

SUMMARY OF BACKGROUND PAPER 6

# **AFRICA INFRASTRUCTURE COUNTRY DIAGNOSTIC**

## **Underpowered: The State of the Power Sector in Sub-Saharan Africa**

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## About AICD

This study is part of the Africa Infrastructure Country Diagnostic (AICD), a project designed to expand the world's knowledge of physical infrastructure in Africa. AICD will provide a baseline against which future improvements in infrastructure services can be measured, making it possible to monitor the results achieved from donor support. It should also provide a more solid empirical foundation for prioritizing investments and designing policy reforms in the infrastructure sectors in Africa.



AICD will produce a series of reports (such as this one) that provide an overview of the status of public expenditure, investment needs, and sector performance in each of the main infrastructure sectors, including energy, information and communication technologies, irrigation, transport, and water and sanitation. The World Bank will publish a summary of AICD's findings in spring 2008. The underlying data will be made available to the public through an interactive Web site allowing users to download customized data reports and perform simple simulation exercises.



The first phase of AICD focuses on 24 countries that together account for 85 percent of the gross domestic product, population, and infrastructure aid flows of Sub-Saharan Africa. The countries are: Benin, Burkina Faso, Cape Verde, Cameroon, Chad, Congo (Democratic Republic of Congo), Côte d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Uganda, and Zambia. Under a second phase of the project, coverage will be expanded to include additional countries.



AICD is being implemented by the World Bank on behalf of a steering committee that represents the African Union, the New Partnership for Africa's Development (NEPAD), Africa's regional economic communities, the African Development Bank, and major infrastructure donors. Financing for AICD is provided by a multi-donor trust fund to which the main contributors are the Department for International Development (United Kingdom), the Public Private Infrastructure Advisory Facility, Agence Française de Développement, and the European Commission. A group of distinguished peer reviewers from policy making and academic circles in Africa and beyond reviews all of the major outputs of the study, with a view to assuring the technical quality of the work.



This and other papers analyzing key infrastructure topics, as well as the underlying data sources described above, will be available for download from [www.infrastructureafrica.org](http://www.infrastructureafrica.org). Free-standing summaries are available in English and French.

Inquiries concerning the availability of datasets should be directed to [vfoster@worldbank.org](mailto:vfoster@worldbank.org).

Underpowered:

## The State of the Power Sector in Sub-Saharan Africa

**Anton Eberhard, Vivien Foster, Cecilia Briceño-Garmendia, Fatimata Ouedraogo, Daniel Camos, and Maria Shkaratan**

**S**ub-Saharan Africa is in the midst of a power crisis marked by insufficient generating capacity, unreliable supplies, high prices, and low rates of popular access to the electricity grid. The region's capacity for generating power is lower than that of any other world region, and growth in that capacity has stagnated. The average price of power in Sub-Saharan Africa is double that of other developing regions, but supply is unreliable. Because new household connections in many countries are not keeping up with population growth, the electrification rate, already low, is actually *declining*.

The manifestations of the current crisis are symptoms of deeper problems that are explored in this study of power sector institutions in 24 countries of Sub-Saharan Africa, which draws extensively on a new body of research undertaken as part of the multi-donor Africa Infrastructure Country Diagnostic (AICD).

### Africa unplugged

At 68 gigawatts (GW), the entire generation capacity of the 48 countries of Sub-Saharan Africa is no more than that of Spain. Without South Africa, the total falls to a mere 28 GW, equivalent to the installed capacity of Argentina. As much as 25 percent of these 28 GW of installed capacity are not currently available for generation owing to a variety of causes, including aging plants and lack of maintenance.

