

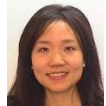


THE BOTTOM LINE

The aggregate price per kilowatt-hour charged to commercial and industrial customers varies by a factor of more than 20 across 38 Sub-Saharan African countries studied. Tariff schedules also show large differences: Nearly half the countries do not use time-of-use pricing, about a fifth have no demand charges, and three have neither demand nor fixed charges for any customer category. As Africa's power sector develops, there is considerable scope to tailor tariff schedules to meet the needs of different customers, reduce the costs of supply, and ensure minimum revenues from medium-size and large customers. Doing so would strengthen utilities' financial health and increase the quantity and quality of electricity delivered.



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Electricity Tariffs for Nonresidential Customers in Sub-Saharan Africa

What do Africa's electricity bills tell us?

Prices for nonresidential power customers vary widely across the subcontinent, as do patterns in tariff structure

Tariff schedules reflect the level of power sector development, the costs of service delivery, and government subsidy policy. Together with service quality, they shape the decisions of local businesses and investors.

Tariffs in most countries in Sub-Saharan Africa are below cost-recovery levels, and power shortages are widespread. Tariffs are exceptionally low in a handful of countries, exacerbating the cost-recovery problem, and high in many others, hobbling competitiveness, while still not covering costs.¹

This note reviews regulated grid electricity tariffs and monthly electricity bills for nonresidential customers in 38 countries in Sub-Saharan Africa.² It is based on information collected from power utilities and regulators on tariffs, taxes, and other charges in effect in July 2014.³

¹ Kojima and others (2016) and Kojima and Trimble (2016) analyze tariff schedules and connection charges for residential customers in the same countries covered here. Trimble and others (2016) compare tariff levels with levels of cost recovery, decomposing shortfalls in cost recovery into underpricing, system losses, collection losses, and overstaffing.

² The countries are Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Chad, Comoros, Côte d'Ivoire, Ethiopia, The Gambia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé and Príncipe, Senegal, the Seychelles, Sierra Leone, South Africa, Swaziland, Tanzania, Togo, Uganda, Zambia, and Zimbabwe.

³ Tariffs are confined to published schedules. Because they exclude bilaterally negotiated power purchase agreements and other tariffs not disclosed to the public by the utilities and regulatory agencies, they may not capture payments made by very large consumers, who tend to negotiate tariffs bilaterally. Mining companies in Zambia, for example, have individual power purchase contracts, the details of which are not available by company; only overall average tariff increases and prices may be announced (Bloomberg News 2017).

Tariff design for nonresidential customers can differ markedly from that for households. Because of equity considerations, cross-subsidization of low-consumption households by higher-consumption households is common. In contrast, tariffs for medium- and high-voltage customers are often designed to capture economies of scale (arising in part from significant fixed supply costs), with unit charges typically *declining* with consumption. While residential customers may face fixed charges to cover the cost of meter reading, maintenance, and billing, medium- and large-consumption customers are more likely to face "demand charges," which require them to pay the utility to supply electricity up to the contracted demand even if they do not always use all of their contracted power capacity. In a variation of this pricing mechanism, the charge may depend on the highest actual demand recorded over a given period. Demand charges are intended to help utilities recover the fixed costs of service delivery.

The regulated tariff schedules in the countries covered range widely, both in their structure and in unit prices. In Liberia all customers pay the same price per kilowatt-hour (kWh), regardless of level of consumption or other attributes. In South Africa tariffs are differentiated by voltage levels, time of day, season, and customer category, and customers may pay fixed and demand charges as well as levies for cross-subsidization. Country-to-country variations in unit prices are considerable among the sample, far more so than in the countries of the Organisation for Economic Co-operation and Development (OECD).

Tariffs in most countries in Sub-Saharan Africa are below cost-recovery levels, and power shortages are widespread. Tariffs are exceptionally low in a handful of countries, exacerbating the cost-recovery problem, and high in many others, hobbling competitiveness, while still not covering costs.

