the costs behind them vary with the load demanded by the customer. A large factory, for example, will require a medium-voltage connection and a transformer, and the connection charge will be high. Even for low-voltage (residential) consumers, a three-phase connection will cost more to provide than a single-phase connection. Similarly, a 100 ampere (amp) connection will cost more than a 30 amp connection. Some utilities have standardized the lowest rating connection cost. Therefore, even if the distance from the pole is 10 meters (m) or 30 m, all households are charged a common rate based on an estimated average distance to the nearest pole. In some utilities, the minimum rating offered to residential customers is 30 amp single-phase (using 16 mm^2 conductors). More forward-thinking utilities also offer a lower (thus less costly) single-phase rating, such as 10 or even 5 amps, using less costly service cable (6 or even 4 mm^2).

electricity. The rural electrification rate is about 70 percent in the world, but less than 15 percent in Sub-Saharan Africa.

By 2030, the International Energy Agency (IEA) estimates that—at current levels of growth in generating capacity—access to power will just keep pace with population growth (IEA 2010b). Forty percent of Sub-Saharan Africa countries will not reach the goal of universal access to electricity by 2050.

Table 1. Access to Electricity in the Developing World

	Population without electricity (millions)	Overall electrification rate (%)	Urban electrification rate (%)	Rural electrification rate (%)
Africa	587	41.8	68.8	25.0
North Africa	*2*	*99.0*	*99.6*	*98.4*
Sub-Saharan Africa	*585*	*30.5*	*59.9*	*14.2*
Developing Asia	675	81.0	94.0	73.2
China and East Asia	*182*	*90.8*	*96.4*	*86.4*
South Asia	*493*	*68.5*	*89.5*	*59.9*
Latin America	31	93.2	98.8	73.6
Middle East	21	89.0	98.5	71.8
Developing countries	1,314	74.7	90.6	63.2
World	1,317	80.5	93.7	68.0

Source: IEA 2011.

Note: World includes Organization for Economic Co-operation and Development (OECD) countries and Eastern Europe/Eurasia.

The low rates of electrification in rural and urban Sub-Saharan Africa are serious obstacles to the region's development. Electricity is one of the necessary conditions for development (IEG 2008; World Bank 2002). These low electrification rates result in a loss of significant benefits—such as productivity gains in business, the creation of new jobs, opportunities to study at home, improvements in health, and better communication via television and radio. Because school attendance is improved by access to electricity, deficits in electricity access also may represent a loss in the development of human capital (Khandker, Barnes, and Samad 2009, 2012a, 2012 b).

The distribution of electricity—whether for social or productive uses—is a capital-intensive enterprise, and the cost of providing household connection to electricity service can be quite high. When connection charges are recovered through one-time, up-front fees for new customers, they can constitute a powerful disincentive to people who wish to obtain electricity, no matter how much they might desire the service.

Making it easier for households and small commercial enterprises to gain access to grid electricity without aggravating the financial problems of distribution companies is a delicate balance, but in most countries in the region, it is an achievable goal. If efforts to expand access to electricity are to be aligned with the important goal of ensuring utilities' financial sustainability and operational efficiency, they must be planned carefully (Barnes 2007;

World Bank 2010a; AEI 2012). Several policy issues arise in trying to strike the appropriate balance.

Speaking broadly, tariffs must be high enough to allow the utility to recover its 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"). That dilemma is resolved through graduated tariff structures in which unit costs rise at higher levels of consumption. Similarly, connection charges must be high enough to reimburse utilities for the connection service, but not so high as to discourage potential new customers from joining the network.

The pricing of electricity—and particularly the advantages and disadvantages of different tariff structures—has been the subject of a vast amount of research. But the connection charges have received much less attention, despite the fact that high connection fees are a significant deterrent to consumers desiring to connect to a network. The next section explores how connection charges levied on new consumers have affected electrification rates in Sub-Saharan Africa.

Customer Connection Charges in Sub-Saharan Africa

Most households deciding whether to access electricity from the national grid find themselves in one of two situations. In the first scenario, electricity may not be physically available in the local area. In this case, no household in the community receives electricity from the grid. The choices available to households are decentralized options such as minigrids, solar home systems, and batteries. Organizations and small businesses may rely on diesel-powered generators. The second scenario is that once an electricity network has been extended to a given community, households must decide whether to obtain the service. Of the factors influencing that decision, and the most researched, is the price of electricity.

High electricity prices can discourage low-income households that may not be able to afford the monthly bills. However, in practice, high prices are not such an obstacle, because the cost of alternatives generally used, such as kerosene oil, candles and batteries, are comparable to most grid-supplied electricity tariffs for small consumers. The main obstacle is the high up-front charges the consumer has to pay for a grid connection. These include the cost of house wiring and the connection charge payable to the utility. The connection charges faced by small residential consumers vary considerably across countries. The charges can range from very modest (often subsidized) sums of $10–$20 to close to $200 and more in some countries (see appendix 2). In many cases, to obtain service the consumer is expected to reimburse the utility for the entire 20- or 30-year capital cost of an electricity service that often has been designed not for subsistence consumers, but for users of larger amounts of electricity. High connection charges have a dramatic dampening effect on electrification rates because they significantly deter poor households from electing to obtain available service. Not only are households deprived of the benefits of electricity, but utilities

are deprived of the revenue stream from the deterred customers.[3] In this situation, nobody wins.

In theory, low connection charges for new customers accompanied by cost-reflective tariffs allow utilities to build up sufficient numbers of customers in a given location for it to become a reliable source of revenue over many years. Everybody wins. But utilities in Sub-Saharan Africa have very high consumer connection charges. Sometimes the connection charges are so high that they exceed a country's annual income per person (appendix 2)—an obvious barrier to obtaining electricity (Bernard 2012). In fact, of all the countries for which information is available, Sub-Saharan African countries had the highest number of countries with connection charges more than $100 per customer at lowest rating—and correspondingly low rates of electrification (figure 1).[4]

There are various reasons for these high charges for smaller consumers, including:

- weak commitment of utilities to provide electricity access (because of greater emphasis on high-consuming urban consumers, power generation constraints,[5] and inability to recover costs because of politically motivated limits on tariffs);
- lack of incentives to adopt solutions to make the connections affordable to poor populations;
- high costs of providing electricity connection, which stem from overrated technical specifications for low loads[6];
- inefficient procurement practices;
- greater distances between the household and the distribution pole in rural areas; and
- lack of financing options to make connection charges affordable.

