SUSTAINABLE DEVELOPMENT SERIES

TURNING THE LIGHTS ON ACROSS AFRICA

An Action Agenda for Transformation

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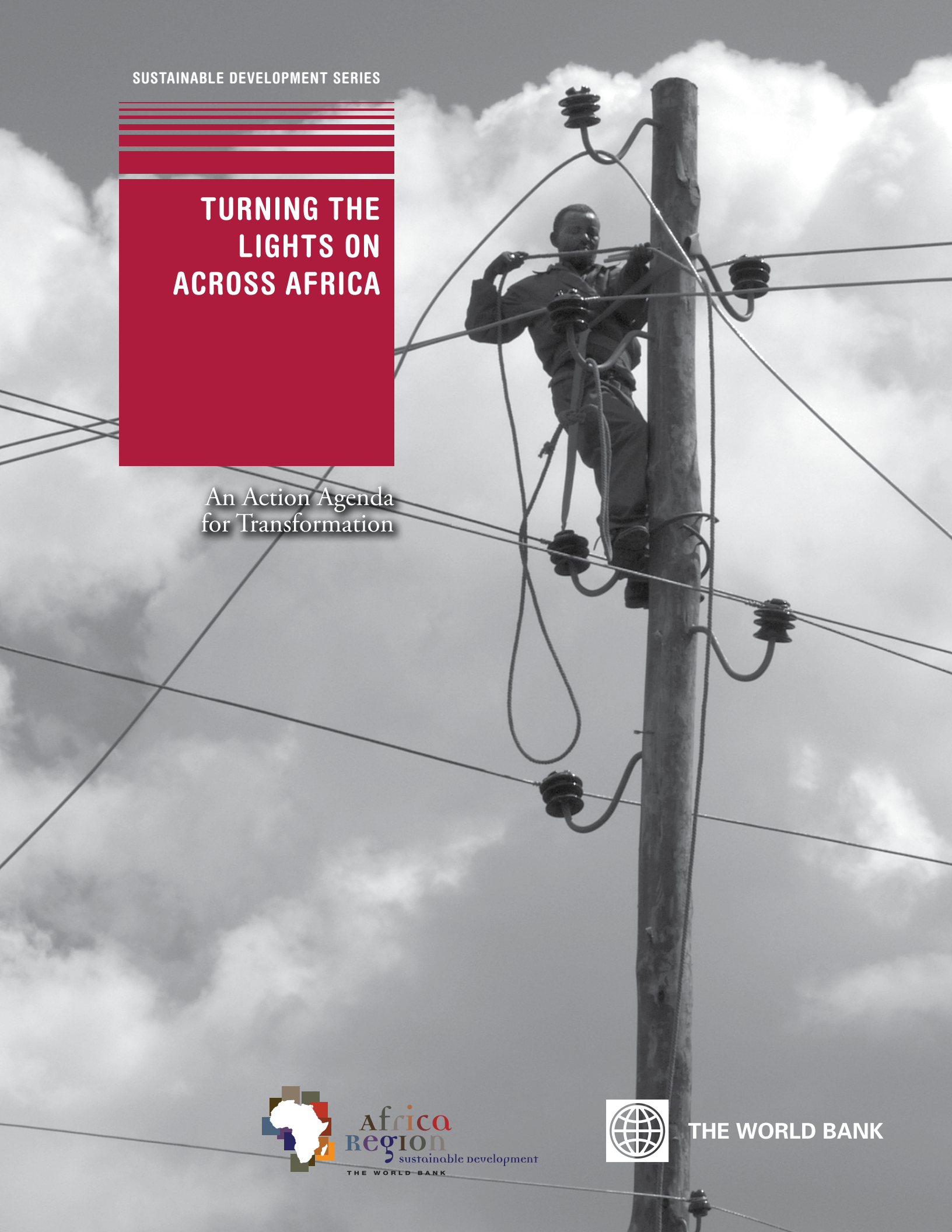

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Acknowledgements

The preparation of this paper was led by Chloë Oliver (AFTSN), with significant contributions from Rahul Kitchlu (AFTG1) and Elvira Morella (AFTG1), and under the guidance of Jamal Saghir (Director, AFTSN), Lucio Monari (Sector Manager, AFTG1), and Meike van Ginneken (Sector Manager, AFTG2). The paper benefited from inputs from Richard Damania (AFTSN), John Nash (AFTSN), Raluca Golumbeanu (AFTG2), Sudeshna Banerjee (SEGEN), Hocine Chalal (AFTN3), George Ledec (AFTN3), Sarwat Hussain (AFRSC), Atsushi Iimi (AFTSN), Carolina Giovannelli (AFTSN), Alvaro Federico Barra (AFTSN), and Jason Russ (AFTSN).

Foreword

This new Africa Region Sustainable Development Series aims to focus international attention on a range of topics, spur debate, and use robust, evidence-based, informed approaches to advance policy dialogue and policy-making. This new Series synthesizes a large body of work from disparate sources, and uses simple language to convey the findings in an easily-digestible format. Ultimately, we want to seed solutions that can help accelerate the fight to end poverty in Africa.

Only one in three Africans has access to electricity. Africa's energy crisis is chronic, sustained, and is putting a brake on economic growth while hampering human well-being.

Boosting investment in energy infrastructure is a proven pathway to securing more growth, more jobs, and greater opportunity for all Africans. To power its relentless rise, Africa needs more energy that is both affordable and green.

This is the overarching message of this publication. By publishing the Sustainable Development Series ahead of the Spring Meetings of the World Bank and International Monetary Fund, we seek to inform, indeed persuade, the international community about the significant development challenges confronting Africa, and the new opportunities to overcome them for a better future for all.

We want to galvanize action and forge new partnerships that can help Africa to achieve a vibrant economy that contributes to more growth, more jobs, better food and an overall improvement in the quality of livelihoods, particularly for poor people.

Jamal Saghir
Director, Sustainable Development
Africa Region
The World Bank
Washington, DC
April 2013

Acronyms and Abbreviations

ACCES	Africa Clean Cooking Energy Solutions
AFD	Agence Française de Développement
AfDB	African Development Bank
AICD	Africa Infrastructure Country Diagnostic
AMADER	Agence Malienne pour le Développement de l'Energie Domestique et d'Electrification Rurale
bcm	billion cubic meters
BDEAC	Central Africa States Development Bank
BOT	Build Operate Transfer
CAPP	Central African Power Pool
DFI	Development Finance Institution
DRC	Democratic Republic of Congo
EAPP	Eastern African Power Pool
EARS	East African Rift System
ECOWAS	Economic Community of Western African States
EEPCo	Ethiopian Electric Power Corporation
EIB	European Investment Bank
ERB	Electricity Regulatory Board
GDC	Geothermal Development Company
GDP	Gross Domestic Product
GPOBA	Global Partnership on Output Based Aid
GW	gigawatts
ICA	Infrastructure Consortium for Africa
IDA	International Development Association
IFC	International Finance Corporation
IFI	International Financial Institution
IMF	International Monetary Fund

IPP	Independent Power Producer
IPS	Industrial Promotion Services
IRENA	International Renewable Energy Agency
KenGen	Kenya Electricity Generating Company Ltd
KPLC	Kenya Power and Lighting Company
kWh	Kilowatt hour
LED	Light-emitting Diode
LPHP	Lom Pangar Hydropower Project
MDB	Multilateral Development Bank
MDG	Millennium Development Goal
MIGA	Multilateral Investment Guarantee Agency
MOU	Memorandum of Understanding
MW	megawatts
NBI	Nile Basin Initiative
OECD	Organization for Economic Cooperation and Development
PPA	Power Purchase Agreement
PPF	Project Preparation Facility
PPI	Private Participation in Infrastructure
PPP	Public-Private Partnership
PRG	Partial Risk Guarantee
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SE4All	Sustainable Energy for All
SSA	Sub-Saharan Africa
STE	Mozambique Regional Transmission Backbone Project
SWAp	Sector Wide Approach
UNECA	United Nations Economic Commission for Africa
WAPP	West African Power Pool

Table of Contents

Figures

Tables

Boxes

Hydro power plant. Ghana. Photo: © Arne Hoel/The World Bank

1 Executive Summary

Africa is suffering from a sustained and chronic power crisis. Despite abundant low-carbon, low-cost energy resources, Africa faces chronic energy shortages. It has developed less than 7 percent of its hydropower capacity, and its generation capacity is lower than any other comparable region in the world. Worse still, investments to increase generation capacity have stagnated with the result that the combined power generation capacity of Sub-Saharan Africa's 49 countries (with a total population of around 800 million people) is 80 gigawatts (GW)—no more than that of the Republic of Korea (which has a population of about 50 million and a surface area slightly smaller than that of Benin).

The weakness of Africa's power sector constrains economic growth and development. Power shortages slow development and, without access to electricity at affordable prices, Sub-Saharan Africa will be unable to achieve its Millennium Development Goals.

The power crisis is the result of several constraints that combine to create a vicious cycle. The challenges in Sub-Saharan Africa are distinctive: (1) the quantum of investments needed far exceed available finance, and high risks and up-front development costs typically preclude private investment; (2) African economies are generally small but growing fast, which exacerbates the demand for energy; (3) governments have trouble raising funds for much-needed investments in generation capacity and maintenance; and (4) utilities are inefficient and perform poorly. These challenges create a vicious cycle of poor energy services and high energy prices, which in turn negatively affect country competitiveness and ultimately crimp economic growth.

The lack of finance available to small but fast-growing economies, combined with political economy issues and size-related and geographic challenges, result in severe energy sector problems. Africa's energy sector fails to provide adequate electricity services to most of its population, and the supply is notoriously unreliable (manufacturing enterprises experience power outages on average 56 days per year). The price of electricity is double the cost in other developing countries, making it difficult to secure an affordable source of power. Although Africa has plentiful resources for producing energy, most of them remain undeveloped. The existing stock of infrastructure is the most costly in the world, and the region installs only about 20 percent of the capacity that is required each year to achieve universal energy access by 2030.

Recognizing these challenges, the World Bank has embarked on an ambitious program that seeks three main outcomes: (1) lower the cost of electricity services to improve their affordability and thus **expand access** to reliable and affordable modern energy services both for the population at large (for lighting, cooking, and other household uses), and to support the delivery of social services; **(2) provide adequate power supply that is reliable and sustainable** and enables more businesses and households to achieve their economic potential; and **(3) reverse or stem woodland loss and land degradation** from the unsustainable consumption of biomass.

The World Bank is working towards these outcomes in five strategic areas:

1. **Lowering the cost of supply by scaling up regional power generation and transmission capacity**. The World Bank supports the development of the next generation of low-cost-large-scale, transformative regional generation projects. This includes tapping Africa's abundant hydropower, geothermal, and gas resources. Equally important is the development of regional markets and interconnections (power pool institutions and infrastructures). It is estimated that regional power trade could save US$2 billion annually in power costs and reduce the long-run marginal costs of power by between 20 and 40 percent for some countries, while at the same time reducing carbon emissions by 70 million tons annually.

2. **Expanding access**. Financing expansion to low-income households that consume little electricity is a high priority for the World Bank. The World Bank is working with governments to create robust national programs for electrification, as well as to scale up financing, reform subsidy programs while introducing smart subsidies, and provide technical assistance to increase the capacity of power sector institutions (including through South-South cooperation).

3. **Improving sector planning and utility performance**. The World Bank supports public and private utilities in their efforts to improve performance. Improved planning involves regional integration as a means to harness diverse endowments and ensure that benefits are shared by all. Integrated planning entails providing supply- and demand-side opportunities in a level playing field to make energy more reliable and affordable. The World Bank supports regulation reforms aimed at increasing cost recovery, rationalizing subsidies, and strengthening the financial viability of incumbent utilities.

4. **Applying demand-side management and energy-efficiency programs**. The World Bank works to scale up demand-side interventions that best fit the country context, so as to maximize efficiency gains. This includes improving end-use energy efficiency and promoting more efficient utilization of the power system capacity through demand-side management techniques (such as solar water heaters, more efficient electric cook stoves, time-of-use tariffs, load control, and smart metering).

5. **Promoting sustainable biomass supply and use**. While traditional fuels will remain a vital resource through much of Sub-Saharan Africa, the World Bank has integrated programs to improve the sustainability of wood fuel supply and use, including community-based approaches to forest management systems and various alternatives as a means to promote demand-side management.