Normalized per million people, the installed capacity of Sub-Saharan Africa, excluding South Africa, is a little more than a third of South Asia's (the two regions were equal in 1980) and about a tenth of that of Latin America. Capacity has remained largely stagnant during the last three decades, registering growth rates of barely half those found in other developing regions. As a result, the gap between Sub-Saharan Africa and the rest of the developing world has widened over time. As a general rule, generation capacity should grow at about the same rate as the economy in order to keep pace with demand. However, this has not been the case. The region's GDP has grown at an annual rate of about 5 percent in recent years, whereas generation capacity has grown at an annual rate of less than 3 percent since 1980.

The low level of power generation is accompanied by correspondingly low rates of electrification. Less than a quarter of the population of Sub-Saharan Africa has access to electricity, versus about half in South Asia and more than 80 percent in Latin America. Once again, progress in Sub-Saharan Africa lags behind other regions, and the gap is widening. With current trends, fewer than 40 percent of African countries will reach universal access to electricity by 2050.

Given the region's low levels of generation and access, it is not surprising that per capita consumption of electricity averages just 457 KWh annually, with the average falling to 124 KWh if South Africa is

excluded. By contrast, the annual average per capita consumption in the developing world is 1,155 KWh and 10,198 kWh in high-income countries. If South Africa is excluded, Sub-Saharan Africa is the only world region in which per capita consumption of electricity is falling.

Sub-Saharan Africa's power supply is famously unreliable. Manufacturing enterprises experience power outages on an average of 56 days per year. By comparison, a typical power security standard in the United States is one day in ten years. As a result many firms are forced to maintain back-up generation capacity. Frequent power outages result in significant losses for enterprises in forgone sales and damaged equipment, equivalent to 6 percent of turnover on average for firms in the formal sector, and as much as 16 percent of turnover for informal sector enterprises that lack their own backup generation.

The deficiencies of the region's power sector are a serious drag on long-term growth and competitiveness. If all countries were to catch up with the regional leader, Mauritius, in terms of infrastructure stock and quality, their rate of economic growth per capita would be enhanced on average by 2.2 percent per year.

The extent of the power crisis is revealed in countries' growing recourse to so-called emergency power. To cope with power shortages, countries enter into short-term leases for generation capacity. These contracts are extremely expensive, with costs approaching 3–4 percent of gross domestic product (GDP) in some countries. Ultimately, the prevalence of emergency power represents a planning and procurement failure on a colossal scale.

The subcontinent's power problems are deeply rooted, and concerted effort will be required to resolve them. Resolving those problems—and powering up the region—will require vast sums of investment capital. The keys to attracting that capital are sounder power sector institutions (achievable through a smart new approach to reform) and greatly expanded cross-border trade in power. Development finance institutions and bilateral donors have key roles to play in both areas.

### Persistent dysfunction despite some reform

Sub-Saharan Africa has gradually conformed to the global trends in power sector reform that began in the 1980s. By 2006, all but a few of the 24 countries of Sub-Saharan Africa covered by the Africa Infrastructure Country Diagnostic (AICD) had enacted a power sector reform law; three-quarters had introduced some form of private participation in power; two-thirds had corporatized their state-owned power utilities; a similar number had established some kind of regulatory oversight body; and more than a third had independent power producers in operation.

But the extent and payoff of reform remain limited. Nowhere in Sub-Saharan Africa does one encounter the “standard” reform model, that is, unbundling, privatization, and wholesale and retail competition. Instead one finds what might be termed hybrid power markets. In most countries, the national state-owned utility retains its dominant market position, serving as the single buyer of electricity and maintaining its own generation plants. Private sector cooperation is either temporary—for example, a limited-term management contract—or marginal, in the form of independent power producers (IPPs) that contract with the state-owned national utility.

There are nearly 60 medium- to longer-term power sector projects involving the private sector in the region—excluding leases for emergency power generation. Almost half of these are IPPs. Involving more than \$2 billion of private sector investment, these IPPs have added early 3,000 MW of new capacity. A few IPP investments have been particularly well structured and contribute reliable power to the national grid. But these are the exceptions.