What features are most prevalent in African tariff structures?

Separate treatment for large customers can be strengthened; time-of-use pricing is underused

The countries of the sample differ in how they incorporate the following features in their tariffs:

- Schedules for high-voltage customers
- Time-of-use pricing
- Demand charges
- Sector-specific tariffs
- Block tariffs

These features are detailed by country in table 1 and described below.

Separate tariffs for high-voltage customers. Supplying electricity at high voltage is efficient for large volumes of consumption; it is also the lowest-cost option for the provider. The presence of high-voltage customers signals the size and maturity of the power sector (a small system is likely to have only low- and medium-voltage supplies).

About 60 percent of the countries studied publish tariff schedules for high-voltage customers. However, these are not necessarily distinct from medium-voltage tariffs, and high voltage in some countries may be considered medium voltage in others.

International standard 60038 of the International Electrotechnical Commission classifies voltages into four categories. Low voltage is defined as less than 1 kilovolt (kV); medium voltage is 1–35 kV; high voltage is 35–230 kV; and extra-high voltage is above 230 kV. Virtually all countries in Sub-Saharan Africa have medium-voltage customers, but not all have customers who are supplied at high voltage according to the 60038 classification. As a result, several countries classify some medium-voltage customers as high-voltage customers. All but one of the countries studied classify 33 kV as high voltage, and Lesotho and Nigeria classify 11 kV as high voltage. Lesotho and Mauritius include only low voltage and high voltage in their tariff schedules. The highest voltage cited in any of the tariff schedules is 132 kV (in Ethiopia, Kenya, and South Africa). At the opposite end of the spectrum is Liberia, which has only low-voltage customers.

Time-of-use pricing is surprisingly uncommon. One way to smooth consumption across time is to provide customers, particularly large ones, with financial incentives to use electricity during off-peak hours. Time-of-use pricing reflects variation in service delivery costs, which are high during peak periods and low during off-peak periods.

Electricity delivered during peak hours is the most expensive to supply, because it depends on the presence of capital-intensive spare capacity (for generation, transmission, and distribution). The flatter the aggregate consumption pattern across time of day and day of week, the less expensive are supply costs. Electricity supplied during peak hours can also be more polluting, because peak electricity tends to be generated from diesel or fuel oil. Despite these higher costs, almost half of the sample countries do not use time-of-use pricing.

Time-variant pricing provides incentives to avoid electricity consumption during peak hours by charging more during periods of high demand than during standard and off-peak hours. Options include real-time pricing, time-of-use pricing, and critical peak pricing (in which customers are informed a day or even just a few hours before electricity prices go up).

In the sample countries, time-variant pricing consists of either different prices at different times of day (dividing a day into two or three blocks, labeled as peak, off-peak, and normal, sometimes further differentiated by the day of the week) or in different seasons. Namibia, South Africa, and Swaziland have seasonally differentiated tariffs (winter is the peak season, because of heating demand). South Africa and Swaziland also use time-of-use pricing that depends on the time of day and day of the week.

Eighteen countries in the sample have no time-of-use pricing for any customer category. Yet half of them have high-voltage customers. Comoros distinguishes between day and night pricing for medium-voltage customers, but unusually charges more for electricity used at night.

Demand charges are nearly universal in countries with customers using higher voltages. To ensure cost recovery, utilities often charge two-part tariffs, in which a price less than the average cost is charged per kWh (referred to as the energy charge),

One way to smooth consumption across time is to provide customers, particularly large ones, with financial incentives to use electricity during off-peak hours. Yet 18 countries in the sample do not practice time-of-use pricing, even though half of them have high-voltage customers. If some of those customers could be induced to shift consumption to off-peak hours, utilities could cut their supply costs.