As financing requirements are very large, the World Bank is strengthening its efforts to leverage financing within the World Bank Group and with other donors and private sector partners. Key to the success of mobilizing resources is tapping local capital markets, including pension funds as well as sovereign funds and non-traditional donors. The World Bank proactively offers partial risk guarantees to lower the risk for private investors who are investing in Africa's energy sector, including renewables.

The World Bank is undertaking this ambitious program by engaging with partners and facilitating a collective focus on key, large-scale transformative projects. This includes close cooperation among World Bank Group partner agencies—the International Development Association (IDA), the International Finance Corporation (IFC), and the Multilateral Investment Guarantee Agency (MIGA)—to leverage resources more effectively, seek a comparative advantage, and develop instruments to promote energy investments across Africa. The World Bank will increase its focus on key and transformative projects, leverage investment by the private sector and other donors, strengthen the capacity for project development and execution, enhance its knowledge-brokering role, and mobilize technology, skills, and resources for world class energy solutions that contribute to building shared prosperity and improving human wellbeing

Efforts to develop the regional markets and institutions are essential, and political economy matters. Incentives for cooperation will vary by country, and a balance must be reached where regional trade produces the benefits of a lower cost of supply without increasing domestic energy security risks. Good governance and the improved capacity of utilities and regulatory institutions are critical to ensuring sustainable outcomes on access, services, and financial viability. Quality and realism in project preparation must be high to ensure success in public-private partnerships and deliver sustainable and lasting development outcomes.

To accelerate progress, all stakeholders (including government, private investors, donors, and international financial institutions) must come together to scale up finance, raise the capacity for project preparation and execution, and improve the investment climate. A broad consensus is necessary if regional transformational projects and needs are to translate into cohesive regional planning, consistent national plans, and high-quality preparatory work. Realism must be injected into project preparation; the upstream work requirements are high, but with a focus on multi-year planning, and by apportioning adequate resources to preparation, complex and transformational projects can be made into sustainable ones.

There is an urgent need to do more to support the sustainable development of Africa's energy sector, and to make those interventions timelier. The World Bank's full suite of service offerings–its financing, technical assistance, and global knowledge cannot, alone, manage to produce the intended effects. Successful partnerships must be fostered to achieve lasting results. These partnerships should focus on African institutions and actors, combining the strengths of the public and business sectors, as well as those of civil society, and mirroring each party's comparative advantage.

The Lethaba Power Station outside Sasolburg in the Free State. South Africa. 2007. Photo: John Hogg / World Bank

2 Introduction

Africa is in the midst of a power crisis. Despite abundant low-carbon, low-cost energy resources, Africa faces chronic energy shortages. The region's power generation capacity is lower than that of any other region in the world, and when compared with other developing regions, its capacity growth has stagnated. The combined power generation capacity of Sub-Saharan Africa's (SSA) 49 countries, with a total population of around 800 million people, is 80 gigawatts (GW)—no more than that of the Republic of Korea,[1] whose population numbers roughly 50 million people and the total area of which is slightly smaller than that of Benin.

The power crisis is the result of several constraints that, together, create a vicious cycle. Challenges to the sector's development throughout Africa include the geographic concentration of resources, the small scale of most national utilities, the lack of power system interconnection, and widespread reliance on expensive oil-based generation and biomass. Insufficient investment in generation capacity and networks also leads to stagnation in connectivity rates and to the electrical infrastructure's weak reliability. High generation costs and, consequently, the high tariff rates of African electricity further impede access to power as well as efficient system maintenance, refurbishment, and expansion.

Africa's electricity access is the worst in the world. Almost 70 percent of the continent's population (nearly 600 million people) and 10 million small- and medium-sized enterprises have no access to electricity. Sub-Saharan Africans account for nearly 45 percent of people lacking electricity across the globe. Most regions in the world have urban electrification rates of 90 percent or higher; in SSA, less than 60 percent of those living in urban areas have electricity (see Table 1). If current electricity connection trends continue, fewer than 40 percent of SSA countries will reach universal access to electricity by 2050 (Barnes 2012).

1 US Energy Information Administration, *International Energy Statistics.*

Table 1. Electricity Access in Developing Countries, 2009

	Population without electricity (millions)	**Electrification rate** (%)	**Urban electrification rate** (%)	**Rural electrification rate** (%)
Sub Saharan Africa	585	30.5	59.9	14.2
Developing Asia	675	81.0	94.0	73.2
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: World Energy Outlook (2011).

Sudan. Photo: © Arne Hoel / World Bank

3 Why is Increasing Access to Electricity so Important?

Lack of access to modern energy services that are efficient and sustainable is an obstacle to economic growth, poverty reduction, and achieving the Millennium Development Goals (MDGs).

The power sector's weakness constrains economic growth and development in the region. Power outages cause losses in foregone sales and damaged equipment for firms. The economic cost of such disruptions can range between 1 and 4 percent of Gross Domestic Product (GDP). Power shortages curb development and, without access to electricity at affordable prices, SSA will fail to achieve its Millennium Development Goals (MDGs). Box 1 summarizes recent research on the relationship between energy supply and economic growth.

Box 1. Does Energy Supply Stimulate Economic Growth?

Economic growth and energy consumption typically go hand in hand, but their causal relationship can be difficult to determine. The correlation between energy consumption and growth has been the focus of many empirical studies and has broad implications for policy makers. If it is energy consumption that drives growth, then policies that improve access to energy can pay large dividends towards future economic development. In contrast, if economic growth seems to spur demand for energy consumption, or if there is no causal link between the two at all, then policies that conserve energy usage in order to improve environmental sustainability or allocate investments to more efficient sectors may be warranted.

Until recently, the literature on this topic has not successfully elucidated the link between energy consumption and growth. Most studies have examined time-series models of single countries over relatively short periods, leading to low observations with little statistical power; even when a causal link is found in such cases, it cannot be said to be definitive. Results have been mixed, with some studies finding causality running from increased GDP to energy consumption (Soyas and Sari 2003, Ouedraogo 2010), others finding causality running from energy consumption to increased GDP (Odhiambo 2009a and 2009b, Akinlo 2009), some finding bi-directional causality (Ebohon 1996, Wolde-Rufael 2009), and still others finding no causal link between

the two, or a relationship that varies by country (Wolde-Rufael 2005 and 2006, Esso 2010, Odhiambo 2010).

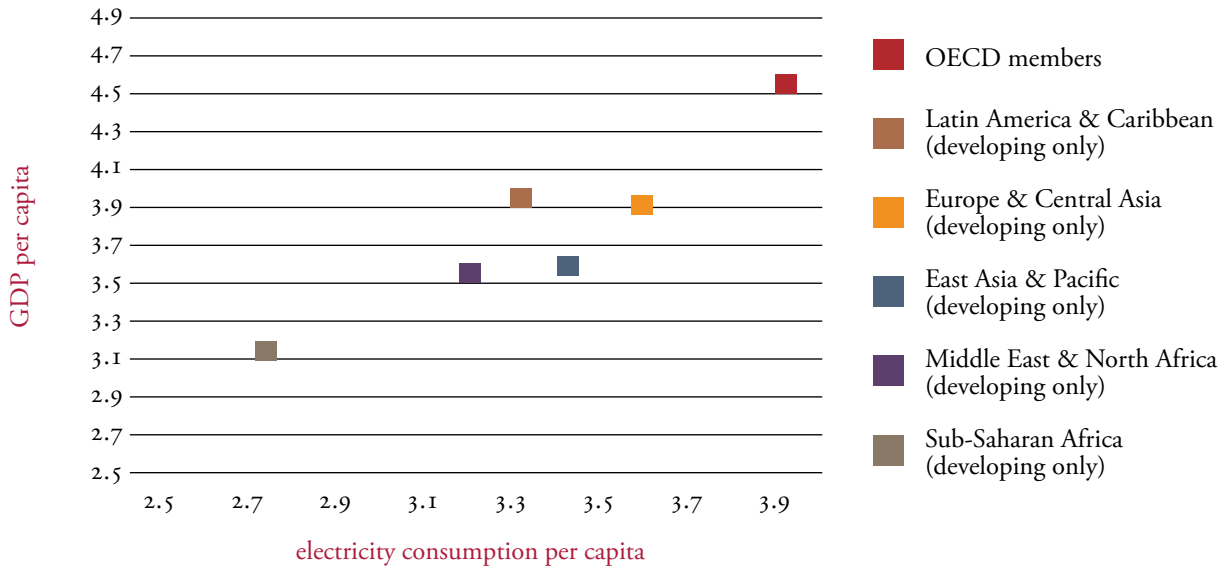
A recent study of the fifteen countries that make up the Economic Community of Western African States (ECOWAS) used newly developed statistical methods to test for short-run and long-run causality. The study finds that, over the short-run, the direction of causality runs from GDP to energy consumption (demand). As incomes increase, the consumption of energy is therefore motivated by the desire to increase household comfort. However, over the long term, causality runs in the opposite direction, from energy consumption to income. Access to an affordable, reliable, and modern energy supply is therefore vital to increasing production and maintaining economic growth in the long run.

The results of this study are as striking as they are intuitive. An increase in energy consumption in the short run, which is only allowed for after a sufficient increase in income, can lead to increased production in the long term, thus creating a virtuous cycle. The policy implications are twofold. While the overconsumption of energy—which can occur in response to generous energy subsidies—is not desirable due to the harmful externalities it can cause, policy makers must be careful not to limit access to energy in areas where the population already has very low access. This can severely hamper long term growth. Likewise, a substantial investment in energy infrastructure, which delivers reliable access to poor households, can have a large effect on future economic growth and improve the welfare of current and future generations.

Source: Ouedraogo 2012.

Poor energy infrastructure and, in particular, power outages, have a detrimental effect on firm productivity. Enterprise survey data collected through the World Bank's Investment Climate Assessments reveals that, in most countries in SSA, infrastructure accounts for 30 to 60 percent of the effect of investment on firm productivity—well ahead of other factors, including red tape and corruption (Escribano, Guasch, and Peña 2008). In half of the countries analyzed, the power sector accounted for 40 to 80 percent of the infrastructure effect (Eberhard et al. 2011).

Figure 1. Per Capita Electricity Consumption and GDP



Source: World Bank database 2010.

"Without energy, it is not possible for a health clinic to work in remote areas in Africa. Without energy, it is not possible for our kids to learn because they will not be able to study in the evening. Without energy, it is not possible for a woman, who walks 10 kilometers a day to fetch water in remote Tanzania or remote Senegal, to be able to reduce the incidence of certain diseases in our countries… So let's link that discussion on energy to… inclusive growth, reducing poverty, [and] reaching the Millennium Development Goals." —Makhtar Diop, World Bank Africa Vice President, at the IMF/World Bank 2012 Annual Meetings Event: The Energy Challenge in Africa.

Increasing access to electricity reduces poverty, whereas power shortages curb development. Achieving the MDGs requires access to electricity at affordable prices. The MDGs, set in 2000 at the United Nations Millennium Summit, outlined several time-bound goals in the areas of poverty, health, education, and the environment. Without electricity, students cannot read after sunset, businesses cannot grow, and health centers cannot refrigerate vaccines. According to the *Poor People's Energy Outlook 2013*, 225 million people in SSA are served by health centers without electricity. The link between energy and the MDGs is outlined in Annex A.

Ethiopia. Photo: © Arne Hoel / World Bank

4 What is the Scope of the Challenge?

The scope of Africa's energy sector challenge is enormous; Africa's power-generating capacity is lower than in any other region in the world. While the cost of electricity is double that of other developing countries, the electricity supply is notoriously unreliable. Total African power sector investments, including operation and maintenance, are around US$50 billion per year, but another US$20 billion per year would be needed to reach universal access by 2030. New targets set under the "Sustainable Energy for All" (SE4All) initiative call for universal access to modern energy services by 2030 and will require nearly US$500 billion in investments. While the private sector could be one potential source of these funds, Africa's power infrastructure received only 2 percent of all private investment in energy infrastructure allocated to developing regions from 2001–2011.

Africa's energy sector is affected by four principal constraints:

- ***Lack of finance***—The investments needed in the African energy sector far exceed the available finance. The upfront development costs for projects are often staggeringly high, as are the long-term project risks. There is a lack of capacity to develop bankable projects, and weak sectors mean non-creditworthy public utilities that preclude public-private partnerships (PPPs) and commercial financing. Current power sector spending is equal to 1.8 percent of regional GDP. The spending is disproportionally allocated to operation and maintenance, and only 0.7 percent of GDP is left to fund long-term investment. Over the last decade, on an annual basis, private transactions have averaged only US$0.5 billion, and donor funding has at times been ad hoc and uncoordinated. Widespread sector reforms geared toward increasing private participation failed where governments were unable or unwilling to raise tariffs to cost-recovery levels, and funding for the elements of the sector that were riskier or not commercially viable (such as transmission) was lacking.