The other half of the PPI transactions in Sub-Saharan Africa have taken the form of concession, lease, or management contracts, typically for the operation of the national power system as a whole. These projects have been characterized by a relatively high rate of disappointment, with around a third of the contracts either currently in distress or already cancelled.

The emphasis on independent regulation has not delivered, either. Regulators are far from independent in many situations. Governments still pressure regulators to modify or overturn decisions. In some countries, turnover among commissioners has been high, with many resigning under pressure before completing their full term. The gap between law (or rule) and practice is often wide. Tariff-setting remains highly politicized, and governments are sensitive to popular resentment against price increases that are often necessary to cover costs.

The poor payback from reform has forced reconsideration of whether certain reform principles and programs—notably the unbundling of the incumbent power utility to foster competition—are appropriate for Sub-Saharan Africa. Restructuring the power sector for competition makes sense only in countries large enough to support multiple generators operating at an efficient scale. As noted above, the power systems in most of Sub-Saharan Africa are too small to meet that criterion.

### The region's unexploited energy resources

With 12 percent of the world's population and 18 percent of its land area, Sub-Saharan Africa has slightly less than its proportionate share of global energy reserves. But those reserves remain largely unexploited. In 2004, the power plants of Sub-Saharan Africa generated only 2 percent of the world's electricity, nearly three-fourths of which was generated in South Africa's coal-fired stations. When South Africa is excluded, hydropower accounts for close to 70 percent of electricity production (or about 50 percent of installed generation capacity), with the remainder split more or less evenly between oil and natural gas generators.

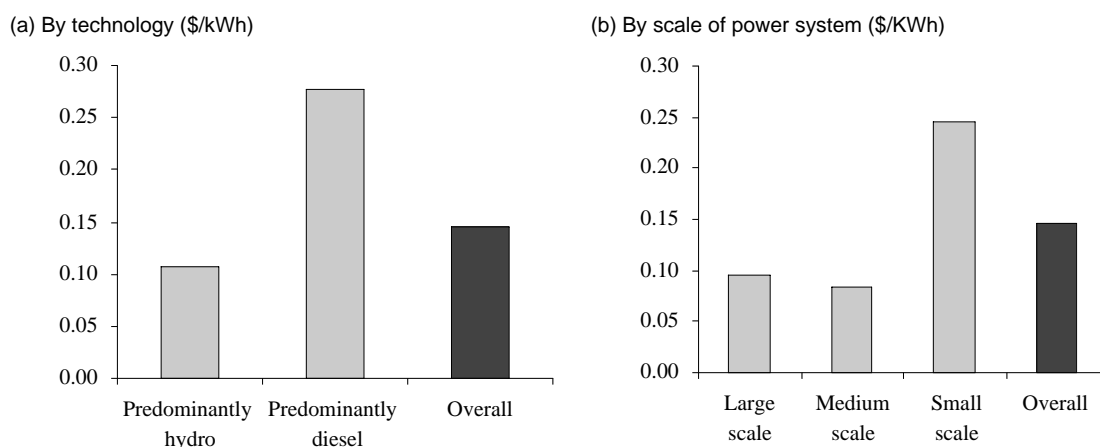
Africa's energy future lies in hydropower. At present, however, 93 percent of the continent's economically feasible hydropower potential (estimated at 937 TWh/year, about a tenth of the world's total) remains unexploited. Natural gas reserves are concentrated primarily in Nigeria (5.2 trillion cubic feet, Tcf). Significant discoveries have also been made in Southern Africa, Mozambique, Namibia, and Angola. Proven oil reserves are concentrated in Nigeria (36 billion barrels), Angola (9 billion barrels), and Sudan (6.4 billion barrels). There are a number of smaller deposits in other countries, but Sub-Saharan Africa accounts for less than 5 percent of global oil reserves.