Although many African households could afford monthly electricity bills of $3 to $7 per month (in part because the alternative monthly payments for kerosene, candles, and batteries are as high or even higher), many of them cannot afford the initial charge to obtain an electricity connection (appendix 2), which is in addition to the cost for internal wiring of the house.

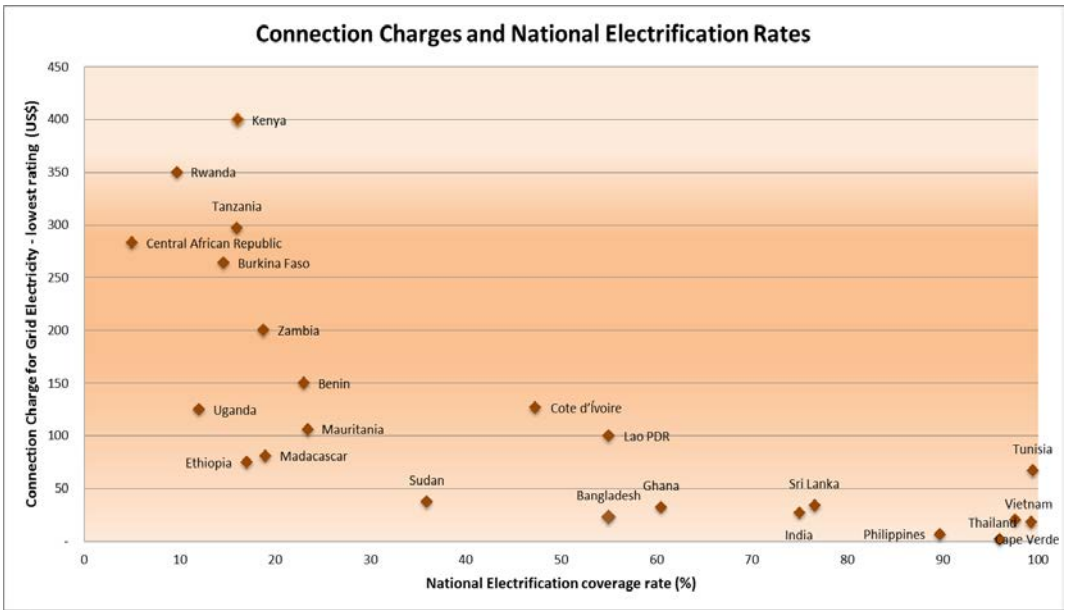
[3] A socioeconomic baseline study on a German Agency for International Cooperation (GiZ) rural electrification project in Benin emphasized affordability as a key barrier to obtaining a service connection, in addition to accessibility of the distribution network and lack of knowledge among the poor on the benefits of electricity.

[4] There are some difficulties in comparing connection charges due to differing international practices. This study uses estimates obtained from various countries using a standard set of questions about charges for a new electricity connection. These questions were answered by people knowledgeable about the local electricity companies, or information was drawn from reputable reports.

[5] The access programs in Ethiopia were hindered for over two years by a moratorium on connections adopted by the government at the end of 2008 due to power generation supply constraints.

[6] In Benin, for example, the utility charge is around $150 for a single phase, 5–30 amps. But since the consumption in rural areas is expected to be very low (below 5 amps), the use of a service conductor designed for 30 amps increases the cost.

Figure 1: The Relationship between Connection Charges and National Electrification Rates



Source: Connection charge data collected from utilities, studies, and World Bank staff; access data are from IEA's *World Energy Outlook 2011*.

Utilities around the world have treated connection charges quite differently. At one extreme, subsidies are provided to cover entire connection charges; at the other, the new customer is required to bear, in advance, the full costs of providing a connection. Between these two extremes, there are various ways to lower up-front charges: subsidizing some of the connection charge, incorporating some or all of the charge into the electricity tariff, financing the charge through a local or regional bank, or allowing consumers to pay the connection charge over time through credit schemes provided by the utility.

The most common practice in Sub-Saharan Africa is to require the new consumer to pay, in advance, the full connection charge for the electricity service. This general rule holds except in isolated cases, where fully subsidized programs have been funded by donors. The charge is computed as a function of the new customer's distance from existing electricity lines. An example from Tanzania is provided in table 2. In Tanzania, in addition to the connection charges, the customer must pay an additional 18 percent value-added tax (VAT) and an application fee.

Table 2. Tanzania: TANESCO Connection Charges for New Customers, 2011

D1 and T1 categories, single phase, with prepayment meter

	Distance from existing distribution line		
Materials and fees for new service	Up to 30 meters (US$)	31–71 meters with 1 pole (US$)	71–20 meters with 2 poles (US$)
Materials + 10% contingency	249	736	1,089
18% value-added tax	45	132	196
Application fee	3	3	3
Total charges	297	871	1,288

Source: NRECA 2012a, 2012b.

For consumers within 30 meters of existing electricity lines—who require no more than a drop line—the connection charge is close to $300. For customers who are between 31 and 70 meters from the nearest distribution point, a pole is required, so the fees are higher—well over $800. Those living more than 71 meters away are required to pay more than $1,200. In addition, new electricity users are responsible for their own home wiring, which is likely to add an additional $175 (one room) to $380 (three rooms). The main drivers of these high connection charges are oversized conductors and complex configurations of the single-phase drop line used to service low rural loads (NRECA 2012a, 2012b). In some cases, the conductor size is as large as 50 mm^2 for the single-phase service, big enough to carry a current of almost 200 amps. Most poor rural consumers are likely to need no more than 5 amps. To help households lower the costs of household wiring, the national Tanzanian utility offers ready boards suitable for a one- or two-bedroom house at a cost of $75–$150. However, the cost of a ready board can be reduced even further by using appropriate practices to meet the main requirements of a low-income household. The result of these up-front connection fees in a country where an average family earns about $220 per month is that electricity is unaffordable for the majority of the population, even those living close to electrical lines.