- ***Small but fast-growing economies***—Sub-Saharan African economies are small in relation to the lumpy investments required for power generation. Multi-country collaboration is often required, yet such investments can be difficult to implement. Furthermore, over the last decade, unprecedented GDP growth (averaging nearly 5 percent per year) combined with high population growth rates, especially in urban areas, has increased the growth rate of demand for power to almost 7 percent, outpacing GDP growth. Yet, generation capacity has increased by less than 3 percent per year.

- ***Political economy***—African power sector institutions are only as strong as the institutions in the country; often they fall short of the capacity required, for instance, to implement multi-country projects or manage complex environmental and social issues that require careful treatment. The incentives for sector reforms—such as setting cost-recovery tariffs—and improvements are often lacking. Sector reforms also overlooked governance problems associated with state-owned enterprises, which are now reflected in deficient utility performance. The operational inefficiencies of power utilities, including distribution losses and revenue under-collection, cost the region 0.8 percent of GDP on average.

- ***Size and geography***—Energy resources are concentrated in just a handful of countries that are geographically removed from the center of power demand (the economic centers in Southern, Western, and Northern Africa). Large rural populations mean low density and demand levels that make extending energy infrastructure to rural areas costly, and usually a low priority for governments.

Low levels of access, exorbitant connection charges, unreliable supplies, and high construction costs have long impeded the growth of the energy sector, which has had a significant impact on the development and prospects of the region.

4.1
Low Access and Unreliable Supply

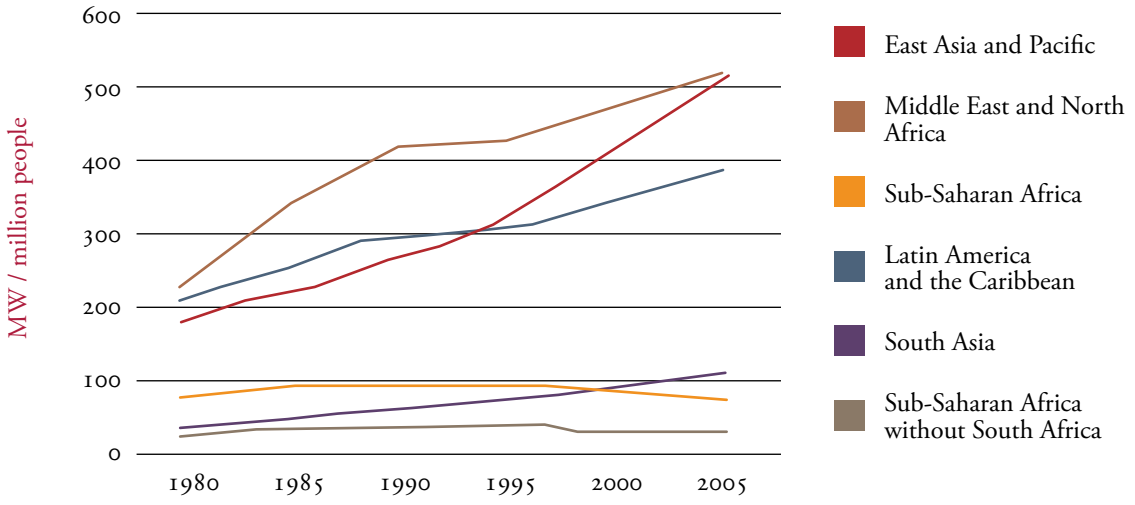
Despite a large endowment of energy resources, Africa's power-generating capacity is lower than any other region's. The combined power generation capacity of SSA is 80GW, but if South Africa is excluded, that figure actually drops to 34GW. As much as 25 percent of this capacity is non-operational, however, due to aging plants and lack of maintenance (Eberhard et al. 2011).

Africa's capacity growth has stagnated compared with that of other developing regions (see Figure 2). In the decade before 2005, expansion was barely 1 percent per year (or less than 1,000 megawatts (MW) per year). In contrast, China adds about 100GW of installed capacity each year. According to the Africa Infrastructure Country Diagnostic (AICD), installed capacity will need to grow by more than 10 percent annually to meet suppressed demand, keep pace with projected economic growth, and provide additional capacity to support electrification efforts.

Africa's power supply sector fails to provide adequate electricity services to most of SSA's population. Electricity blackouts occur on a regular basis and, as a result, people and enterprises often rely on expensive diesel power generation. Africa's manufacturing enterprises experience power outages an average of 56 days per year (Eberhard et al. 2008). As a result, firms lose six percent of sales revenues (Foster and Steinbuks 2009). In the informal sector, where back-up generation is limited, losses can be as high as 20 percent. In SSA, 31 out of 49 countries experience daily power

outages; these cost more than 5 percent of GDP in Malawi, South Africa, and Uganda, and 1 to 5 percent in Kenya, Senegal, and Tanzania (Foster and Briceño-Garmendia 2010).

Figure 2. Power-Generation Capacity by Region, 1980–2005



Source: Eberhard et al. (2011).

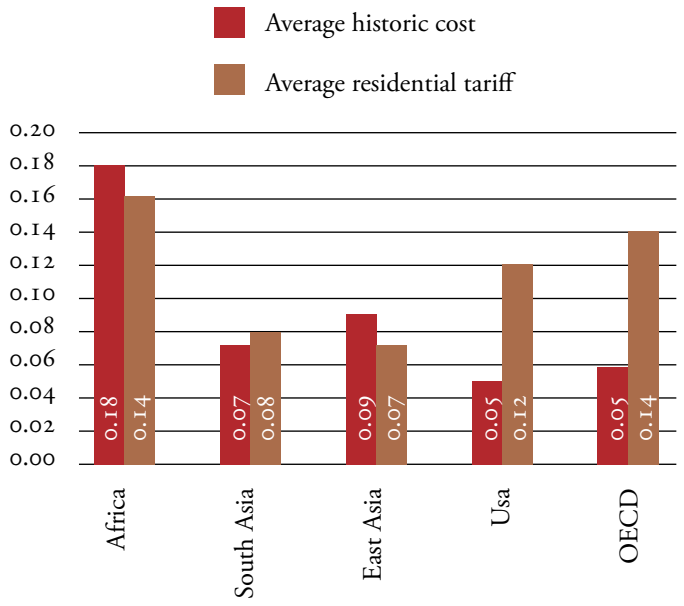
4.2 High Costs

The average cost of power in SSA is double that in other developing countries. Typically, power tariffs in most parts of the developing world fall in the range of US$0.04 to US$0.08 per kilowatt-hour (kWh); in SSA, the average tariff is US$0.12 per kWh (Eberhard et al. 2011).

Historically, the average generation cost in SSA has been about US$0.18 per kWh, while the same cost in member countries of the Organization for Economic Cooperation and Development (OECD) countries averages US$0.04 per kWh. Tariffs can be even higher where there is dependence on diesel-based systems;[2] given the infrastructure's unreliability, many firms operate their own diesel generators at two to three times the expense of traditional power (and with additional environmental costs). Even when charging high tariffs, most countries in SSA are only just covering their average operating costs.

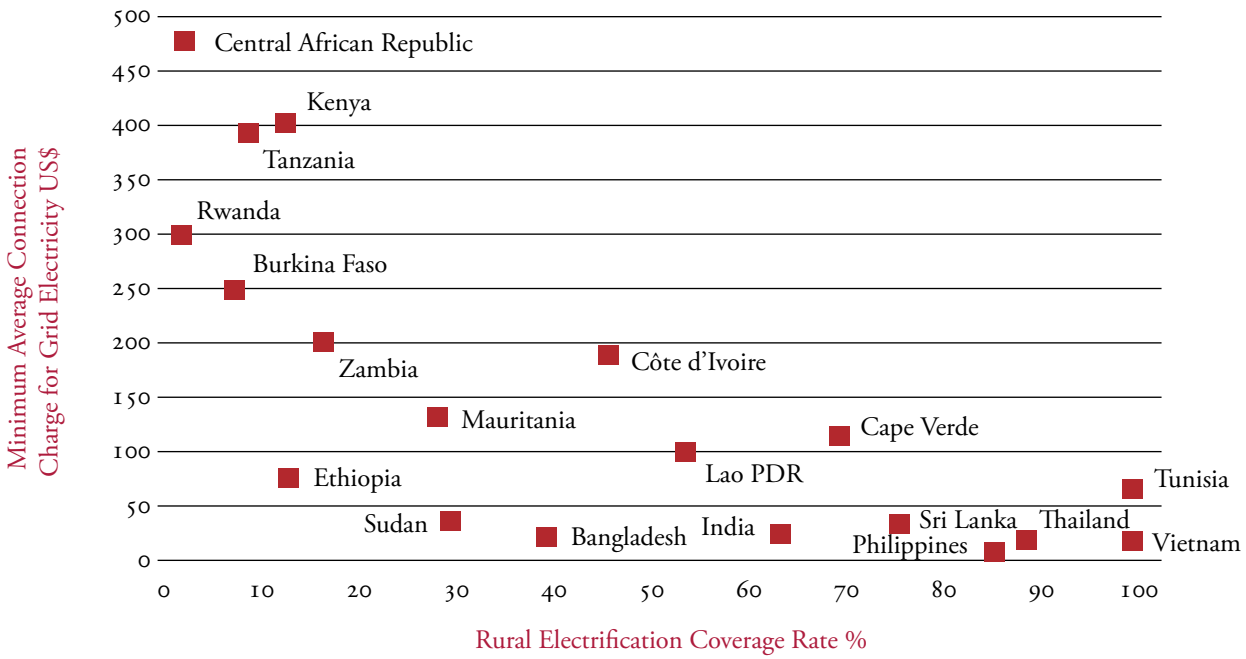
2 In the Democratic Republic of Congo, Equatorial Guinea, and Mauritania, diesel generators are responsible for over 50 percent of all power generation.

Figure 3. Average Historic Generation Costs and Residential Tariffs



High electricity connection charges and prices are the main factor discouraging people from subscribing to a new service. The full cost of providing an electricity connection service—even without the expense of building additional distribution systems—can often reach more than US$300 in urban areas, and even higher still in rural areas (Barnes et al. 2010). In the very poorest parts of the world, new customers are being asked to pay very high upfront costs for access to electricity. These high connection charges in SSA are driven by: a weak commitment on the part of utilities to access programs (due to, for instance, supply constraints or subsidized tariffs), sophisticated technical specifications for low loads and procurement practices leading to high costs, dispersed population in rural areas, and recovery of high connection costs (plus, in some cases, cost of part of the upstream network) through connection charges (Golumbeanu and Barnes 2012). Of course, there are also significant lost benefits when households lack access to electricity, such as productivity gains in business, opportunities to study, improvements in health, and so on.

Figure 4. Connection Charges and National Electrification Rates, 2010



Source: Golumbeano (2012b).

4.3
Undeveloped Resources

Reducing the cost of power is necessary for increasing access, and developing Africa's resources will help the continent bring down the cost of power. Africa is well endowed with both fossil fuels (oil, gas, and coal) and renewable resources (hydropower and geothermal in particular).

There is a vast resource potential for clean energy in Africa, including 45GW of economically feasible hydropower potential, new oil and natural gas finds, more than 15GW of geothermal potential in the Rift Valley, and wind and solar potential of 1,000GW. However, the challenges in developing energy infrastructure are daunting indeed. The region's hydropower and thermal potential can be effectively unlocked only by developing power pools, which allow member countries to share the resources for their collective benefits. It is estimated that regional power trade could save US$2 billion annually in power costs and reduce the long-run marginal cost of power by US$0.01 per kilowatt-hour (kWh) overall (and between 20 to 40 percent for some countries), while at the same time reducing carbon emissions by 70 million tons annually.

In recent years, opportunities for gas to power have increased with new finds of natural gas reserves in countries along the east coast of Africa and also in West Africa. Natural gas-generated power can serve as an affordable bridge to a more sustainable energy supply and is already playing a critical role in the primary energy portfolios of many developing countries. In the next five to seven years, at least 4GW of new generation potential is possible with such thermal resources presenting a viable lower carbon growth strategy for African countries.

4.4
Inadequate Investment

Africa's infrastructure is the most costly in the world. The region installs about 1 - 2 GW of new capacity each year, but its needs are closer to 6–7 GW per year. Some studies suggest the need may be twice that; the International Renewable Energy Agency (IRENA), for instance, proposes the continent will have to add around 250GW of capacity between now and 2030 to meet demand growth (IRENA 2012). If "business as usual" continues, less than 30 percent of Africans will have electricity in their homes by 2030.