The bottom line is that the unexploited energy resources of the region are concentrated in a handful of countries that are geographically removed from the centers of power demand. There are exceptions: South Africa relies on its own coal, Nigeria on its oil and gas. But most countries of Sub-Saharan Africa lack domestic resources. Much of the region's hydroelectric potential lies in the Democratic Republic of

Congo and Ethiopia, both of which are far from the main economic centers in southern, western, and northern Africa, and their economies are small relative to the multibillion dollar investments that would be needed to develop their hydropower potential.

Uneven distribution of resources and the distance separating hydropower points from economic centers have forced many countries in Sub-Saharan Africa to adopt technically inefficient forms of generation powered by expensive imported diesel or heavy fuel oil to serve small domestic power markets (figure A), even though, in many cases, the hydro and gas resources of neighboring countries could support much cheaper forms of generation.

**Figure A Operating cost drivers for power systems in Sub-Saharan Africa, 2005**



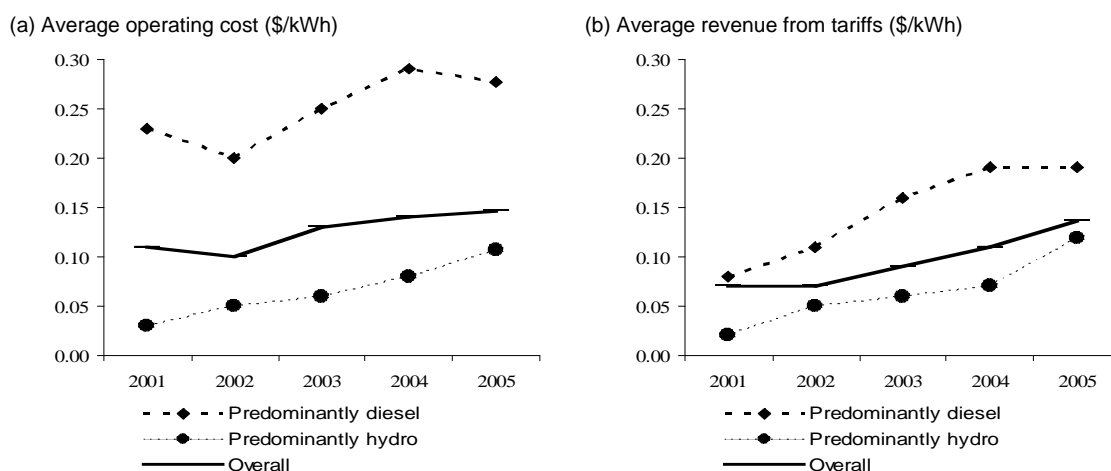
Source: Africa Infrastructure Country Diagnostic (AICD Power Sector Database), 2008.

### The high (and often hidden) costs of inefficient generation

The price of power in Sub-Saharan Africa is high by international standards. The average tariff in the region rose from \$0.07 per kWh in 2001 to \$0.13 per kWh in 2005, around twice that found in other parts of the developing world, and almost on par with the high-income countries. Tariff increases have been particularly large in countries reliant on diesel-based power-generation systems, where prices have risen from \$0.08 to \$0.17 per kWh on average in response to escalating oil prices. In spite of these increases, however, the average tariff in these countries, at \$0.17 per kWh, still falls significantly short of average operating costs, at \$0.27 per kWh (figure B).<sup>1</sup>

<sup>1</sup> Countries with small national power systems (of less than 200 MW installed capacity) face an operating cost penalty of as much as \$0.15 per kWh relative to countries with large national power systems (above 500 MW installed capacity). Landlocked countries and island states face a further cost penalty attributable to the high cost of transporting fossil fuels.

Figure B Trends in electricity costs and revenues by type of power system, 2001–05



Source: AICD Power Sector Database, 2008.

Nowhere in Sub-Saharan Africa do residential or commercial and industrial customers pay full cost-recovery prices, a mixed legacy of subsidies based on concern for the poor and outdated industrial policy. Some countries have historically priced power at highly discounted rates of just a few cents per kWh to large-scale industrial and mining customers. Salient examples include the aluminum smelting industry in Cameroon and Ghana and the mining industry in Zambia.