Additional fees are included in the connection charges in Sub-Saharan African countries such as inspection fees, government taxes, and mandatory security deposits. Moreover, internal wiring is the responsibility of the households. In Uganda, where the cost of a very simple home wiring is about $108, a security deposit of about $43 is required. Kenya has a minimum security deposit of about $30 for a single-phase connection. These additional fees further increase the financial burden for poor households and may put electricity out of their reach.

The combination of low-income households and high up-front connection charges impedes the pace of providing electricity to a larger proportion of the population. In fact, the relationship is negative for all countries included in figure 1. For all countries worldwide with available data, every $10 increase in the connection charge corresponded to a 1.1 percent decrease in the population with electricity, even after controlling for increases in the consumer price of electricity (table 3). In Africa, the decrease in electrification for each $10 increase in the connection charge is 0.5 percent. The lower figure in Africa probably reflects the fact that most countries have high connection charges. Thus, due to the larger number of countries and higher variation in connection charges, the global figures are probably a more accurate reflection of the impact of connection charges on obtaining electricity. A good rule of thumb might be that one would expect a $10 hike in connection charges to result in a 1 percent decline in electricity adoption rates. Because of the small number of countries in the sample, these findings are purely suggestive, but the coefficients stay fairly consistent after controlling for gross domestic product (GDP) per capita, which has the expected positive relationship with connection rates.

These findings suggest that low electrification rates are related to consumer connection charges, and that high connection charges may not, in fact, do much to help electricity companies recover the costs of providing electricity services or obtain the benefits of

economies of scale. Generally, good electrification planning will identify rural communities and parts of urban areas in which sufficient revenues can be generated from new connections if most of the households within reach of the new line are connected to the network. But if high initial charges suppress demand for electricity, the assumptions of such plans will not be realized. Ways must be found to enable potential new customers to connect to the grid—for their own benefit and also to secure revenues so that the utility can recover its investment in service expansion.

Table 3. Relationship between Connection Charges and Electrification Rates

	Statistic	All countries	Africa only
Descriptive statistics			
Countries/cases	Number	22	15
% with electricity (dependent variable)	Mean	44	28
Connection charge fee (independent variable)	Mean	128	172
GDP per capita (independent variable)	Mean	1,424	1,080
Regression statistics			
Connection charge fee	Coefficient (T statistic)	-0.11 (-3.32)	-0.05 (-1.99)
GDP per capita	Coefficient (T statistic)	0.02 (5.03)	0.03 (6.61)
Constant	Coefficient (T statistic)	34.29 (3.98)	14.47 (1.98)
R square	R square	0.777	0.849

Source: Data compiled from World Bank statistics, the International Energy Agency, and statistical analysis from this report.
Notes: GDP rates are for 2010. Connection charge rates are for 2010–13. Connection rates are for 2010.

Financing Electricity Access in Africa: Several Emerging Programs

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. In many countries, isolated, fully subsidized connection programs have been supported by donors.[7] 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 engineered to improve poor households' access to electricity without distorting energy markets. Subsidy policies must be carefully assessed for efficacy, efficiency, and cost-effectiveness. *Efficacy* is ensuring that the subsidy reaches those for whom it is intended—the poor, who would not have access to electricity without the subsidy—rather than allowing it to reach wealthier households who would connect to the grid without a subsidy. *Efficiency* is structuring the subsidy so that it encourages service provision at the least cost, which is an issue that needs to be addressed more thoroughly in efforts to restructure the energy sector, which often do not give adequate attention to increasing access, particularly in remote rural areas. *Cost-*

[7] Full connection subsidies, like overly broad consumption subsidies, may actually 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.

effectiveness is ensuring that the subsidy achieves social goals at the lowest program cost, while providing incentives to utilities to serve poor and rural populations. These are the main three criteria to consider when making decisions about which groups to target and the form, eligibility criteria, and financing of subsidies.

Some newer subsidy programs are based on results-based financing or output-based aid (OBA), meaning that subsidy payments are disbursed on the basis of pre-agreed and independently verified outputs, such as functional household connections, billing cycles, distribution of compact fluorescent lamps, and so forth. OBA strongly emphasizes targeting of low-income households on various criteria—geographic, self-selection, means-tested, or community-based selection. For instance, in Senegal, to increase connections of new customers, the Rural Electrification Priority Program provides output-based subsidies to private electricity concessionaires that agree to finance the related investment. The subsidies target poor and remote communities (de Gouvello and Kumar 2007) within the concession area. In those communities, the average cost of providing a connection inclusive of upstream network development is estimated at $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) is one of the selected concessionaires 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 compact florescent lamps through a monthly bill, making the adoption of electricity more affordable for poor households.

Box 1. Senegal: Prefinancing Customers' Internal Wiring in the MBOUR Concession

The prefinancing of customers' internal installation costs (wiring, bulbs, plugs, power limiters, and meters) by the concessionaire is expected to facilitate access to electricity services in Senegal by removing the barrier of high, up-front high connection charges. Here, the connection charge is recovered in the customer's electricity bill over a period of 120 months, at 15 percent interest (see table).

Internal installations	Wiring, accessories, lamps, and others			
	Service level 1	Service level 2	Service level 3	Service level 4
Investment cost ($)	90	124	210	276
Initial contribution required ($)	24	45	78	132
Loan ($)	66	79	132	144
Repayment period	10 years			
Interest rate	15%			
Monthly payment ($)	1.06	1.27	2.13	2.32

Note: $1 = 500 CFA francs.

The private operator has the obligation to complete the internal installations for the first three customer service levels. For the fourth level of customers, this rule is optional.

Customers must pay an affordable sum of money up-front before being connected. The 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 a monthly repayment of the initial contribution.

Source: ASER Senegal.

The World Bank is implementing Global Partnership on Output-Based Aid (GPOBA) grants to reduce the burden of connection charges in Liberia, Kenya, and Uganda by encouraging utilities to connect poor people who otherwise would not be able to pay the full charge for a grid connection. In Monrovia, Liberia, the program subsidizes part of the overall cost of $950 for providing a connection (inclusive of upstream development).[8] In the slums of Kenya, a subsidy is provided to lower the $300 connection charge. Subsidy disbursement schemes vary from country to country, but are linked to verified household connections. That is, the subsidy is disbursed only after a certain number of households have obtained connections. Such initiatives are in early stages of development, but they bode well for the future of electrification in Sub-Saharan Africa.