Total African power sector investment, including operation and maintenance, is today around US$50 billion per year (UNECA 2011). SSA investments from the World Bank Group alone amount to US$10 billion per year in the power sector.[3] Universal energy access by 2030 would require an additional investment of about US$20 billion per year (over and above the baseline investments) (IRENA 2012). While many developing countries have partnered with the private sector to improve infrastructure, Africa accounts for only around two percent of private investment in energy infrastructure (see Section 6.1 for a discussion on increasing private sector participation).

3 US$2.27 billion for grid extension, US$4.59 for grid-connected supply, US$1.37 billion for off-grid renewable electricity, US$1.07 billion for policy/regulation, and US$0.76 billion for the efficient use of electricity (Monari 2011).

Transmission lines, Sudan. Photo: © Arne Hoel / World Bank

5 The World Bank's Commitment to Energy Sector Development in Africa

The World Bank is committed to scaling up its efforts to reduce extreme poverty levels in Africa, and ensuring adequate and sustainable energy supplies for economic growth, shared prosperity, and social wellbeing. The World Bank Africa Energy Unit's portfolio has grown significantly in recent years and currently has 52 active projects, totaling over US$10 billion. These projects range in objective from increasing people's access to electricity to rehabilitating war-torn, dilapidated grids, to ensuring international environmental and social safeguard policies are respected during the development of energy projects. The portfolio and pipeline are large and diverse.

In particular, the World Bank seeks three main outcomes: (1) **lower the cost** of electricity services to improve their affordability and thus **expand access** to reliable and affordable modern energy services, both for the population at large (for lighting, cooking, and other household uses), and to support the delivery of social services; (2) **provide adequate power supply that is reliable and sustainable** and enables more businesses and households to realize their economic potential; and (3) **reverse or stem woodland loss and land degradation** from the unsustainable consumption of biomass.

Five strategic areas of engagement have been identified as instrumental to achieving the abovementioned outcomes. The first outcome is an imperative from a social, poverty reduction, and political point of view, and the World Bank will continue to place the expansion of energy coverage at the top of its agenda (see Section 5.1). Tackling Africa's generation capacity deficit is a precondition of any effort to realize the second outcome—expanding access and providing adequate supply for sustaining economic growth. The Bank is strongly committed to scaling up regional generation and transmission capacity (see Section 5.2). Improved planning and regulation at the sector level and better management at the utility level are prerequisites for successful energy sector outcomes and are critical to achieving both the first and second goals (see Section 5.3). Well-designed demand-side management and energy efficiency programs can also contribute considerably to reducing the power supply demand gap (see Section 5.4). Finally, a focus on sustainable supply and use of biomass will assist in climate adaptation and mitigation strategies (see Section 5.5).

5.1
Access Expansion

Financing expansion to low-income households—which consume little electricity and account for only a small portion of utility revenues—is a high priority for the World Bank. This requires concerted action, a systematic approach to planning, and significantly greater concessional financing from development partners. The historic approach in development partner financing has led to fragmented planning and uncertain financial flows. To provide greater certainty, the World Bank is committed to supporting access to electricity in urban and rural areas through multi-year programs of access roll-out based on coherent national strategies and using sector-wide approaches (SWAPs), supported by multiple development partners.

The relatively low coverage rates throughout SSA—even in densely populated urban areas—suggest that, even where infrastructure is physically present, service coverage is not guaranteed. Part of the access deficit is related to demand-side barriers that prevent households from hooking up to the service, even when they reside in the proximity of networks. Demand-side barriers can take a variety of forms, including high connection charges that make hook-ups unaffordable, illegal tenure that disqualifies households from connecting, and a variety of other social and economic factors that may deter households from becoming utility clients. Inefficient subsidization compounds the problem.

In SSA, tariff subsidies benefit the relatively affluent minority of households that have power in their homes, even though analysis shows that, in most countries, cost-recovery tariffs would be affordable to them (Foster and Briceño-Garmendia 2010). Typically, the goals of electricity subsidies are to improve access among poor households without distorting energy markets. To achieve this, policies must be carefully designed for **efficacy** (subsidy reaches those for whom it is intended), **efficiency** (subsidy is structured in such a way that it encourages the provision of service at least cost), and **cost-effectiveness** (subsidy achieves social goals at the lowest cost to the subsidy program, while still providing incentives to the private sector to serve poor and rural populations). Electricity subsidies in Africa—which absorb about US$2 billion per year, or 0.4 percent of GDP—fail to reach the vast majority of the poor that have no access to electricity and create a large fiscal hemorrhage that holds back sector investment and access programs. In fact, while cost recovery tariffs are politically controversial, there is no strong evidence of real social impacts; less than 20 percent of connected households cannot afford cost-recovery tariffs for minimum consumption (50 kWh/month).

Once energy subsidies are in place, they are very difficult to remove. When households and businesses adapt to lower energy prices by investing in energy consuming capital (for instance, purchasing cars, wiring their homes for electricity, and adopting energy-intensive technologies and equipment), the opposition to removing energy subsidies can become fierce. The difficulty of

removing energy subsidies is exacerbated in oil-producing nations, where there is a strong belief that the domestic price should not be higher than its production cost.

Box 2. Designing Subsidy Reform

A recent study by the IMF suggests that there are six elements to subsidy reform: (1) a comprehensive energy sector reform plan that includes clear long-term objectives, analyzing the impact of reforms, and consulting with stakeholders; (2) an extensive communications strategy, supported by improvements in transparency; (3) phased price increases; (4) improving the efficiency of state-owned enterprises to reduce producer subsidies; (5) targeted measures to protect the poor; and (6) institutional reforms that depoliticize energy pricing, such as the introduction of automatic pricing mechanisms.

As an example, in 2007, the Government of Gabon successfully reformed energy subsidies, culminating in an increase of gasoline and diesel prices by 26 percent. Several measures were taken to mitigate the effect that this price increase had on very low income households. Payments made to the poor through the National Social Guarantee Fund were resumed, and assistance to single mothers via the Ministry for the Family and microcredit programs was increased. In addition, school enrollment fees for students attending public schools were waived and all textbooks were distributed free of charge. Public transportation in the capital, Libreville, was also expanded to help offset increasing transportation costs.

Source: IMF (2013) and http://rru.worldbank.org/documents/publicpolicyjournal/310Bacon_Kojima.pdf.

Subsidies for electricity connections rather than tariffs could more effectively target the poor in SSA. In Ethiopia, for example, the national utility (Ethiopian Electric Power Corporation, EEPCo), has already connected about 25,000 poor households under the World Bank-funded Access Rural Expansion Project Phase 2, with participation of the Global Partnership on Output Based Aid (GPOBA). The grant allows EEPCo to finance 80 percent of the connection charges for poor rural households with five-year, interest-free loans, reducing the upfront financial burden on households to only 20 percent (see Box 3 for more details). The Bank is also implementing GPOBA grants in Kenya, Liberia, and Uganda to lower the connection charges in order to increase access to electricity. In Liberia, the program subsidizes a connection charge of US$950 per customer in the capital, Monrovia. In the slums of Kenya, a subsidy is provided to lower the US$300 connection charge. Under these programs, the subsidy is disbursed only after a certain number of households have been verified as having adopted electricity.

Box 3. Ethiopia Rural Electricity Access Expansion and the GPOBA

The goal of the Second Electricity Access Rural Expansion Project is to establish a sustainable program for expanding access to electricity in rural communities, thus supporting broad-based economic development and helping to alleviate 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 allows EEPCo to implement a connection charge financing program in which rural households pay 20 percent of the US$75 connection charge with the remaining 80 percent collected over five years, as an interest-free loan. The utility receives an overall subsidy of US$35 that covers the interest rate for financing over five years. In total, the household must pay US$15 for the connection upfront, with the rest being paid in installments of about US$1 per month, which covers the remainder of the payment over five years.

The results of the project are very promising; a high number of poor households are finding the electricity connection charges affordable thanks to the financing structure. A recent survey showed that close to 70 percent of participating households have annual cash incomes of US$300 or less, indicating that the subsidy has been well targeted. Many households rely on informal connections wired in from another household, and virtually all households in the survey had completed their own internal house wiring. These preliminary results appear to confirm that spreading the initial connection charges over time increases the number of households adopting new electricity connections.

Source: Reproduced from Golumbeanu and Barnes 2012.

Given the scale and nature of the access gap and the locations involved, it will be necessary to provide electricity though both centralized and decentralized energy technologies and systems, including grid, mini-grid, and off-grid solutions.

Mini-grid and off-grid solutions are more efficient options when bringing electricity into sparsely populated areas, but grid extension is often the least-cost option in areas with high population densities. If pursued at the regional level, especially in Africa, grid extension also offers the opportunity to tap into significant hydropower potential (see Section 5.2.1). However, rural areas account for the bulk of additional connections needed to reach universal electricity access by 2030, and African rural populations tend to be sparse. In SSA, only 15 percent of the rural population lives within 10 kilometers of a substation (or within 5 kilometers of a medium-voltage line), while as much as 41 percent lives in areas considered isolated or remote from the grid. Rolling grids to such sparsely populated areas would impose prohibitive costs and supply would be unreliable, due to the high technical losses inherent in long-distance transmission systems.

In regions where grid extension is not economical, such as in dispersed rural areas, SWAps will include off-grid solutions based on appropriate technologies and driven by local resource availability. To this end, the World Bank supports implementing new institutional models for rural areas, including innovative rural energy financing mechanisms to engage the private sector and local communities. The World Bank's grid intensification programs also support efforts to reduce the cost of supply, improve pricing and affordability, and promote complementary off-grid programs such as *Lighting Africa*.

Until the energy access gap can be closed, millions of people can be taken out of the dark by deploying lighting solutions that meet basic household needs. Clean, off-grid lighting solutions can significantly raise the quality of life for hundreds of millions of people. Today, solar and other lighting products offer a valid alternative to expensive, inefficient, and polluting lighting sources such as candlelight or kerosene lamps, on which a large part of Africa's population relies. They offer better illumination, longer life, and features such as chargers for cell phones and other appliances. Their durability can allow a small business to extend its work day and provide hours of light for studying. Such technologies lower greenhouse gas emissions and, by reducing indoor air pollution, they also improve general health. These lighting products are becoming more affordable for African low-income households, which spend an estimated US$10.5 billion on kerosene for lighting annually.

Market-based approaches are needed to spread cleaner off-grid lighting solutions. The emerging market for off-grid products is hard to penetrate. Manufacturers struggle to find business partners, while financial institutions unfamiliar with the industry are unable to fully exploit the market's growth potential. In addition, end users have not yet embraced the new technologies, and low-quality products undermine consumer confidence. Market-based approaches and programs providing businesses policy, technical, and financial support can make a difference. Programs such as *Lighting Africa* (see Box 4) and Mali's AMADER (see Box 5) can serve as catalysts to make quality off-grid lighting products accessible to energy-poor households in several regions of the continent.

The World Bank also helps disseminate and promote the uptake of technology advances that have been successfully commercialized elsewhere in Africa. Among these, the *Lighting Africa* initiative is mobilizing and supporting the private sector in its efforts to supply quality, affordable, clean, and safe lighting. The initiative encourages innovations, such as new light-emitting diode (LED), fluorescent, and solar technologies. Thanks to Lighting Africa, off-grid lighting services are being incorporated into rural electricity access projects in several countries, including Ethiopia, Ghana, Tanzania, and Zambia. This initiative will be further expanded in many other countries.

Box 4. Lighting Africa

Launched in 2007, this joint World Bank–IFC initiative aims to mobilize and support the private sector in building sustainable markets for providing safe, affordable, and modern off-grid lighting to people in Africa by facilitating sales of off-grid lighting products. It supports the development of new LED, solar and fluorescent products and seeks to make them accessible to consumers in SSA.

Lighting Africa has five components, each addressing identified barriers that constrain the higher penetration of high-quality products across the continent: (i) quality assurance, (ii) market intelligence, (iii) business development linkages and financing, (iv) consumer awareness, and (v) policies and regulations. In its first two years, the initiative contributed to establishing a market of low-cost, off-grid lighting products. In 2010-2011, *Lighting Africa* expanded beyond the pilot countries of Ghana and Kenya and launched activities in Ethiopia, Mali, Senegal, and

Tanzania. The expansion is continuing, with the goal of establishing regional programs in East Africa, Francophone and Anglophone West Africa, and in post-conflict states.