But the substantial power-consumption subsidies provided by the region’s utilities leave millions of African households in the dark. Across the bottom half of the income distribution, barely 10 percent of households have access to electricity, while three-quarters of households *with* electricity come from the top two quintiles of the income distribution. Further disparities are evident across geographic areas. Around 70 percent of households in urban areas have access to electricity, but barely 10 percent of rural households are connected to the grid (figure C).

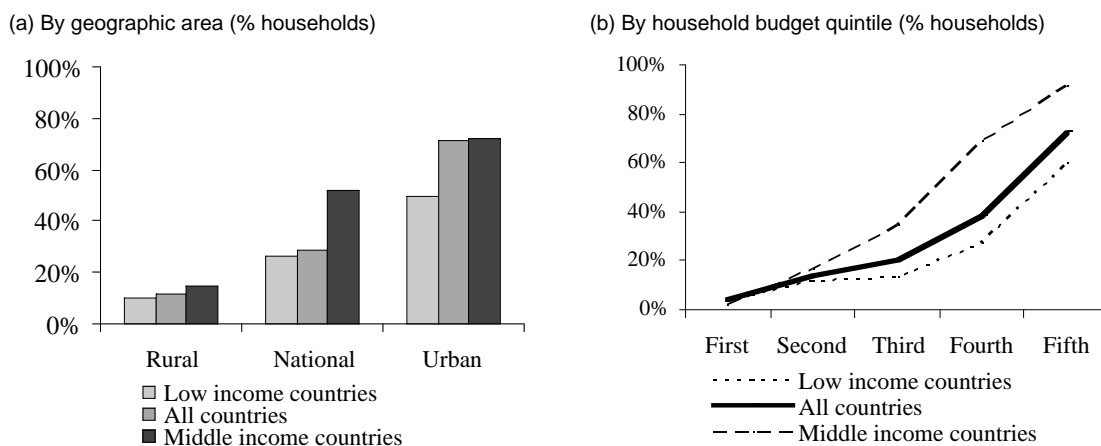
Subsidies have missed their mark because of widespread use of increasing block tariffs that provide relatively large blocks of highly subsidized power to all consumers, regardless of income, and because so few poor households are connected to the grid. To the unconnected, cheap power is as inaccessible as costly power.

The concentration of household connections to the power grid among upper-income customers might lead one to believe that full cost-recovery pricing would be the way forward. But the complex reality hinges on a critical distinction between countries where the cost of power is very high and those where it is substantially lower.

In the high-cost countries, where today’s full cost of power provision can easily amount to \$0.25 per kilowatt hour (kWh), moving to full cost-recovery tariffs would absorb more than 5 percent of household

budgets and would therefore present a major social and political problem.<sup>2</sup> It is clear that the first step is to bring costs down to provide the basis for ultimate cost recovery. This presents the challenge of finding the substantial bridge financing needed in the short run to bring down sector costs in the long run.

Figure C Patterns of electricity service coverage in Sub-Saharan Africa



Source: Banerjee and others, 2008; AICD Power Sector Database, 2008.

In the continent’s larger countries, and in those that rely on hydropower and coal-based generation, costs are already within the \$0.12 per kWh benchmark cited above. As a result, these countries—with the exception of a handful of the poorest cases—have the opportunity to move quickly toward cost recovery, without facing major affordability problems.

The quickest way to recover costs is to reduce inefficiency. The inefficiencies of Sub-Saharan Africa utilities, combined with the widespread practice of charging below-cost prices for power, generate substantial hidden (or “quasi-fiscal”) costs for the economy. These hidden costs, on average, amount to 1.8 percent of GDP in Sub-Saharan Africa and may be as large as 4 percent of GDP in some countries. Around half of these costs stem from the underpricing of services and nearly 30 percent from distribution losses, with the balance attributable to inefficiencies in billing and collection. These estimates suggest that the dividend from improving utility performance is in many cases very high.