Table 1. Features of nonresidential tariff schedules in selected countries in Sub-Saharan Africa, 2014

Country	High voltage in tariff schedule	Tariff cites voltage of at least 33 kV	Time-of-use pricing	Demand charge	Stand-alone categories		
					Public lighting	Government	Agriculture
Angola	✓			✓	✓		
Benin				✓	✓		
Botswana				✓			
Burkina Faso			✓	✓	✓		
Burundi				✓	✓	✓	
Cabo Verde				✓	✓		
Cameroon	✓		✓	✓	✓		
Chad			✓	✓	✓		
Comoros			✓				
Côte d'Ivoire	✓		✓	✓	✓		
Ethiopia	✓	✓			✓		
Gambia, The						✓	✓
Ghana	✓			✓			
Guinea	✓			✓		✓	
Kenya	✓	✓		✓	✓		
Lesotho	✓			✓	✓		
Liberia							
Madagascar	✓		✓	✓			
Malawi		✓	✓	✓			
Mali			✓	✓	✓		
Mauritania	✓		✓	✓	✓		
Mauritius	✓		✓	✓	✓		✓
Mozambique	✓			✓			✓
Namibia	✓	✓	✓	✓			✓
Niger	✓		✓	✓	✓		
Abuja, Nigeria	✓	✓			✓		
Rwanda			✓				
São Tomé and Príncipe						✓	
Senegal	✓		✓	✓	✓		
Seychelles				✓	✓	✓	
Sierra Leone				✓	✓		
South Africa	✓	✓	✓	✓	✓		✓
Swaziland	✓		✓	✓			✓
Tanzania	✓			✓			
Togo			✓	✓	✓		
Uganda	✓	✓	✓	✓	✓		
Zambia	✓		✓	✓			
Zimbabwe	✓	✓	✓	✓	✓		✓
Number of countries	22	8	20	31	23	5	7
Percentage of sample	58	21	53	82	61	13	18

Note: Data are as of July 2014. Mining is not included as a separate category in the table. Only two countries (Ghana and Namibia) publish tariffs for mining as a stand-alone category. Tariffs in Comoros and Liberia depend only on consumption volume and supply characteristics and do not even distinguish between residential and nonresidential customers.

Some countries maintain stand-alone tariff categories for government, but government generally does not enjoy price discounts. Seven countries have separate schedules for agriculture. Only two publish separate tariffs for mining.

with the balance of the cost recovered through a fee or set of fees that does not depend on monthly consumption. Demand charges fall under the latter category.

Demand charges are found in 31 of the 38 countries of the sample. They are applied primarily for medium- and large-volume customers. They are usually not levied on residential customers or other small low-voltage customers. Madagascar and Niger have demand charges for every nonresidential customer category. In Niger small nonresidential customers are charged a monthly “fixed” charge that is exactly proportional to installed capacity down to 3 kilowatt (kW). (In this note, a charge that varies linearly with installed capacity is considered a demand charge.)

Of the seven countries that do not impose demand charges, two (Ethiopia and Nigeria) have high-voltage customers in the tariff schedule.

Three countries—Burundi, Mauritius, and Namibia—offer certain customers a choice between a schedule with and without a demand charge. The energy charge is higher for the schedule without a demand charge; above a certain consumption level, it is cheaper to select the schedule with a demand charge.

In some countries, public lighting, government, agriculture, and mining may be subject to distinct tariff schedules.

For equity and other reasons, some countries create different customer categories, which pay different tariffs for similar consumption volumes and patterns. Countries may decide to subsidize street lighting, for example, or agriculture, the largest source of employment and income-earning opportunities in Sub-Saharan Africa.

Public lighting is a separate category in 23 of the 38 countries of the sample. About half of these (12 countries) exempt public lighting from both fixed and demand charges. Of the remaining 11, 6 have fixed charges, 3 have demand charges, and 2 have both. Five countries (Cabo Verde, Ghana, Mali, Mauritania, and Togo) collect a fee to fund public lighting.⁴

⁴ By contrast, 12 countries—Benin, Botswana, Burkina Faso, Côte d’Ivoire, Ghana, Kenya, Lesotho, Madagascar, Namibia, South Africa, Tanzania, and Zimbabwe—levy a fee to fund electrification. In addition to charging a fee for rural electrification, South Africa’s utility, Eskom, imposes a levy to cross-subsidize urban low-voltage customers.