As of December 2012, *Lighting Africa* had provided 6.9 million people in Africa with clean lighting and better access to energy thanks to solar lanterns.

*Sour*ce: World Bank data.

Box 5. Rural Electrification in Mali

Mali has had success in rural electrification through off-grid solutions and by partnering with the private sector. Mali's AMADER (Agence Malienne pour le Développement de l'Energie Domestique et d'Electrification Rurale), created by law in 2003, uses two major approaches to rural electrification: the "bottom-up" electrification of specific communities, and the "top-down" electrification of large geographic areas. The bottom-up approach, which has shown greater success than its top-down counterpart, involved the establishment of 80 mini-grids, operated by 46 local private operators. AMADER typically provides grants for 75 percent of the start-up capital costs related to the rural electrification subprojects. By December 2009, 41,472 households, 803 community institutions, 172 schools, and 139 health clinics had been connected to a mini-grid.

Only 13 percent of the rural population in Mali has access to electricity. Most rural Malians rely on expensive, unreliable, and dirty fuels—such as kerosene, wood, charcoal, and car batteries—to light and power their homes, schools, and health clinics. These fuels can cost up to 10 times the price per kWh of electricity from the grid. This leaves considerable room for private, mini-grid operators to turn a profit by selling electricity to rural communities, while also providing energy that is cheaper, cleaner, and more reliable than is currently available.

*Sour*ce: Eberhard et al. 2011.

A roadmap toward universal access includes a number of building blocks with commitments and actions at the national and international levels:

- ***Robust national programs***—Governments need to prioritize energy access and develop robust, large-scale electrification programs complete with clear targets, financing plans, and implementation roadmaps. The scale and nature of the access gap and the locations involved require that electricity be provided through both centralized and decentralized approaches, which calls for an integrated vision of the sector, a rigorous planning process, and regulatory reforms to support the deployment of innovative institutional approaches and technical solutions. In rural areas, new institutional models should be explored, including innovative rural energy finance mechanisms, to engage the private sector and local communities.

- ***Scaled-up financing***—Given the scale of the effort required, access to various sources of financing is critical, particularly for generating the initial capital. Donor and government resources—typically including a combination of targeted government subsidies, concessional loans from various sources, grants, cross-subsidization, output-based aid, and end-user tariffs—should be pooled for a large-scale, sustained, programmatic effort.

- ***Smart subsidization***—Tariff policies need to be carefully designed, striking the right balance between cost recovery (essential for the ongoing sustainability of services) and affordability. Subsidies towards connection fees, which in many countries represent a major barrier preventing poor households from hooking up to the service, have a considerable social impact. Reducing poorly designed tariff subsidies can improve the financial viability of the utilities, freeing up resources for further investment in lower-cost generation and electrification for the poor.

- ***Increased capacity***—Technical assistance from multilateral institutions and international agencies should target local institutions and communities to enhance their capacity for service delivery, quality monitoring, financing, and operations and maintenance. Capacity-building programs supported by governments, global counterparts, and South-South cooperation should aim to develop expertise on new technologies and applications, in particular those based on renewable energy sources, as well as to support local market development for the production and commercialization of innovative, clean, and affordable lighting and cooking applications and alternative cooking fuels.

- ***Improved utility performance***—Large-scale and sustained electrification can be deployed only by well-functioning utilities. Renewed government efforts to reform utilities should favor governance over technical fixes and should first seek to improve corporate governance, oversight, and transparency. Efforts should also focus on reducing technical and commercial losses and on improving revenue collection rates, which requires advancements both in terms of the technologies used (for instance, smart metering, load management) and in relevant business practices (for instance, prepaid metering, making bills available on cell phones, and outsourcing of services).

5.2 Scaling up Regional Power Generation and Transmission Capacity

The World Bank supports the development of the next generation of large-scale, transformational regional generation projects. These involve blending public and private capital; diversifying the energy mix to include hydropower (e.g. Inga/DRC), natural gas (Mozambique, Nigeria), geothermal (Rift Valley), wind and solar power, and clean coal; and implementing other new technologies.

The World Bank also focuses on investments in large-scale, high-impact projects and partial risk guarantees (PRGs), as well as granting increased attention to fragile states through continuous policy dialogue in an effort to create institutions and frameworks that are better equipped to attract the private sector.

Transformational projects are those that imply major positive improvements to some binding constraint and are ultimately capable of effecting a fundamental change in a country. Generally, these projects: (i) significantly influence supply prices, (ii) reap large economies of scale or other efficiencies by acting collectively in the pursuit of common objectives to increase regional or subregional supply capacity and improve market access, and (iii) affect a large number of people.

Equally important is the adoption of an expanded regional agenda to develop regional markets and interconnections—power pool institutions and infrastructures—since large-scale generation resources are not always located in proximity to markets. Once produced, electricity can flow across countries, but only if the needed cross-border transmission infrastructure is in place. Furthermore, harmonizing regulations and system operating agreements to facilitate trade is also required. The World Bank supports the rehabilitation and expansion of cross-border transmission hardware while fostering the development of the necessary software and capacity for aligning regulations and operating systems. Harmonizing environmental and social protection frameworks would also help to streamline the development of and interconnections among these regional markets.

By promoting joint actions in tackling common challenges, regional transformational projects have the potential to generate large-scale benefits when it comes to improving access to electricity services beyond borders. The increased effort to develop and implement such transformational projects at the regional level reflects the recognition that the energy infrastructure deficit is a basic impediment to development and that regional solutions are needed, given the large financing requirements necessary. These sorts of transformational projects are characterized by highly complex designs (including challenging safeguard requirements), they require significant financing, and they often take place in difficult and risky environments. Despite these challenges, such projects can have very large potential spill-over benefits at the subregional and regional levels.

A number of initiatives are currently under way to help focus global attention on the issue and to move potential regional transformational projects forward from identification to full-scale development. At the global level, the G20 meeting in Mexico 2012 focused on transformational projects and produced a list of priority projects for support in Africa. The G20 effort has been bolstered by the Multilateral Development Bank (MDB) Working Group on Infrastructure, which has stressed the need to unlock transformational projects' potential with technical assistance and targeted financial support.[4]

4 Infrastructure Action Plan: Submission to the G20 by the MDB Working Group on Infrastructure, October 2011.

5.2.1
Energy resource development

Africa has massive low-cost and clean energy resources. It has vast renewable hydropower capacity in the "water towers of Africa," which can produce large-scale power at about one-third of the cost of thermal generation. Clean gas to power can be produced along the coast of East Africa as well as in some West African countries. The geothermal capacity of the Rift Valley can also be tapped for large scale clean energy generation.

Africa's energy resources remain largely unexploited. Estimates indicate that 93 percent of Africa's economically feasible hydropower potential remains unused. Much of this potential is located in a handful of countries (see Figure 5) that are geographically removed from the center of power demand (economic centers in Southern, Western, and Northern Africa) (Eberhard et al. 2008). The countries' economies are small relative to the multibillion dollar investments that would be needed to develop this hydropower potential. Regional cooperation leading to the full development of power pools and power trade is therefore critical to achieving the scale required to produce hydropower efficiently and extend its benefits to the wider African population.

A review of planned Sub-Saharan hydro projects suggests that considerable hydropower potential of 30GW can be developed within the next decade, in various countries strategically located across Africa (Cameroon, the Democratic Republic of Congo, Ethiopia, Ghana, Guinea, Mozambique, Sudan, Uganda, , and Zambia,). In total, these countries have collectively developed less than 10GW of hydropower over the last decade. But the necessary substantial scale-up requires considering several factors, including high capital costs, long lead times, the lack of hydrological data and analysis, the complexity of water allocation across users and jurisdictions, and environmental and social concerns. Capacity building should be deployed at the country level to strengthen energy sector planning and water management, and at the regional level to build long-term river-basin management and support regional planning and coordination to foster regional power markets. Furthermore, while large hydropower projects can expand generation capacity at a lower unit cost, initial capital costs and environmental and social impact assessment costs can be prohibitive. In particular, project preparation costs for large hydro projects can exceed US$100 million, as illustrated by the experience of Nam Then II in the Lao People's Democratic Republic. More resources must be made available through a combination of private sector participation and donor funding, which requires stakeholder coordination.

Given the scale of these investments there is a need to carefully assess and address the social and environmental impacts of large-scale hydro power projects (see Box 6). Dams influence river patterns and hydropower projects need to consider the cumulative impacts in the river basin. This can include establishing a river basin entity to manage the allocation of scarce water resources among different economic uses while ensuring environmental flows. Depending on the project site, these adverse impacts can include the involuntary displacement of people from their homes and

sources of livelihood, the loss of natural habitats and wildlife, the blockage of fish migrations and other harm to aquatic life, water quality deterioration, downriver changes in water and sediment flows, water-related diseases, floating aquatic weed proliferation, and the loss of physical and cultural resources. Aside from the dams themselves, new access roads (particularly through remote forested areas) and power lines can also pose environmental and social challenges. In many cases, World Bank support goes beyond compliance with social and environmental safeguards to support local development activities close to the dam site. Increasingly, consideration is also being given to seeking environmental offsets.

Figure 5. Africa's Hydropower Potential

Source: Foster and Briceño-Garmendia.

Box 6. Site Selection and Environmental and Social Safeguards for Hydropower Projects

Large hydropower infrastructure can have significant environmental and social implications. On the environmental side, the impoundment of large areas of land can lead to the loss of

significant natural resources and biodiversity. On the social side, the most direct impact from hydropower projects is often the involuntary resettlement of great numbers of people. In some cases, cultural resource assets are affected or threatened as well.

A key consideration in hydropower planning is that different project sites vary tremendously in their potential for environmental or social impacts, both in absolute terms and relative to power-generation capacity. Thus, the most important mitigation measure for a new hydropower project is to choose the most environmentally and socially favorable site. For example, one proposed hydroelectric dam in eastern Africa, with only 8MW of generation capacity, would eliminate biologically unique river rapids, likely resulting in the global extinction of up to five species of fish and the endangerment of other aquatic life; meanwhile, a much larger proposed project in a neighboring country with a generation capacity of roughly 4,000MW would, based on its location and design, cause no major population declines in any known species (aquatic or terrestrial).

A variety of quantitative indicators can be used to asses and rank potential new project sites from an environmental and social standpoint. In general, hydropower or multi-purpose dam projects are environmentally more benign if they:

- Inundate a relatively small area (with a favorable hectare-per-MW ratio)
- Displace relatively few people
- Avoid damaging protected areas or other critical habitats
- Inundate relatively short stretches of river upstream
- De-water relatively short stretches of river downstream
- Avoid blocking river segments with important fish migrations
- Have a short mean water retention time (for better water quality)
- Avoid inundating important cultural resources

Since good site selection is so important in minimizing adverse environmental and social impacts, it is important to be selective when considering new hydropower projects. In most African countries, the presentation of multiple potential project sites enables planners to consider carefully the environmental, social and economic costs and benefits of each. This is normally achieved by combining planning studies on river basins that consider natural resources with least-cost development electricity plans.

Once a site is selected, best practice calls for identifying and addressing the issues as early as possible and initiating meaningful consultations with relevant stakeholders, in particular with the populations expected to be affected. The environmental and social assessment process provides an efficient way to identify potential impacts and relevant mitigating measures. The challenge, then, is one of implementation capacity and commitment.

Source: World Bank.

Box 7. Lom Pangar Hydropower Project, Cameroon

The Lom Pangar Hydropower Project (LPHP) is a priority project in the Government of Cameroon's development strategy to improve access to reliable low-cost hydropower supply for economic growth and poverty reduction. The LPHP consists of a regulating dam, a hydroelectric power plant at the foot of the dam, a transmission line between the power plant and the Eastern Network, a rural electrification scheme along this transmission line, environmental and social measures, and technical assistance and support for project management.

In March 2012, the World Bank approved US$132 million in zero-interest financing for the LPHP. The World Bank loan will finance the project, together with funds from the African Development Bank (AfDB), the Central Africa States Development Bank (BDEAC), the European Investment Bank (EIB), the French Agency for Development (AFD), and the Government of Cameroon. The estimated cost of the project totals US$494 million.

The immediate benefit for the population of Cameroon will be a 120MW increase in electricity generation at two existing hydropower plants, which will improve the reliability of power supply for up to 5 million Cameroonians and help to lower the cost of power. In the medium term, the LPHP opens the possibility of incrementally constructing a cascade of downstream hydropower plants on the Sanaga River.

*Sour*ce: World Bank, various.