In Ethiopia, the national utility, the Ethiopian Electric Power Corporation (EEPCo), has connected about 60,000 poor households under the World Bank–funded Electricity Access Rural Expansion Project, Phase 2 - GPOBA (see box 2). The grant allows the utility to finance 80 percent of the connection charge for poor rural households through five-year, interest-free loans—reducing the up-front financial burden for households to just 20 percent of what it was previously. Households also receive two free compact fluorescent lamps as part of the connection package to promote energy efficiency and to make monthly electricity bills more affordable. The poor households in rural areas were targeted through implementation of the GPOBA financing scheme a year after the community was connected to the electricity grid. The preliminary results of an impact assessment analysis show that the program has been accurately targeted toward poor households.

Box 2. Ethiopia's Rural Electricity Access Expansion and GPOBA

The goal of the World Bank–funded Second Electricity Access Rural Expansion Project, Phase 2 (GPOBA), is to establish a sustainable program for expanding access to electricity in rural communities, thus supporting broad-based economic development and alleviating poverty. Ethiopia's goal is to increase the rate of household connections to the main power grid in rural towns and villages that already have electricity. The project is helping the Ethiopian Electric Power Corporation (EEPCo) finance connection charges. Rural households participating in the program must pay 20 percent of the $75 connection charge levied by the EEPCo, with the rest being paid in installments of about $1 per month, which covers the remainder of the payment over five years. The utility receives a subsidy of $35 per household, which covers the interest rate of financing the connection charge over five years and two compact fluorescent lamps worth about $6. Preliminary results appear to confirm that spreading the initial connections charges over time does increase the number of new poor households connecting to the main grid.

Source: World Bank 2012.

The financial contribution of customers is essential for sustainability, and financing options that allow customers to make payments over time are a good way to make connection charges affordable. However, the recovery of high connection charges through monthly bills

[8] The connection cost is based on the medium-voltage distribution system that is used in Monrovia. According to the Liberia Electricity Corporation (LEC) Master Plan 2011, the charge includes medium-voltage lines, transformers, drop lines, suitable drop-line anchors, poles, line hardware, auxiliary equipment, meters, and installation.

is not yet a common practice in Sub-Saharan Africa, where many utilities are prevented by governments from recovering even their operating costs through tariffs. One exception is Senegal, where electricity distribution concessions now offer a prefinancing scheme for connection charges and internal wiring. The connection charges are financed as part of the electricity bill, at an interest rate approved by the regulator for a certain period of time (AEI Workshop, Dakar, 2011). Senegal's program could be replicated in other countries to promote access to electricity by middle- and low-income households deterred by up-front connection charges.

Côte d'Ivoire has set up a revolving fund that allows customers to finance 90 percent of the connection charge with interest-free loans over a maximum of two years. In Botswana, the government offers loans to rural customers for 95 percent of the standard connection charge ($615).[9] The loan is payable over 15 years at the prime interest rate. The 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 decreased by lower-cost designs. Meanwhile, offering loans to help new customers pay connection charges is a step in the right direction. Some subsidies to the interest rate may be justified.

The Kenya Power and Lighting Company (KPLC) offers several financing schemes to help expand access and to ensure its financial viability. In 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 up front, with the balance repayable over three years at an annual interest rate of 15 percent. A second program, financed by the Ministry of Energy, is the Rural Electrification Deferred Payment Plan. Under the plan, customers pay 30 percent of the connection charge up front 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 up-front payment, with the balance due 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 who normally would not be eligible 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.[10]

Ghana's rural electrification program has been in operation for two decades (box 3). The program has incorporated many successful practices, including keeping connection costs low and community participation such as voluntary labor to erect poles, which lowers the cost of providing electricity to villages. The net result is that the country has made faster progress than most of the subcontinent in expanding access to electricity.

[9] Botswana Power Corporation, standard connection cost within 500 m of transformer coverage.

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

South Africa's government considers electrification a social service. The government typically has provided capital subsidies for electrification directly from the national budget. Customers, too, have been asked to make modest financial contributions. A program in Cape Town allows households that cannot afford to pay the $24 connection charge as a lump sum to discharge it over time on the 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 program to reduce connection charges. Under the project, a government subsidy of about $120 covers 75 percent of the cost of a basic household connection. The utility receives the subsidy in the form of materials and equipment to be 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.

Box 3. Ghana's Long-Standing Rural Electrification Program

Ghana's experience shows that low connection charges encourage local populations to participate in rural electrification. Although about 23 percent of Ghana's rural population has electricity, the country has one of the highest rates of rural electrification in Sub-Saharan Africa. The country is set to make even further progress.

In 1989, the government launched the National Electrification Scheme (NES). The goal was to connect all communities with a population of more than 500 to the national grid by 2020. External funding was provided by a consortium of institutional and bilateral donors under the auspices of the World Bank.

Complementing the NES was a three- to five-year rolling electrification program called the Self-Help Electrification Programme. Communities not scheduled for immediate connection to the national grid, but 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 therefore ensure that at least 30 percent of the households in the community are wired and ready to be serviced as soon as the electricity supply becomes available. This work is accomplished by the community 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 productive and income-generating uses of electricity. More recently, this credit facility has been used to help pay for household wiring.

Source: EUEI-PDF 2008.

Rwanda shows how a capital subsidy policy combined with low-cost electrification technologies and improved procurement practices can be translated into significant access results. The Rwanda Electricity Corporation (RECO) has been able to lower its costs through bulk purchases of hardware for local installations including bundled low-voltage cable, 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 a doubling of the number of connected households in the targeted urban and peri-urban areas over the period 2010–11 (Rwanda Electricity Access Scale-up and Sector Wide Approach Development

Project). This low-cost electrification project was the result of cooperation between the RECO and the Tunisian electricity company.