Some countries in the sample maintain stand-alone tariff categories for government or “administration.”⁵ But government generally does not enjoy price discounts. One exception is Liberia, where the government is among the institutions exempt from the 7-percent tax on electricity. Burundi, The Gambia, and the Seychelles include government as a stand-alone tariff category with no special treatment (it is unclear whether government includes lighting in The Gambia). Guinea has a category called *administration*. It pays only the energy charge, but the charge was the highest assessed in Guinea in 2014 (it fell to second-highest in October 2016, when a higher charge was levied on foreign institutions, embassies, and nongovernmental organizations). São Tomé and Príncipe has a category called *public administration*. It has the highest energy charge of all customer categories and is not exempt from fixed charges.

Seven countries (The Gambia, Mauritius, Mozambique, Namibia, South Africa, Swaziland, and Zimbabwe) have separate tariff schedules for agriculture (Botswana has a category called water pumping, but it is unclear whether it is for irrigation or water utilities). In The Gambia, the lowest nonresidential tariff is for agriculture; it is identical to the lowest rate for residential consumers. Mozambique is the only country that uses increasing block tariffs for agriculture. NamPower in Namibia has several schedules for agriculture and farms, but the tariffs are the same as for commercial use, water pumping, and mining. Swaziland has separate categories for smallholder irrigation and large irrigation. The schedule for smallholder irrigation includes time-of-use pricing (both time-of-day and month-of-year variation). The charge for smallholder irrigation is the lowest of all categories; large-scale irrigation has the second-lowest energy charge, although three additional charges (fixed, demand, and access) make these tariffs more costly than residential tariffs. Zimbabwe uses time-of-use pricing for agriculture, as does Mauritius.

Only two countries (Ghana and Namibia) publish tariffs for mining as a stand-alone category. The fact that other countries do not may in part reflect widespread bilateral negotiations with mining companies. Mining companies may also generate their own electricity if they are operating in remote areas far from the grid or if grid electricity is unreliable. Ghana charges mining companies more

⁵ We do not consider government a stand-alone category here if street lighting is explicitly included, as it is in Botswana, which has a category that covers all government, municipal, and street lighting installations.

Because the unit costs of supply drop with increasing consumption, cost-reflective tariffs would suggest, especially in commercial and industrial settings, decreasing rather than increasing block tariffs. Yet just five countries in the sample have decreasing block tariffs.

than other customers for high-voltage electricity. Namibia applies the same tariffs to mining companies as it does to commercial and agricultural customers and water utilities. Zimbabwe lists mining in the same category as industrial and commercial customers.

Increasing block tariffs are much more common than decreasing ones. So-called increasing block tariffs are common for residential customers. They are intended to cross-subsidize low-consumption households, which may lack the ability to pay, and to discourage high consumption. Because the unit costs of supply drop with increasing consumption, cost-reflective tariffs would suggest, especially in commercial and industrial settings, *decreasing* rather than increasing block tariffs.

Just five countries have decreasing block tariffs, including Burundi, Cameroon, and Mali, which have both. Multiple blocks are far less common than for residential customers: Of the 38 countries studied, 29 have multiple blocks for residential customers, but only 17 have them for nonresidential customers. In 16 countries with multiple blocks, there is no change in tariff as a result of increasing consumption above 1,000 kWh. The only exception is South Africa, which has five blocks, the fifth of which starts at 3,000 kWh.

What patterns emerged from our survey?