Natural gas is an affordable, large-scale energy resource and is already playing a critical role in the primary energy portfolios of many African countries. Moving from oil and coal toward gas is a major step forward in reducing CO_2 emissions. Tremendous undeveloped resources have been found along the east coast (in Mozambique, 120 billion cubic meters (bcm); in Tanzania, 6 bcm) as well as in some West African countries in (Nigeria and Côte d'Ivoire, for example). There is the potential to generate an estimated 4GW of gas to power over the next five to seven years.

Figure 6. Opportunities for Gas to Power

Source: World Bank.

Geothermal energy is well-suited to providing base-load power and is ideal for rural and off-grid applications, given its reliability and low unit costs when compared to other renewable technologies. Geothermal is a reliable green source of energy. The East African Rift System (EARS) has abundant geothermal potential, able to generate over 15GW with today's technologies. The exploration and development of geothermal resources has been carried out to varying degrees by EARS countries; Kenya is at the forefront of such prospecting and has a current capacity of 198MW (see Box 8).

Figure 7. African Rift Valley Geothermal Potential

Source: World Bank.

One main limiting factor in developing geothermal resources remains the high upfront cost of exploration and drilling activities, which are needed to confirm resource availability and solicit the interest of the private sector to build and operate power plants. The inadequate technical capacity and lack of geothermal resource data are other issues that affect the development of geothermal plants.

Box 8. Geothermal Energy Development in Kenya

Kenya has an estimated geothermal potential of 7–10GW spread over 14 prospective sites. Geothermal development is paramount to Kenya's energy diversification strategy. Despite its advantages, the development of geothermal has been slow. The current installed geothermal capacity concentrated in the Olkaria Blocks is 198MW, of which 48MW is privately operated. The Government has introduced policies and measures to expedite and scale up geothermal development, including opening up the field to private sector participation, establishing the Geothermal Development Company (GDC), and setting a feed-in tariff policy. Two additional independent power producers (IPPs) have been licensed to develop Suswa and Longonot geothermal prospects, while an additional 280MW is under development in the Olkaria Block and is scheduled for commissioning in 2013. Another company is undertaking drilling operations in the Menengai Field, which has an overall potential of 1,600MW, for

initial development of 400MW. Activities are additionally under way to develop 800MW in the Bogoria-Silali Block. This is geared toward meeting the Vision 2030 medium-term target of 1,600MW by 2016 and 5,000MW by 2030.

Source: World Bank, operational teams.

As the mining sector continues to grow in the region, mining companies can inspire confidence as credible off-takers for developing energy resources. Box 9 provides an overview of how mining initiatives might improve power sector infrastructure. Differing models of power sourcing for mining have developed in Africa—from mining companies developing their own enclave infrastructure, to sourcing electricity from the national grid, to acting as net contributors to the grid. These various experiences have significant implications in power sector planning when it comes to determining the priority of investments. The natural complementarity provides an opportunity for large-cost savings as well as significant welfare gains if power investments are coordinated among different mines as well as between mines and the national power system.

Box 9. Mining and Improving Power Sector Infrastructure

It is estimated that SSA hosts about 30 percent of the planet's mineral reserves, including 40 percent of gold, 60 percent of cobalt and 90 percent of the world's platinum group metal reserves. Mining sector development has been an important contributor to the economic growth agenda of mineral-rich countries in Africa. Between 2001 and 2010, these countries grew by nearly six percent on average—among the fastest growth rates of any group of countries in the world. Moreover, the Human Development Indexes of these countries grew by 1.81 percent annually in the 2000s, compared to 1.2 percent for non-extractive SSA countries. Investment in mining in the top 12 SSA destinations was about US$40 billion in the same period, a figure that is expected to double from 2011–15.

Power is one of the most critical inputs to mining. The nature of power demand differs hugely by mineral type, from those that are highly energy-intensive in relation to value (iron,[5] aluminum) to those that are moderately energy-intensive (copper), from types with a relatively low energy intensity (gold) to those that are net energy producing (coal). The demand from mining companies is therefore a sizeable component of net demand for power in mineral-rich economies. Substantial increases in energy demand by the mining sector in SSA are projected over the next 10 years, particularly if there is to be a greater amount of downstream processing of minerals in the region. Starting from an already high base, energy demand could increase by 73 percent in 2015 and by 141 percent in 2020, with substantial implications for the national power scenario. For instance, mining demand could constitute about 80 percent of the total power demand in 2030 for Liberia.

5 Iron is only a high-intensity mineral if turned into steel. If processed into pig iron or a similar product, it is of moderate or medium energy intensity.

The power needs of the mining sector are substantially higher than Africa's power sector can currently support. High fuel prices are a major concern in Africa, where unreliable sources of power make it necessary for many mines to run on diesel, which can substantially increase the cost of processing the minerals and consequently reduce taxable profits. Further, the geological potential of minerals in Africa is underexplored, partly due to a lack of dependable and cost-effective energy, as well as other supporting infrastructure.

Therefore, a continuum of institutional models of power sourcing for mining has materialized in Africa. A common tendency in resource-rich countries is for mines to develop their own enclave infrastructure in isolation from the rest of the economy, as well as from other mines. This tendency is explained by a number of factors. First, there may be significant uncertainties in the timing of concession development that complicate coordination (as in the case of mining exploration). Second, resource-rich countries often lack reliable public power supply in sufficient quantity. Third, mining plans may be time-sensitive, whereas cooperative solutions may take longer to develop.

However, models have emerged in which national power systems play a role. In Zambia, for instance, the national grid supplies all power for mining purposes. Mines have sourced power from the national grid if they are located close enough to emerge as anchor customers that would allow the country to benefit from large-scale hydropower and other types of projects. In addition, many mining companies with deep pockets are making substantial investments in power infrastructure elsewhere on the continent. This involvement is being discussed in relation to a wide gamut of technologies, ranging from mid-sized thermal to large hydro. In this way, mines could potentially become net contributors to the grid if infrastructure development plans are appropriately coordinated. In addition to the two extremes, various hybrid models are emerging, including the use of mining companies either as anchor customers for major third-party investments (Ghana from 1960-2000 and potentially the Democratic Republic of Congo), or as central investors with off-take obligations to the public utility (Cameroon).

Source: World Bank.

5.2.2
Regional integration

Regional power planning and trade can address key energy challenges in Africa, including the continent's chronic struggle for adequate generation capacity and affordable production. Full development of regional power trade will allow Africa to efficiently tap its enormous energy potential by realizing economies of scale in a context where resources tend to be concentrated and most countries have energy systems that are simply too small to achieve adequate scale individually. Secondly, interconnecting countries will help to lower the cost of generation, as countries that now depend on expensive thermal generation could move to cheaper large-scale generation resources,

such as hydropower. Thirdly, power systems will become more reliable and seasonal power shortages will be reduced, as each consumer will be served by more than one power source. Further, trade will put Africa on a less carbon-intensive path by allowing the diversification of the energy portfolio at the power pool level by incorporating greener energy into the mix.

Energy resources can be pooled and economies of scale can be leveraged through regional trade arrangements. Under such arrangements, regional power demand is met by the most cost-effective energy resources available to the region as a whole, and additional cross-border transmission capacity is added wherever required to allow power to flow from production to consumption locations. This arrangement stands in contrast to a situation without trade, where incremental power demand is met solely through the expansion of the domestic power sector with no increase in additional cross-border interconnectors. Power trade can be especially attractive to countries that are forced to rely on expensive imported fuels to develop their domestic power sectors and meet their growing demand.

Box 10. Africa's Regional Power Pools

Regional power trade and the infrastructure needed to facilitate it are best understood in the context of power pools, which span economic communities in Africa. The four main power pools are:

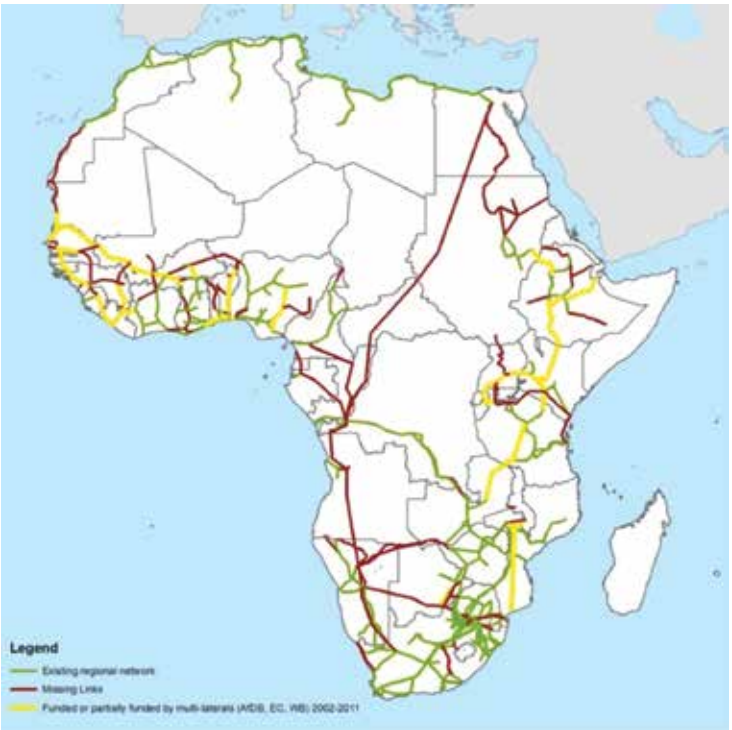
- The West African Power Pool (WAPP), comprising Benin, Burkina Faso, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo. It is the main power pool for ECOWAS. This power pool can help transport hydropower from Guinea and gas-generated power from various countries to others without energy resources.
- The Central African Power Pool (CAPP), comprising Cameroon, the Central African Republic, the Republic of Congo, Equatorial Guinea, and Gabon. It is the main power pool for the CEMAC region and is still in its early stages of development.
- The Eastern Africa Power Pool/Nile Basin initiative (EAPP/NBI), comprising Burundi, Djibouti, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda. Owing to the central role of the Nile Basin in determining hydropower potential for the region, it is difficult to think about East Africa's long-term energy prospects without including Egypt, Ethiopia, and Sudan.
- The Southern African Power Pool (SAPP), comprising Angola, Botswana, the Democratic Republic of Congo, Lesotho, Malawi, Mozambique, Namibia, South Africa, Zambia, and Zimbabwe. It is the main power pool for the Southern African Development Community (SADC).

Source: World Bank, operational teams.

Expanding trade depends critically on massive investment in hydropower in a few countries—Cameroon, the Democratic Republic of Congo, Ethiopia, Guinea and Sudan. Such projects alone could amount to nearly 75 percent of Sub-Saharan power trade.

Developing power trade will also require significant investments to expand cross-border transmission capacity. Figure 8 portrays a vision of power interconnection across the continent. As is evident, a significant number of links are missing. Around 116,000 kilometers of links currently exist, while over 32,000 kilometers remain missing.

Figure 8. Existing and Missing Power Trade Links in Africa



Source: Derived from Foster and Briceño-Garmendia, 2010.

Deepening regional power trade would bring substantial economic benefit by reducing the long-run marginal costs of power, compared to a situation without trade. Given that power is a key production input to the economy, any reduction in the reference level of power costs spurs productivity and competitiveness. In CAPP as a whole, trade expansion would reduce the long-run marginal costs by US$0.02 per kWh, or 20 percent; EAPP, the smallest pool, would see reductions of less than US$0.01; SAPP would benefit from a decrease of US$0.02, or 5 percent; and WAPP would see a 5 percent reduction in its long-run marginal costs, from US$0.19 to US$0.18 per kWh.

Regional trade has the potential to offer great savings to importers who are heavily reliant on thermal power production. It is estimated that these savings could amount to over US$1 billion per year at the regional level. The regional trade in power can also boost regional economic cooperation and can represent a large source of revenue for resource-rich countries (for instance, by 2020 power exports could raise over US$700 million for Ethiopia—nearly 2 percent of the country's GDP). This will reduce production costs for utilities and can help to reestablish the financial equilibrium of the power sector without raising tariffs multifold. The wholesale export price of power (under a bilateral power purchase agreement) is usually lower than average domestic tariffs in power importing countries and is also lower than the cost of power generation domestically. For example, the current Ethiopia–Kenya export tariff (around US$0.07/kWh) will lead to over 40 percent cost savings for Kenya (where the marginal cost of domestic production is over US$0.13–0.14/kWh). Power trade can reduce vulnerability to seasonal rainfall patterns and climate shocks (droughts, for example) through imports from surplus countries. However, the political economy considerations should also include risks to domestic energy security that can be affected by bilateral relations.