While certainly not a trivial task, there is little doubt that configuring 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 the connection affordable combined with low-cost electrification technologies and effective procurement practices that help reduce the cost of connection service are prerequisites for accelerated access expansion in Sub-Saharan Africa. There are many options available to help make connection charges affordable for consumers; choosing the best option will depend on the specific conditions found in individual countries. Generally, political support and specialized institutions are needed to deal with the challenges of scaling up electricity access.

International Approaches to Connection Charges

Most of the countries outside Sub-Saharan Africa have lowered connection charges. Examining some of these practices will be helpful in exploring the relationship between connection charges and electrification rates.

In some countries, the costs of the service connection to households are included in the electrification project itself, allowing utilities to keep connection charges low. In Bangladesh and the Philippines, for example, where connection charges are relatively low, the service connections to consumers are included in the overall distribution system development costs, which are provided as loans to the operating rural electrification cooperatives. Mechanisms for repayment of these loans are developed through a combination of economic prices for electricity service and capital subsidies under programs that have been in existence for decades. Except for a modest service connection fee, the actual capital costs of providing new electricity service are expected to be recovered through the price of electricity.

The costs of providing electricity to communities (extending power networks at medium and low voltages) can be shared by local, regional, and national governments. In Vietnam, an effective partnership between the national state utility (Electricity of Vietnam [EoV]) and local operators and communities, as well as multiple funding sources (customers' contributions; community funding; district, province, and central government budgets; international donors; and others) has helped increase rural households' access to electricity from around 60 percent in 1995 to 94.5 percent in 2008 (Hung 2009; World Bank 2011c). The cost-sharing arrangements among customers, local authorities, and EoV have varied over time and have been reflected in the electrification rate. Before 1995, all rural electrification costs were paid by customers and local authorities. Since 1999, by contrast, EoV has gradually taken over medium-voltage systems and some low-voltage systems. The EoV's share of capital costs rose accordingly from 40 percent during 1996–2000 to 70 percent over 2001–4. The average contribution paid by the local authorities over 1996–2004

was 32 percent, about 8 percent of which came from customers.[11] This is a quite different institutional arrangement than found in most Sub-Saharan African countries, where funding for electricity expansion is mainly provided through government-sponsored projects to national power companies.

Well-designed subsidies can sometimes create a critical mass of customers, with positive effects on the energy sector in general. A socioeconomic survey conducted in 2004 in the Lao People's Democratic Republic showed that approximately 20–40 percent of households had not been able to afford the connection charge of $100 because of limited access to financing. In response, a financing scheme, Power to the Poor (P2P; box 4), was devised by the utility Electricité du Laos (EDL) to help the poorest households as well as female-headed households obtain connections (World Bank 2007, 2011a). The household connection rate under the pilot varied slightly across 20 villages, but even the lowest rate (84 percent) showed success. In 2009, EDL decided to extend the P2P program to all electrified villages in the country by establishing a revolving fund to provide financial support to targeted beneficiaries. The program was part of a comprehensive electrification strategy that included solid planning (including off-grid solutions when cost-effective), low-cost electrification technologies, improvements in operating efficiency, and actions to improve financial sustainability.

[11] These programs address system development costs as well as connection charges.

Box 4. Lao PDR Connection Charge Program: Power to the Poor

The Power to the Poor (P2P) program, implemented by Electricité du Laos (EDL) with the support of the Ministry of Energy and Mines, subsidizes connections and finances indoor wiring for poor rural households. The objective is to increase household connection rates to 85–90 percent in villages already connected to the grid. The program, which uses participatory methods, particularly targets poor female-headed households. Eligible households receive the same no-cost "basic" 3/9 amp meter (low voltage) provided by EDL to all households. This is sufficient for an average household to run two light bulbs and a small electrical appliance, such as a radio. Participating households make an average up-front payment of about $24 and can obtain an interest-free credit of up to $87 to cover the costs of installation and indoor wiring. The credit is paid back over three years in installments of about $2.50 as part of the household's monthly electricity bill. One of the key ideas behind P2P is to keep targeted households' monthly expenditures—for both the repayment of the interest-free credit and electricity consumption—at the same level as their expenditures for vastly inferior traditional energy (such as batteries, diesel lamps, and candles) before connecting to the grid. The monthly savings in household energy expenditure are projected to be enough to allow households to repay the connection cost in three years.

The case of Ms. Phanh, 57 years old and divorced, is an excellent example of how P2P has benefitted the poor. She has been living on her own for 20 years, as her adult children have moved away. Her home is made of wood and thatch and consists of one very small room, where she sleeps, and an equally small covered porch area. She works 6–7 hours a day finding fish, frogs, and bamboo shoots for her own subsistence and to sell; this is her only income-generating activity. She earns about $6.25 per month. Other than this work, she is unemployed, as local opportunities are limited to manual field labor, where men dominate. Her income is often not enough to meet her needs, and she depends on her son for additional food and money. Since her home was connected in April 2009, Ms. Phanh has been using electricity mostly for lighting and operating some small appliances. She consumes a very small amount of electricity per month, approximately 14 kWh (kilowatt hours), for which she pays approximately $0.35. In addition, she pays about $2.50 toward the P2P credit provided by EDL for the up-front connection costs. Now that Mrs. Phanh has electricity, she hopes to purchase an electric water pump to irrigate a small vegetable garden she would like to plant near her home to earn additional income.

Source: World Bank 2011a.

There are several reasons why many international programs focused on rural electrification favor capital subsidies over consumption subsidies. Consumption subsidies require a constant stream of revenue from national governments and distort energy markets by encouraging consumers to use more power than they would if the price were not subsidized. In countries where the price of electricity is subsidized, but access to the grid is low, rich households, which are more likely to be connected to the grid, are the main beneficiaries of the price subsidies. After the initial wave of rural electrification takes place in a given country, it is mainly the poorer households, those not able to afford the connection charge, that still lack electricity, so connection subsidies tend to be well targeted. Moreover, the social benefits of capital subsidies have been shown to be quite high—sometimes well over 50 percent of the cost of providing electricity service (IEG 2008; Meier et. al 2010; Khandker et. al. 2012a). The first use of electricity is generally for household lighting, which has a very high value for customers. As a consequence, encouraging the widespread adoption of electricity yields substantial benefits, both for households and for nations.