A tendency toward cost-sensitive and sustainable tariff structures can be detected—but it is not universal

Of the 38 countries studied, 33 impose either time-of-use or demand charges (see table 1). The tariff schedules of 20 of these countries include supply at high voltage (although not necessarily as defined by the industry); the remaining 13 have only low- and medium-voltage customers. Of the 22 countries that list high-voltage customer categories, only two (Ethiopia and Nigeria) impose neither time-of-use nor demand charges. Eighteen countries impose both time-of-use and demand charges, of which 13 also list high-voltage customers in the tariff schedules. Just three countries (The Gambia, Liberia, and São Tomé and Príncipe) have no high-voltage categories in the tariff schedule, no time-of-use tariffs, and no demand charges.

Table 2 shows the numbers of tariff schedules with various characteristics in each country. Where the tariff structure differs by location, tariffs in a large city, such as the capital, are examined. In some countries residential tariffs are not listed separately; this note excludes a category called *social tariffs*, which we consider residential even if it is not designated as such. If two or more categories are separately listed but have identical charges, they are counted as a single category.

Of the 38 countries studied, 5 have 11 or more categories, 18 have 6–10 categories, and 15 have 1–5 categories. Fixed charges are prevalent: 15 countries have such charges for every nonresidential customer category. Demand charges are also common: One-third of countries levy demand charges on at least two-thirds of tariff categories. Time-of-use pricing is the least common of the surveyed features: Three countries apply it (by time of day or season) to at least 80 percent of customer categories.

And what about unit prices?

Monthly bills for the same volume of consumption differ vastly across countries

The unit charges for monthly consumption of 5,000 kWh of electricity vary by a factor of 18 across the countries sampled. For monthly consumption of 20,000 and 200,000 kWh, the highest charge is 24 times the lowest charge.

Monthly bills capture all charges, including taxes and levies that are passed on to the government or other parties and not retained by the utilities. In most countries, more than one tariff class can be used to compute the bills. For simplicity, where there is a distinction in the tariff schedule, 5,000 kWh is confined to low-voltage nonresidential customers and to commercial rather than industrial customers (where the two classes can be distinguished). Calculation of monthly charges for consumption of 20,000 kWh is based on medium-voltage customers operating 12 hours a day, 6 days a week (where industrial and commercial categories exist, customers are assumed to be commercial). Calculation of monthly charges for consumption of 200,000 kWh is for industrial customers operating 16

Table 2. Number of nonresidential tariff schedules with various features in selected countries in Sub-Saharan Africa, July 2014

Country	Total number of schedules	Number of schedules specifying				Type(s) of block tariffs applied
		Demand charge ^a	Fixed charge	Time-of-use pricing	Multiple blocks	
Angola	5	3	0	0	0	n.a.
Benin	6	4	4	0	0	n.a.
Botswana	5	2	5	0	1	Increasing
Burkina Faso	8	6	8	4	2	Increasing
Burundi	7	2	1	0	2	Increasing and decreasing
Cabo Verde	3	2	3	0	0	n.a.
Cameroon	3	1	0	1	2	Increasing and decreasing
Chad	4	2	0	1	1	Increasing
Comoros	3	0	0	1	0	n.a.
Côte d'Ivoire	10	9	10	8	1	Decreasing
Ethiopia	5	0	5	0	1	Increasing
Gambia, The	3	0	0	0	0	n.a.
Ghana	5	4	5	0	1	Increasing
Guinea	6	2	2	0	1	Increasing
Kenya	8	5	8	0	0	n.a.
Lesotho	4	2	0	0	0	n.a.
Liberia	1	0	0	0	0	n.a.
Madagascar	9	9	9	3	0	n.a.
Malawi	6	2	4	2	0	n.a.
Mali	13	1	5	1	11	Increasing and decreasing
Mauritania	6	3	6	1	0	n.a.
Mauritius	19	12	19	5	2	Decreasing
Mozambique	8	4	6	0	2	Increasing
Namibia (Windhoek)	18	15	1	14	0	n.a.
Niger	10	10	7	3	0	n.a.
Nigeria (Abuja)	10	0	10	0	0	n.a.
Rwanda	2	0	1	1	0	n.a.
São Tomé and Príncipe	5	0	5	0	0	n.a.
Senegal	11	7	3	6	2	Increasing
Seychelles	6	5	0	0	2	Increasing
Sierra Leone	6	1	6	0	1	Increasing
South Africa (Johannesburg, City Power)	8	5	7	7	2	Increasing
Swaziland	8	6	8	4	0	n.a.
Tanzania	4	3	3	0	0	n.a.
Togo	12	11	11	4	1	Increasing
Uganda	5	3	4	4	0	n.a.
Zambia	6	4	6	4	0	n.a.
Zimbabwe	7	3	0	3	0	n.a.