But a host of technical, financial, and political challenges make this a difficult prospect. Vastly expanding existing generation capacity presents a huge technical and financial challenge. Guinea, for example, would need to invest around US$786 million annually over the course of a decade—equivalent to almost one quarter of its GDP—in order to realize its planned hydropower generation potential. Likewise, the DRC would need to make an annual investment of US$892 million for hydropower expansion over ten years, equivalent to almost 15 percent of its GDP. Such levels of investment would not be financially tenable for either nation without massive capital contributions from those neighboring countries that would ultimately import power or without credible guarantees for the payment of future off-take of power that could serve as a basis on which to raise private capital. Unfortunately, the risk associated with future payment by ill-performing, non-creditworthy utilities is a major red flag in the eyes of private investors. Moreover, several of the countries with hydropower potential have suffered from political instability and weak governance, which lessens their appeal as destinations for investments of this magnitude. Further, policy makers in power importing countries might be concerned about the heavy reliance on power imports for their supply of electricity.

5.2.3
Priority projects for transformative impact

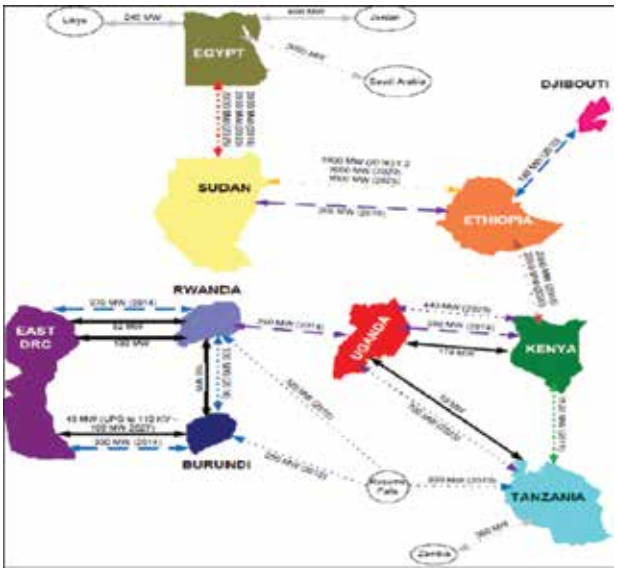
There is a strong need to scale up the transformative impact by engaging in large-scale opportunities along the energy value chain, particularly in low-carbon, low-cost generation and regional integration. The resources required to keep pace with the needs of the sector are well beyond the capacity of any one institution. Scaling up concessional finance is obviously critical, but equally important are partnerships and leverage, in order to achieve scale. Selectively identifying

countries and projects with the greatest transformative potential is also critical for maximum impact. Some of these projects, categorized by region, are discussed in Box 11.

Box 11. Priority Projects

Eastern Africa Power Pool

Roadmap of development of the EAPP and priority interconnections:



Priority Interconnections		
Connection	**Capacity (MW)**	**Year**
Tanzania-Kenya	1,520	2015
Ethiopia-Kenya	2,000	2016
Ethiopia-Sudan	2x1,600	2016
Egypt-Sudan	2,000	2016
Tanzania-Uganda	700	2023
Uganda-Kenya	440	2023
Ethiopia-Kenya	2,000	2020
Ethiopia-Sudan	1,600	2020
Egypt-Sudan	2,000	2020
Ethiopia-Sudan	1,600	2025
Egypt-Sudan	2,000	2025

Source: EAPP Master Plan, 2011.

Anticipated sources of generation (countries) and priority generation projects:

	Current Generation Capacity (MW, 2010, MW)	Potential Generation Capacity (2030, MW)	Potential Demand (2030)	Surplus (2030)
Ethiopia	2,179	15,796	8,464	7,332
Sudan	3,951	15,261	11,054	4,207
Egypt	25,879	72,449	69,909	2,540
Tanzania	1,205	6,086	3,770	2,316

Country	Project	Fuel	Capacity (MW)
Eastern DRC	Ruizizi III	Hydro	145
Eastern DRC	Ruizizi IV	Hydro	287
Ethiopia	Gibe III	Hydro	1,870
Ethiopia	Gibe IV	Hydro	1,468

	Current Generation Capacity (MW, 2010, MW)	Potential Generation Capacity (2030, MW)	Potential Demand (2030)	Surplus (2030)
Uganda	822	3,353	1,898	1,455
East DRC	74	1,191	179	1,012
Kenya	1,916	8,805	7,795	1,010
Djibouti	123	310	198	112
Burundi	49	470	385	85
Rwanda	103	514	484	30

Country	Project	Fuel	Capacity (MW)
Ethiopia	Karadobi	Hydro	1,600
Ethiopia	Grand Renaissance	Hydro	5,250
Kenya	Menengai	Geothermal	400
Rwanda	Kivu I	Methane	100
Rwanda	Kivu II	Methane	200
Tanzania	Stieglers Gorge (I,II,III)	Hydro	1200
Uganda	Karuma	Hydro	600
Uganda	Ayago	Hydro	600
Uganda	Isimba	Hydro	600

Southern African Power Pool

Roadmap of development of SAPP and priority interconnections:

Project
Zambia-Tanzania-Kenya
Mozambique-Malawi
Mozambique Regional Transmission Backbone
ZIZABONA (Zimbabwe-Zambia-Botswana-Namibia)
WESTCOR (DRC-Angola-Namibia-Botswana-South Africa)
Namibia-Angola
Inga-Zambia
Zambia Backbone (Kafue-Muzuma-Victoria-Falls)
Central Transmission Corridor (Zimbabwe Backbone)

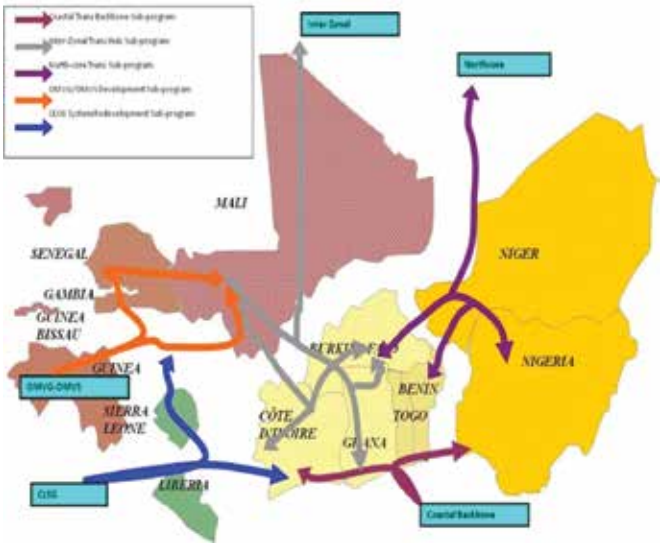
Anticipated sources of generation (countries) and priority generation projects:

	Available Generation Capacity (MW, 2010)	Overall Demand (MW,2010)	Surplus/ Deficit (including 10% reserve requirements)
South Africa	41,074	36,705	699
Mozambique	2,249	560	1,633
DRC	1,330	1,081	141
Angola	1,202	1,100	-8
Tanzania	880	833	-36
Malawi	300	300	-30
Lesotho	72	121	-61
Swaziland	41,7	204	-183
Namibia	360	564	-260
Botswana	190	553	-418
Zambia	1,500	1,750	-425
Zimbabwe	1,320	2,100	-990

Country	Project	Fuel	Capacity (MW)
DRC	Inga 3	Hydro	3000-5000
Botswana	Morupule B	Coal	600
Mozambique	Mphanda Nkuwa	Hydro	1,500
Mozambique	Moatize	Coal	2400 (600-1st stage)
Mozambique	Benga	Coal	2000 (500-1st stage)
Mozambique	Cahorra Bassa-North Bank	Hydro	1,245
Namibia	Kudu	Gas	800
Namibia-Angola	Baynes	Hydro	460
Zambia	Lowe Kafue Gorge	Hydro	600-750
Zambia-Zimbabwe	Batoka Gorge	Hydro	1,600
Tanzania	Ruhudji	Hydro	358

West African Power Pool

Roadmap of development of WAPP and priority interconnections:



Project
Kayes (Mali)-Tambacounda (Senegal)
Bolgatanga (Ghana)- Bobo Diolasso (Burkina Faso)- Bamako (Mali)
Senegal-Gambia- Guinea Bissau-Guinea
Cote d'Ivoire-Liberia-Sierra Leone-Guinea (CLSG)
Segou (Mali)- Ferkessedougou (Cote d'Ivoire)
Reinforcement Ferkessedougou-Laboa
(Ghana)-Lome (Togo)-Sakate (Bénin)
Aboadze (Ghana)- Ouagadougou (Burkina Faso)
Niamey (Niger)-Birnin Kebbi (Nigeria)- Malanville (Bénin)-Ouagadougou (Burkina Faso)-North Core

Central African Power Pool priority interconnections:

Project
Cameroon-Chad Interconnector
Inga-Calabar Interconnector (DRC-Nigeria)
Inga-Cabinda-Pointe Noire Interconnector (DRC-Angola-Congo)

Anticipated sources of generation (countries) and priority generation projects:

	Installed Generation Capacity (MW)	Overall Country Demand (MW)
Cote d'Ivoire	1,202	1,096
Ghana	2,412	1,900
Guinea	242,24	190
Nigeria	8,919	10,000
DRC	2,437	1,300
Cameroon	1,115	722
Benin	119	255
Burkina Faso	306	205
Gambia	62	70
Guinea Bissau	26	34
Liberia	197	51
Mali	304	240
Niger	134	171
Senegal	638	532
Sierra Leone	90	>400 (incl. mining sector)
Togo	208	235
Mauritiana	263	47

Country	Project	Fuel	Capacity (MW)
Mali	Gouina	Hydro	140
Mali	Badoumbé	Hydro	70
Guinea	Kaleta	Hydro	240
Senegal	Sambangalou	Hydro	128
Guinea	Souapiti	Hydro	515
Guinea	Grand Kinkon	Hydro	291
Liberia	Mount Coffe	Hydro	66
Guinea	Fomi	Hydro	90
Cote d'Ivoire	Soubre	Hydro	270
Togo/Benin	Adjarala	Hydro	147
Niger	Kandadji	Hydro	125
DRC	Inga-3	Hydro	3000-5000
Guinea	Koukoutamba	Hydro	280
Guinea	Bouteya	Hydro	160
Senegal	Liberty	LNG	300
++			

Source: World Bank.

The Eastern Africa Electricity Highway (Ethiopia-Kenya interconnector) provides a good example of an ongoing major transformative project. The Eastern Africa Electricity Highway is the backbone of the EAPP. A US$900 million credit was approved under APL1 (Regional) by the Bank Board in FY12. The upcoming 1,000-kilometer, 500 kV DC line between Ethiopia and Kenya would enable 400MW of bilateral trade initially, which can increase to over 1,000MW in the future. The project promotes regional trade and commerce, increases regional energy security, and boosts bilateral cooperation. The electricity tariffs in Kenya are expected to decrease by over 20 percent (from US$0.17 per kWh to US$0.14 per kWh) due to lower cost hydropower exports from Ethiopia. Furthermore, the project assists in reducing the overall carbon intensity of the grid. The Lom Pangar Hydropower Project also provides a good example of this (see Box 7).

Two examples of upcoming transformative projects are:

- **Mozambique Regional Transmission Backbone Project (STE)** will assist in the transfer of over 3,000 MW of power between the north and south of the country. The project contributes to Mozambique's economic and social development by facilitating improved access to electricity through the creation of a Backbone Transmission System to supply electricity at affordable prices to load centers and consumers along the transmission system corridor. It will also facilitate the realization of Mozambique's large power development potential, with particular focus on hydropower and gas to power, for both domestic and industrial use as well as bulk export of cost-competitive renewable energy to South Africa and Southern Africa.

- **Inga III Project in the DRC** could produce 4,500MW of electricity and serve as the centerpiece of the Westcor partnership, which envisions the interconnection of the electric grids of Angola, Botswana, the DRC, Namibia, and South Africa. In a country and region rich in hydroelectric sources but with limited exploitation, Inga III could significantly increase the availability of power to scale up access in the region. Furthermore, industrial productivity can increase, adding to the region's overall economic development.

5.3
Improving Sector Planning and Utility Performance

"Power sector reform" is the overarching umbrella under which electricity sectors are restructured to improve outcomes. Improved planning places an emphasis on regional integration as a means to harness diversified endowments and ensure that benefits are shared by all. Integrated planning entails providing supply- and demand- side opportunities on a level playing field to make energy more reliable and affordable. The World Bank supports regulation reforms aimed at increasing cost recovery, rationalizing subsidies, and strengthening the financial viability of incumbent utilities.