Strategies to Lower Connection Costs in Sub-Saharan Africa

Efforts to scale up access to electricity should be planned and implemented in the context of a broad strategy of system planning and prioritization (including off-grid solutions, when cost-effective) that enhances system development, ensures the financial sustainability of the operator, encourages technical innovations that lower investment costs and reduce losses (for example, through theft or poor billing practices), and makes access affordable to the poor (through well-targeted connection subsidies). A planning process based on detailed information about potential users and their consumption habits will make it possible to achieve economies of scale by giving priority to projects in more densely populated rural villages that show the greatest potential for productive use of energy (such as villages with small businesses, schools, clinics, and so on). Such planning will reduce the cost shared by individual households and minimize the capital subsidies required to make the project financially viable.

Many distribution companies are reluctant to change the way they operate, but sensible changes can reduce the costs of connecting new consumers to the electricity grid. In many countries, inadequate regulations (such as technical standards and codes) keep the cost of providing new connections high; such regulations can and should be modified. In addition, new customers should be able to spread their connection charge over a period of months or years under credit schemes to make it affordable. Connection charges can also be reduced through capital subsidies or through a policy of incorporating the charge into the electricity tariff. In most cases, the change would raise monthly payments for electricity, but slightly higher monthly charges are easier for most households to bear than a high initial payment for obtaining electricity service. The following sections suggest ways for power providers to lower the costs of adding new customers to their system, as well as schemes for financing connection charges.

Technical Solutions for Electricity Companies

The service standards of many electricity distribution companies in Sub-Saharan Africa do not address the low consumption of households in poor urban and rural areas. The cost of providing service to households that require only 25–50 kWh of electricity per month can be significantly reduced in a variety of ways, generating savings both at the level of the medium-voltage grid and at the drop line to the households.

High standards and expensive materials often are not necessary for safe, effective service to low-income customers and rural communities, as amply demonstrated in many countries over recent decades (Karhammar et al. 2006; NRECA 2000, 2012a, 2012b). Some of the technologies and practices that utilities have used to reduce the cost of distribution networks include:

- adopting single-phase medium-voltage and minimal low-voltage network systems, as

in North America;
- using smaller transformers and smaller-gauge lines to handle small loads;
- minimizing the number of poles[12] needed to carry long medium-voltage lines by using appropriate spans;
- employing single-wire earth-return systems; and
- installing so-called shield wire systems on existing transmission lines.

Embracing new standards sometimes requires a change in the corporate culture of power providers[13] (these issues are discussed in appendix 3).

The costs of service connection cables are often passed on to customers through connection charges. Using lower-gauge cable, therefore, could allow the utility to cut the connection charge by a considerable amount. In most of Sub-Saharan Africa, the minimum size of service cable used for a new connection is 16 mm^2 or 25 mm^2. Cables of this size can carry a current in excess of 50 amps, whereas the maximum demand from most rural and urban poor consumers is 1 or 2 amps (with average monthly consumptions of around 25 kWh). In other words, the service connections are heavily overrated, raising the utility's costs and the charges faced by consumers. The use of service cables of 6 or 10 mm^2 could greatly reduce connection charges for the vast majority of low-consumption customers.

At the household level, ready boards have been used to lower costs for more than 50 years. Ready boards are preconfigured electrical connection points that include all the equipment needed to provide household electricity connections. In addition, on the board there are a small number of plugs ready for household use and, in many cases, a fixture for screwing in a light bulb, obviating the need for household wiring. It is also important to ensure that the cost of the ready boards is kept to the minimum by careful choice of materials. As the household's demand for electricity grows, the ready board can be replaced by a more conventional distribution board and the required internal wiring.

Many Sub-Saharan African utilities are expanding their use of prepaid meters. Newer versions of these meters and their corresponding vending systems have sophisticated features. For example, the utility can include partial connection charge payments when customers make their periodic purchase of electricity units using prepayment cards. This pay-as-you-go option has been used by some utilities to allow low-income customers to pay the connection charge over time. But prepaid meters are not the only way of recovering the connection charge over time—indeed, any system of billing can accommodate such installment charges. Prepayment meters cost about 10 times as much as conventional meters and thus increase the connection charge. Because of this, the use of prepayment meters should be considered on a case-by-case basis.

Load limiters, which allow only a small amount of power to be used at a given time, often have been used in place of more expensive meters to lower connection charges. They are suited to households that intend to use electricity only for lighting and other basic services,

[12] Using wood poles instead of cement poles can significantly reduce the cost.

[13] Africa Electrification Initiative meetings in Mozambique (2011) and Senegal (2011).

such as charging a cell phone or powering a radio. The drawback of load limiters is that once a household uses more than a basic amount of electricity, the load limiter cuts off all electricity to the household, requiring a visit by the supply authority to reset the load limiter (depending on the practice adopted by the utility). Because of this limitation, load limiters would not be appropriate for customers who use more than a minimum amount of electricity.

Internal wiring costs for households can be lowered by adopting standards that reflect the consumption habits of low-income customers, through bulk procurement of materials, either by the utility or by other interested organizations, and through group connection programs. The higher-cost materials required by regulations in some countries are not necessary for the small loads of poor households. Bulk purchases of materials can drastically lower costs. Often, trained wiremen are not readily available in remote areas, and consumers have great difficulty in getting the homes wired to the unnecessarily high standards required by the utility. Repeated testing of the home wiring, which often occurs in many countries, also leads to additional charges and delays in securing a connection. These challenges can be mitigated by ensuring qualified wiremen are available and organizing programs for service connections on a group basis prior to electrification. Such group mobilization programs, as practiced by some utilities, have made it possible to achieve a high connection rate immediately after extending the grid to villages. Finally, standardized home wiring kits that conform to regulations can reduce costs for households obtaining new electricity service.

Many electricity distribution companies in Sub-Saharan Africa will provide connections only to dwellings constructed with permanent materials, such as brick or mortar, and often only to those with permanent roofs. Many poor families use less stable materials, such as mud walls and thatched roofs, to build their homes, and thus may not be eligible to obtain electricity. The reasoning behind the restriction is that providing electricity to substandard households may be dangerous, but that rationale ignores the larger risks of the alternatives—such as the fire hazards of using kerosene or candles. Also, as mentioned earlier, ready boards offer a solution to this problem, because the electricity connection is mounted on a safe board that can be affixed to inferior building materials without incurring undue risks. If needed, insulated conduits can also be used on the service wire entering the dwelling. There are several ways to provide safe, lower-cost electricity connections to both poor urban and rural households.