Development finance institutions should consider how they can assist African regimes and utilities in reducing system losses and increasing collection rates—thus raising internal funds. That effort should be complemented by efforts to improve the supervisory and planning agencies responsible for the utility, as described in the next section. Combined, these measures would increase utilities’ ability to attract external funding, public and private, domestic and international.

<sup>2</sup> In the low-income countries of Sub-Saharan Africa, even households in the highest-income quintile have monthly budgets of only \$260 to support families typically comprising five people. Even a very modest consumption of 50 kWh per month<sup>2</sup> at a full cost-recovery price of \$0.25 per kWh (found in some countries of Sub-Saharan Africa) would mean an electricity bill of \$12 per month, representing close to 5 percent of the income of a relatively well-to-do family living on \$260 per month. (Five percent is often considered to be the affordability threshold for electricity services.) A very substantial share of the population in most countries would be unable to afford cost-recovery tariffs. If costs could be reduced to \$0.12/kwh—in line with the region’s average incremental cost of power—the resulting monthly bill of \$6 would be affordable for most of the population, except in the lowest-income countries.



Ending power subsidies for higher-income groups and for industries that do not need them to compete would free up additional fiscal resources. The new-found resources could be used to subsidize the expansion of power networks to serve lower-income rural and periurban communities, or for other poverty-alleviation programs.

### Major investments needed, but from where?

The countries of Sub-Saharan Africa, on average, spend 2.7 percent of their GDP on the power sector; with a number of countries spending in excess of 4 percent. But high levels of spending have not ensured adequate financing for the sector. With revenues barely covering operating costs, utilities contribute little or nothing to capital costs, which historically have been almost entirely subsidized by the state or by donors.

But the contribution of official development assistance (ODA) to public investment in the power sector has averaged only \$700 million per year in the last decade, far below the level needed to keep pace with economic growth, let alone to expand popular access to electricity. Nor has the private sector fulfilled the promise expected of it, perhaps naively, in the 1990s. The overall value of private investment in the sector has averaged just \$300 million per year during the last decade, and flows have been highly volatile. Taking aid and private investment together, external capital flows to the power sector in Sub-Saharan Africa, amount to no more than 0.1 percent of the region's GDP.

In recent years, the China Ex-Im Bank has emerged as a major new financier of power infrastructure in Sub-Saharan Africa. Over the period 2001–06, Chinese financing commitments to the Sub-Saharan African power sector averaged \$1.7 billion per year—equivalent to around 0.2 percent of the region's GDP and more than official aid and other private investment combined. The major focus of Chinese support has been the development of six large hydropower projects with a combined generating capacity of over 7,000 MWs of electricity. Once completed, these projects should increase the region's installed hydropower capacity by 40 percent. An additional 2,500 MWs of thermal power are being financed by China. The India Ex-Im Bank has also financed some significant thermal generation projects in Nigeria and Sudan. If sustained such investment could conceivably close the financing gap, but such an outcome is by no means assured.

### Trading up to larger markets

By creating large regional markets for electric power, greater cross-border trade could help stimulate needed investment in low-cost generation.

Four regional power pools already operate in Sub-Saharan Africa, but the quantities of electricity production traded between countries are still very small. Most of today's trade occurs within the Southern Africa Power Pool (SAPP). The main exporting countries generate electricity from hydropower (the Democratic Republic of Congo, Mozambique, Zambia), natural gas (Côte d'Ivoire and Nigeria), or coal (South Africa).