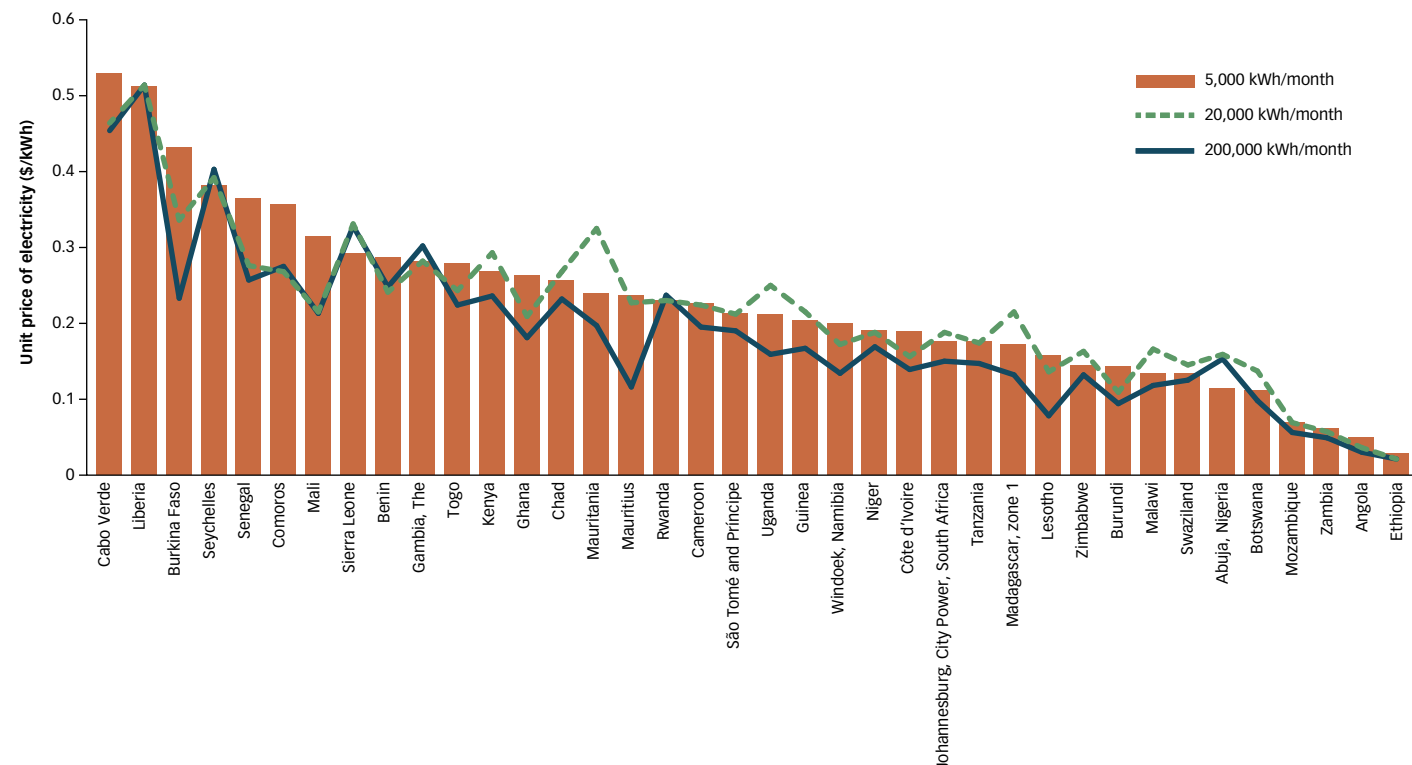
n.a. = not applicable.

a. Any charge that is proportional to kW, kilo-volt-amperes (kVA), or amperes, irrespective of what the charge is called.