Spreading Service Costs over Time

Even after a utility has done its best to reduce the cost of providing a new electrical connection, many customers still may not be able to afford a lump-sum connection charge. Spreading that charge over time to make it affordable is a common practice among distribution companies in many parts of the world—it could be practiced more extensively in Sub-Saharan Africa as well.

The simplest and most common ways of lowering the connection charge for new customers are to incorporate most of the connection cost in the electricity tariff or to allow the customer to pay the charge over a period of years through credit schemes. In the first case, in particular, instead of passing on to the new customer the full cost of the materials and

labor necessary to connect to the grid, the customer is required to pay only a low processing fee, which is collected with the application for new service. The electricity tariff is high enough to reimburse the utility for the bulk of the cost of establishing the service connection. In many developing countries, however, political pressures often prevent electricity companies from raising their tariffs, so distributors are averse to any strategy that depends on doing so. In countries where companies are unable to raise tariffs, consumers may be given the opportunity to pay their connection charge over a period of time (say, three to five years) through credit schemes provided by the distribution company or an agent or partner, such as a finance company, commercial bank, or externally funded nongovernmental organization (NGO).

One promising way of inducing companies to extend service is to partially reimburse them for the costs of connection based on demonstrated outputs (functional connections, billing cycles, and so forth). Under such a "results-based" system, connection charges to new residential customers are steeply discounted, for example, 20–30 percent. Once the household has been connected, the electricity company receives a subsidy per connection from a capital fund established by the government or by a donor. A variation of this theme is for the electricity company to apply for grant funds from a government program that covers the cost of providing new electricity service to communities that promise to yield a positive financial and economic rate of return. This type of program was very successful in increasing the rate of rural electrification in Bolivia by combining financing of connection charges and low-cost technologies for grid extension and densification (single phase feeders, small single phase transformers, small conductor LT, service to low density consumers with no limitations on building construction type) to promote access scale up (NRECA 2011).

A straightforward way of lowering the initial cost of electricity service is for an NGO or bank to finance the connection charge over a period of years. The loan, which may be at commercial banking rates or at subsidized interest rates, would typically be for three to five years, if not longer. Paying connection charges over time is a fairer system for customers since the equipment required for new electricity connections generally lasts for 20 or more years. A similar financing approach can also be applied to internal home wiring.

A final method for obtaining electricity service and simultaneously minimizing connection charges is for a community or other group to agree to meet all or part of the costs of obtaining the service. Under this method, which has been used in Thailand and Latin America, the distribution company estimates the cost of extending electricity to the community, after which the community raises funds to pay a proportion or all of the costs. One advantage of this method is that it engages the richer households in the community, who generally have political connections, in raising grants and community development funds to pay for the new service. Although this arrangement has worked well in many countries, its success depends on the ability of the electricity company to provide reliable service. No one will agree to pay for unreliable service. Community payment schemes involve system development costs, which are broader than connection charges. But they are relevant to this discussion because their purpose is to enable a small group of consumers located fairly close to an existing network to obtain electricity service.

Conclusion

High charges for household electrical connections are a serious impediment to universal electricity access in Sub-Saharan Africa. Connection charges in Sub-Saharan Africa are among the highest in the world, depressing access to electricity in many urban and rural areas. High connection charges mean that the social and economic benefits of electricity are available only to wealthier households, leaving poor households dependent on traditional means of lighting, such as kerosene lamps, which are inferior lighting sources and more dangerous than electricity and, in many cases, more expensive. Deprived of electricity, poor people lack access to high-value appliances such as fans, radios, and telephone chargers. Making connection charges affordable is a necessary and important first step in addressing the electricity access gap between rich and poor households.

Concerted efforts are underway to alleviate the problem of high connection charges and thus increase electrification rates. Innovative programs in Sub-Saharan Africa and elsewhere in the world have demonstrated ways to attract new customers without aggravating the financial burdens of hard-pressed utilities or compromising consumer safety. The array of potential solutions includes low-cost technical designs, innovative procurement practices, and credit schemes or capital subsidies. However, political commitment is essential to the success of such efforts; low-cost electrification approaches must be carefully assessed and chosen based on country context.

This paper confirms that the connection charge for electricity is a major factor for either encouraging or discouraging the take up of electricity in developing countries, and more specifically in Sub-Saharan Africa. Although strategies to lower or make the payment of connection charges affordable appear to be one of the key factors in encouraging higher rates or electricity access in developing countries, it must be kept in mind that they are only part of a larger package of interventions necessary for increasing the spread of electricity connections. Other important factors to promote electricity use include a reliable power supply; a financially healthy electric company; good methods for collecting electricity revenues; involvement of local people in the expansion program; monitoring of electrification progress and customer satisfaction; and overall government support of a healthy electricity program. Connection charges are an important factor among many other complimentary activities necessary for the continued increase in electricity adoption in Sub-Saharan Africa.