Despite limited progress, the potential benefits of increased trade are significant. For example, in the SAPP alone, the volume traded internationally could rise from the current 45 to 141 TWh per year with

additional investments in the regional transmission lines needed to bring cheaper power to consumption centers. Although the overall savings in the annualized cost of the power sector under trade are relatively small, at less than 10 percent, the gains from cheaper power may be substantial for individual countries. Under trade, most countries would see reductions in the average cost of power of a few cents per kWh, representing savings of 20–60 percent. For a handful of countries, the gains would be as much as \$0.10 per kWh, representing a saving of more than 60 percent.

The main effect of increased cross-border trade in power would be to support the development of large-scale hydropower schemes that would not be viable at the national level. The additional hydropower would displace natural gas generation in Eastern Africa and coal generation in Southern Africa. A related consequence would be to increase the share of power coming from key export countries such as Ethiopia in East Africa and the Democratic Republic of Congo in Southern Africa.

Development finance institutions should consider accelerating investments in cross-border transmission links and large hydroelectric projects, which the private sector has found too risky because of their high capital costs, long payback periods, and multiple country risks related to the enforceability of power-purchase agreements.

### Reform redux: smart regulation for hybrid markets

Africa's hybrid electricity markets pose new challenges in policy, regulation, planning, and procurement. Traditionally, planning and procurement of new power infrastructure were the province of the state-owned utility. With the advent of power sector reforms and the introduction of IPPs, those functions were often moved to the ministry of energy or electricity. A simultaneous transfer of skills did not always occur, however, resulting in plans that were not adequately informed by the complexities on the ground—namely the new hybrid market, composed of private and public actors.

Poor understanding of the hybrid market deprives policy makers of clear and transparent criteria for allocating new plants between the incumbent, state-owned utility and IPPs. New plants are rarely ordered on a timely basis, opening power gaps that prompt recourse to temporary power and discourage investors. When procurement is (finally) undertaken, the authorities may not take the trouble to conduct international competitive bidding. This is unfortunate, because a rigorous bidding process lends credibility and transparency to the procurement and results in more competitively priced power.

Hybrid power markets will not disappear from the African landscape anytime soon. To make the best of them, African governments and their development partners must strive to develop a robust institutional foundation for the single-buyer model, with clear criteria for power purchase (offtake) agreements and dispatches of power under those agreements. They must nurture their planning capabilities, establish clear policies and criteria for allocating new plant opportunities, and commit to competitive and timely bidding processes. Institutions built on the new hybrid models also should reduce discretion in regulatory decision-making through more explicit rules and procedures, or through regulatory contracts and the outsourcing of regulatory functions to advisory regulators and expert panels.

Development partners can help by providing advice on transparent contracting frameworks and processes, and by lending expertise to governments and utilities as they seek to reach financial closure with project sponsors and private investors.

## THE STATE OF THE POWER SECTOR IN SUB-SAHARAN AFRICA

The prerequisite for solid sector financing is better operating performance and thus greater financial viability by the incumbent utilities. Several avenues to better performance are open—among them a new generation of performance contracts; closer monitoring of the operations and finances of state-owned enterprises by supervising ministries and regulators; and new approaches, based on recent reforms in Indian, European, and U.S. power corporations, to attack system losses, raise collection rates, and improve customer service.

Staunching the fiscal hemorrhage caused by misdirected subsidies would complement operational reforms. Decades of subsidies to the power sector in Sub-Saharan Africa have failed to meet the goal of making electricity affordable, largely because access to service is almost entirely confined to the wealthier segments of society. Ending power subsidies for higher-income groups would free up scarce fiscal resources—a major accomplishment. The new-found resources could be used to subsidize the expansion of power networks to serve lower-income rural and periurban communities.

Some of the policies we have proposed have been advocated for decades. But the persistence of state-owned power utilities in Africa, coupled with the pressing power needs of firms and households, means that the policy challenge can no longer be skirted. Combined, the measures proposed here would increase utilities' ability to attract external funding, public or private, domestic or international—and thus to develop cheaper and more sustainable forms of energy for a power-hungry subcontinent.