Of the 38 countries studied, 5 have 11 or more tariff categories, 18 have 6–10 categories, and 15 have 1–5 categories. Fixed charges are prevalent: 15 countries have such charges for every nonresidential customer category. Demand charges are also common: One-third of countries levy demand charges on at least two-thirds of tariff categories. Time-of-use pricing is the least common of the surveyed features: Three countries apply it (by time of day or season) to at least 80 percent of customer categories.

Figure 1. Unit price of electricity paid by commercial and industrial customers in selected countries in Sub-Saharan African, 2014

As expected, in 29 countries the lowest unit charge is for monthly consumption of 200,000 kWh, reflecting economies of scale.



Note: Data are for July 2014.

hours a day, 6 days a week. Hours of operation of commercial and industrial customers differ, with industrial customers better able to take advantage of low off-peak prices. In cases where a customer may select from a menu of tariff options, the one with the lowest unit price is shown.

As expected, in 29 countries the lowest unit charge is for monthly consumption of 200,000 kWh, reflecting economies of scale (figure 1).⁶ In five countries the lowest per unit charge is for monthly consumption of 5,000 kWh, perhaps reflecting the desire to keep prices low for small businesses. The unit charge for monthly consumption of 200,000 kWh exceeds \$0.20/kWh in 14 countries.

⁶ Because tariff structures vary markedly across countries, it is not possible to ensure comparability. The results in figure 1 should therefore be treated with caution.

The wide variation in unit aggregate charges and the complexity of tariff schedules suggest high costs, large subsidies, or both, as well as significant scope for increasing efficiency of supply and consumption. The variation is much greater than in 27 OECD countries for which the International Energy Agency has data (IEA 2016). During the same time period, tax-inclusive prices in the surveyed OECD countries ranged from \$0.058/kWh in Norway to \$0.198/kWh in Japan—a factor of only 3.4. Twelve countries had prices within 10 percent of the median (\$0.12/kWh).

In stark contrast, unit aggregate prices in Sub-Saharan Africa range from \$0.021/kWh to \$0.51/kWh for industrial customers consuming 200,000 kWh a month, with a median of \$0.17/kWh. (The two sets of figures are not exactly comparable, because the

A well-designed power tariff system recovers fixed costs through fixed charges and variable costs through variable charges.

prices for Sub-Saharan Africa are not averaged over all industrial customers.) The lowest unit aggregate price (in Ethiopia) may signal a large price subsidy: The quasi-fiscal deficit in the power sector in Ethiopia is four times the cash collected by the national utility (Kojima and Trimble 2016; Trimble and others 2016). The highest unit aggregate price (in Liberia) reflects a very small grid system that relies entirely on diesel generation.

Next steps?

Cross-country comparisons suggest ways to improve nonresidential electricity tariffs in Sub-Saharan Africa

Almost half the countries in Sub-Saharan Africa impose no time-of-use pricing, about one-fifth of them have no demand charges, and three (Comoros, The Gambia, and Liberia) have neither demand nor fixed charges for any customer category. A well-designed power tariff system recovers fixed costs through fixed charges and variable costs through variable charges.

As the power sector develops in countries that do not yet make use of fixed charges, demand charges, or time-of-use charges, tariff schedules can be tailored to meet the needs of different customers, reduce costs of supply, and ensure minimum revenues from medium-size and large customers. Taking these steps would strengthen the financial health of the utilities and increase the quantity and quality of grid electricity delivered.

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