Appendix 1. Minimum Connection Charge in Selected Countries

Country	Minimum reported connection charge ($)	Specifications
Bangladesh	23	Sylhet PBS-1 scheme covers the preliminary survey fee (if not listed in master plan), home-wiring charges, member fees, and the guarantee deposit (assuming 0.5 kW demand)
Benin	150	Single-phase, 5–30 amp consumption
Burkina Faso	264	Single-phase, no-pole, 1–3 kW demand; includes the cost of dropping a wire and panel; $214 is the minimum connection charge for a 1 kW demand
Cape Verde	2	Single-phase, tax included
Central African Republic	283	Single-phase, 15 m, 3 kW; security deposit included
Côte d'Ívoire	127	Single-phase, no pole, wood panel, 10 m, 5/15 amp
Ethiopia	75	Average charge for less than 50 m connection; $50 minimum connection charge
Ghana	32	Single-phase, no-pole connection charge includes meter and application fee; Nordic Electricity Distribution Company supplies materials
India	27	Connection charge for lowest consumption (0.5 kW) includes cost of meter with box and installation testing
Kenya	400	Connection charge for single-phase, domestic customers within 600 m of an existing transformer
Mauritania	106	Minimum connection charge for overhead single-phase lines
Philippines	7	Amount paid by customers under the ANECO scheme; the cooperative covers the highest share of the cost, including for the service drop wire, duplex # 6, kWHR meter, GE i210 Cl 100 with socket base, insulink connector, and other miscellaneous expenses
Sri Lanka	34	Charge for single-phase, overhead, 30 amp connection
Sudan	37.5	Smaller user, 240 V single-phase 50 amp (including the meter, service cable, plus other materials for a complete service)
Tanzania	297	Charge for overhead service lines—single-phase (30 m), conventional meter, including VAT
Thailand	18	Provincial Electricity Authority (PEA) scheme; does not include house-wiring charges
Tunisia	67	2 kVA subscription charge
Uganda	125	*Umeme*, single-phase, no-pole service, tax included
Zambia	200	Drop wire, 30 m of duplex, single-phase prepayment meter, circuit breaker, three CFLs, and lightening arrester

Appendix 2. Connection Charge as Percentage of Family Income

Country	National electrification rates (2009;%)	Connection charge (US$)	GDP per person (US$ 2011)	GDP per family (US$ 2011)	Connection charge as % of monthly income
Bangladesh	41	23	743	3,715	7.5
Burkina Faso	15	264	600	3,000	100.0
Benin	23	150	802	4,010	44.9
Cape Verde	96	2	3,798	18,990	1.3
Central African Republic	5	283	489	2,445	138.9
Côte d'Ívoire	47	127	1,195	5,975	25.5
Ethiopia	17	75	357	1,785	50.4
Ghana	49	32	1,570	7,850	4.9
India	75	27	1,489	7,445	4.4
Kenya	16	400	808	4,040	118.8
Mauritania	23	106	1,151	5,755	22.1
Madagascar	19	81	465	2,325	41.8
Philippines	90	7	2,370	11,850	0.7
Sri Lanka	77	34	2,835	14,175	2.9
Tanzania	16	297	532	2,660	134.0
Thailand	99	18	4,972	24,860	0.9
Tunisia	100	67	4,297	21,485	3.7
Uganda	12	125	487	2,435	61.6
Zambia	19	200	1,425	7,125	33.7
Rwanda	10	350	583	2,915	144.1
Sudan	36	38	1,435	7,175	6.3
Lao PDR	55	100	1,320	6,600	18.2
Vietnam	98	20	1,407	7,035	3.4

Source: GDP per capita data are from the World Bank Data Resources 2013; connection charge data have been collected from utilities and regulatory agencies, World Bank reports, and from regional World Bank staff (see appendix 1); national electrification rates are mainly from IEA (2011).

Appendix 3. Reducing Distribution System–Related Costs

Costs related to the distribution system are another major reason for the low rates of electricity access found in Sub-Saharan Africa, particularly in rural areas. Electricity companies are well aware that providing service in rural areas has a higher unit cost and lower profitability than service in urban areas. That reality offers little incentive to expand rural electrification. The problem is further aggravated by the use of inappropriate design standards, which drive costs even higher. It is common among African electricity companies to design rural networks using the same standards as those used in urban areas—inherited standards generally devised for high-density, high-demand centers in Europe (World Bank 2006). The result is oversized networks with high capital costs for connecting rural loads (NRECA 2000), a higher cost per consumer served, and a smaller number of households that receive access from available funds. Given lower population densities and lower consumption rates in rural areas, lower standards of design and construction are appropriate. Appropriate system planning and the use of low-cost technologies tested in many developed and developing countries can pay very important dividends in reducing the costs of providing electricity.

Some countries in Africa, notably Tunisia and South Africa, already have adopted low-cost standards that do not compromise system integrity. The Tunisian Electricity and Gas Company (STEG) has implemented innovative, low-cost technical options over three decades (Cecelski et al. 2005; Karhammar et al. 2006). The MALT (Mise à la Terre) system developed by STEG, which has reduced costs 20–30 percent, is based on North American and Irish technical design models. It combines a three-phase electricity backbone system and single-phase distribution lines to feed rural consumers (box A3.1). A related system was devised for areas of even lower consumer density, leading to additional cost reductions.

Poor procurement practices are another factor driving up network construction costs. Diversifying the number of suppliers of equipment and materials intensifies competition and reduces procurement delays. Innovative methods to monitor prices of goods and services at national, regional, and international levels—as well as centralized procurement and bulk purchasing—can also be useful in reducing costs. In general, good business practices such as inventory and quality control can yield substantial reductions in network costs; these savings can free additional funds for further rural electrification.

Box A3.1 Overcoming Resistance to Low-Cost Designs in Tunisia

Early on, the officials responsible for promoting rural electrification within the Tunisian Electricity and Gas Company (STEG) decided that expensive three-phase distribution systems were too costly in rural areas. After extensive technical analysis, STEG took the courageous step of adopting the MALT (Mise à la Terre) design—a blend of a three-phase backbone and single-phase network distribution system. The MALT distribution system reduced financing costs by 20–30 percent.

The MALT distribution system consists of major arteries of three-phase, 30 kilovolt (kV), and line-to-line overhead voltage lines, with four conductors (three phases and one neutral wire) and secondary, single-phase, 17.32 kV, and line-to-neutral rural voltage lines (one phase and one neutral). When Tunisia adopted this system, it made a second key technical decision: opting for a relatively high, single-phase 17.32 kV voltage,

rather than the weak 3–5 kV of the North American model. The higher voltage was selected for the single-phase rural electrification overhead lines to compensate for the long distances between villages and the nearest three-phase artery and to provide for future demand growth over the 30-year lifetime of the lines.

Making this technical design decision was not easy for STEG, which faced opposition from many of its own engineers accustomed to serving high-demand urban areas. This case demonstrates how careful and critical analysis of design assumptions and implementation practices can reveal the potential for significant cost savings, more attractive financing, and also accommodate for the future.

Source: Cecelski et al. 2005; http://www.steg.com.tn

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