Poor policies and regulatory constraints cause poor electricity access and service for low-income households. As Besant-Jones (2006) describes, "policies that grant a legal monopoly to a power utility in low-income service areas may impede the flow of private finance to the power sector and discourage innovation in service delivery methods. Regulatory frameworks often raise the biggest barriers to decentralized options for electricity supply, including barriers to alternative power technologies for locations not served by electricity and fuel distribution networks. Poorly formulated taxes and subsidies often undermine electricity service markets by favoring one fuel over another, giving consumers distorted price signals and creating disincentives for entrepreneurial solutions to electricity supply. Finally, power market reforms designed and implemented by technical groups at the national level that allow users little say in the design and delivery of electricity services can end up hurting—rather than benefiting—the poor."

At the utility level, the World Bank deploys technical assistance and capacity building to improve governance and foster oversight and transparency. Supply-side efficiency improvement programs target technical and commercial losses and foster revenue collection. The World Bank works with client countries to assess the benefits and readiness of smart grid technologies and to provide technical assistance in areas of mutual interest. South-South cooperation is being enhanced. Box 12 describes power sector reform and its various elements, and Box 13 provides an example of successful power sector reform in Kenya.

Box 12. Power Sector Reform

Since the early 1990s, roughly 70 of the world's 150 developing countries and transition economies have implemented reforms to their power markets. The drivers of this reform movement are disenchantment with the poor performance of state-owned power utilities, the need for new investments and modernization to meet rapid growth in demand, and fiscal pressure, along with the desire to protect and help the poor. The reforms have generally been tentative and incomplete, however, particularly in relation to market structure, the degree of private sector participation, and the development of a sound regulatory framework.

Power market reform in developing countries should be assessed with respect to the three outcomes that reflect the drivers of reform. These outcomes are: better service quality for electricity consumers to support economic growth and welfare, improvement in government's fiscal position, and more affordable access to electricity for the poor. The main elements of the reform—restructuring power utilities and markets, regulation, competition, and the role of public and private participants—are the means for achieving these outcomes.

Sequencing power market reform should follow a sound strategy:

- The legal and regulatory framework necessary for creating the new market structure and trading arrangements is put in place before privatizing power supply entities and setting up new market trading arrangements.
- Restructuring of power markets progresses from an integrated structure to partially unbundled structures and, eventually for some countries, to a fully unbundled structure.
- Restructuring of wholesale power trading arrangements progresses from only internal transactions within an integrated power utility, to the entry of IPPs selling their output to a single buyer, then to opening access to power networks by large users of power, and eventually to bilateral trading between generators and distributors or to a central power pool under competitive trading.
- Major organizational and financial restructuring precede the creation of private ownership rights to avoid problems with stranded costs.

Some countries have skipped the early stages of these sequences, and others may do so in the future. A sequenced process, however, is less risky and more sustainable than a single-staged

("big bang") process for reforming power markets in the conditions of developing countries. Reform sequencing should not, however, follow an overly cautious approach that runs the risk of delaying reform benefits and losing political momentum.

Power sector reform should be viewed as an opportunity to help the poor. Extending access to affordable modern energy services—including electricity services—for poor households is one of the most practicable ways of improving their welfare.

Reform provides an opportunity to rectify the policy and regulatory constraints on electricity access and service for low-income households. Reform can overcome entrenched attitudes to providing electricity services and introduce different kinds of electricity services better suited to the poor. Opening up the main power market to new entrants can stimulate incentives specifically designed to attract new entrants into markets serving poor areas. The establishment of a new regulatory system for the main power market provides an opportunity to introduce regulations that help the poor. Reforms that place the power market on a sound commercial footing, however, will not automatically improve access and affordability of electricity services to low-income households. They may make little difference to this situation, or even worsen it. It is important to ensure that reform does not adversely impact access and affordability.

Source: Reproduced and adapted from Besant-Jones, 2006.

Box 13. Kenya's Power Sector Reform

Kenya provides a recent example of successful energy sector reforms. The reforms, which culminated in the 2004 Energy Policy, the 2006 Energy Act, and the 2010 Least-Cost Power Development Plan, completely transformed the structure and design of Kenya's power sector into a more transparent, efficient, and investor-friendly environment. The Government of Kenya, with the World Bank's assistance, began the reform process by separating Kenya's government-owned and operated energy utility—Kenya Power and Lighting Company (KPLC)—into two separate companies: the Kenya Electricity Generating Company Ltd, or "KenGen," responsible for electricity generation; and KPLC, responsible for the transmission and distribution assets. Separating the company along functional lines with separate revenue streams and accountabilities paved the way for a much more efficient and transparent sector. Although the Government retains majority ownership, both companies are currently traded on the Nairobi Stock Exchange.

In addition to the partial privatization and disaggregation of the energy sector, the Government of Kenya also established the Electricity Regulatory Board (ERB), which was to oversee the electricity markets, electricity tariffs, and rules governing the participation of private operators. The ERB has set up tariff structures that foster sector sustainability, by ensuring that changes in the market rate of electricity are passed to end consumers, via KPLC, on a regular basis. The tariff structure adjusts rates according to market conditions, reducing the amount of government

subsidies needed. A regularly adjusted tariff structure reduces market risk to suppliers and gives investors confidence to finance energy projects.

The reforms in Kenya resulted in an upswing in private sector investment. KenGen has now partnered with four IPPs to finance, build, and manage electricity generators. Additionally, the Government has recently partnered with the World Bank to raise US$623 million in investments for Kenya's energy sector, more than half of which has come from the private sector and commercial lending.

Although electricity connection rates remain quite low in Kenya (16.1 percent in 2009), connection rates have increased substantially since the reforms were put in place. Between June 2006 and October 2007, KPLC added nearly 170,000 new electricity customers, representing a 20 percent increase in connection rates. This exceptional growth is even more impressive considering that no more than 50,000 customers were added in each year prior to 2005. These reforms, and the private sector investments they have encouraged, are creating real benefits for the people of Kenya.

Source: Parshall 2009.

5.4 Demand-side Management and Energy-Efficiency Programs

It is important to scale up demand-side interventions that best fit the country-specific context so as to maximize efficiency gains. Demand-side interventions will encompass improving end-use energy efficiency and promoting more efficient utilization of the power system capacity through demand-side management techniques. Significant successes have already been achieved in programs investing in fluorescent light bulbs in about 10 countries, including Ethiopia, Malawi, Rwanda, Uganda, and South Africa. Notable cost savings have been observed, in particular during power crises, when most countries rely on expensive emergency generation.

The World Bank attempts to scale up efforts by incorporating energy-efficient appliances as part of the customer "connection package," thereby reducing expenditures on electricity for poor customers. The support also includes other demand-side management options, such as solar water heaters and more efficient electric cook stoves, and facilitates the establishment of time-of-use tariffs, load control, smart metering, and so on. The World Bank continues to partner with its client countries to reduce power shortages and, when necessary, put the processes in place to reduce consumption via demand-side participation, such as the market-based rationing program in South Africa in 2008, when the World Bank provided timely technical support.

5.5
Sustainable Biomass Supply and Use

Traditional fuels will remain a vital livelihood resource through much of SSA. Accordingly, the World Bank works in an integrated fashion across affected sectors to improve the sustainability of wood fuel supply and use. The Africa Clean Cooking Energy Solutions (ACCES) facilitates enterprise-based scale up of clean cooking and builds on both demand- and supply-side approaches. ACCES focuses on household energy, especially for cooking needs, and in particular for the poor. On the demand side, interventions are two-fold. The first approach reduces firewood and charcoal demand by stimulating the deployment of efficient cook stoves. A successful program has taken place in Ethiopia, where 2.2 million open-fire stoves have been replaced to date by fuel-efficient ones. The second approach examines the possibility of inter-fuel substitution whenever it makes technical and economic sense**.** Supply-side programs will support community-based approaches and revisit forest management systems and wood fuel production, emphasizing in particular multipurpose tree use and management. The World Bank will continue to work with client countries to improve the efficiency of charcoal production, including potential co-generation in larger sites.

Transmission lines, Ghana. Photo: © Arne Hoel / World Bank

6 Moving Forward and Focusing on Scale-up

There is an urgent need to do more for the development of the energy sector and do it faster. This calls for rethinking the manner of the Bank's engagement. Scaling up concessional finance is obviously critical, especially for projects that are not commercially viable. But although it is increasing, development financing will remain small relative to Africa's vast needs. The resources and skills required to close the demand-supply gap are well beyond the capacity of any one institution; partnerships and leverage are critical to achieve scale. Selectively identifying countries and projects with the greatest transformative potential (as discussed in Section 5.2.3) is also critical for maximum impact.

The World Bank will continue working with partners to facilitate a collective focus on key large-scale transformative projects for substantial scale up of generation capacity and access. This includes close cooperation with the other World Bank Group agencies (IFC and MIGA) to deploy resources more effectively and leverage diverse comparative advantages and instruments to promote investments in energy. The World Bank intends to work on these main fronts:

- Increasing focus on key transformative projects—engaging in opportunities for transformative impact along the energy value chain, particularly in low-cost clean generation and regional integration.
- Leveraging investment by the private sector and other donors—helping countries deliver key sector reforms leading to strengthened regional power planning, an improved investment climate, and more efficient and creditworthy utilities.
- Strengthening capacity for project development and execution—to bolster its role as a catalytic financier for large and commercially-viable generation projects to focus on the preparation of a bankable pipeline and build capacity. This includes supporting utilities in their efforts to become more efficient so they can better serve their clients, expand their services, and be credible off-takers to engender private investments in future generation projects. Traditional donors will continue to play a critical role, and the World Bank is uniquely positioned to foster coordination among multiple partners and coalitions with existing structures and institutions.

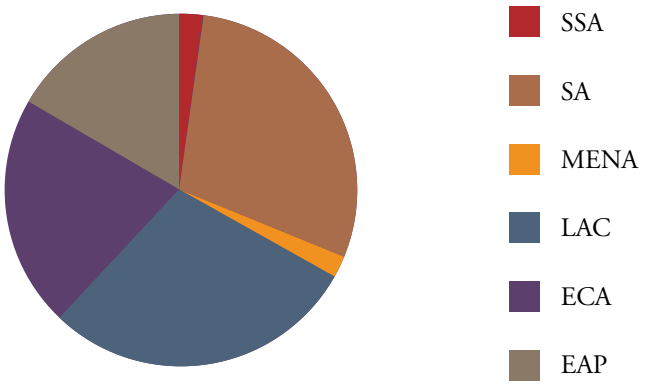
- Enhancing its knowledge broker role and mobilizing technology, skills, and resources for world-class energy solutions—focusing on improved global knowledge base and enhanced South-South cooperation. Internally, the World Bank will need to remove bottlenecks that prevent an effective response to clients and discourage partnerships with the private sector and donors. The Bank's response will support environmentally sustainable energy supply and use.

6.1
Increasing Private Sector Participation

The large inadequacies in African energy infrastructure suggest that higher levels of investment and more expertise to maintain infrastructure are needed—resources that the private sector, under the right circumstances, is equipped to provide.

While many developing countries have partnered with the private sector to improve infrastructure, from 2001–2011 SSA accounted for only 2 percent of private investment in energy infrastructure in developing regions. This compares to 29 percent each for South Asia and Latin America and the Caribbean, 21 percent for Eastern and Central Europe, and 17 percent for East Asia and the Pacific (see Figure 9). Within Africa, investment is not evenly distributed; 80 percent of power investments are concentrated in six countries: Cameroon, Ghana, Kenya, Nigeria, Tanzania, and Uganda.

Figure 9. Total Private Participation in Energy Infrastructure, 2000–2009



Source: Based on data from the World Bank's Private Participation in Infrastructure (PPI) Database.

However, SSA did triple its rate of private participation in infrastructure (PPI), from US$3,077 million from 1990–2000 to US$9,400 million from 2001–2011.[6] Private sector participation in

6 Private Participation in Infrastructure Database, Washington, DC: The Public Private Infrastructure Facility and the World Bank.

SSA's energy sector would increase if the power sector were more creditworthy and better structured. Building a creditworthy power sector involves improving the autonomy, oversight, transparency, and accountability of distribution and transmission utilities. This can be done through public solutions—such as performance contracts— or through private sector participation, for instance through concessions. In addition, this requires building credible regulation: transparent, principled, predictable over time, and not politicized.

African countries have increasingly involved the private sector—through PPPs—in the energy sector, though challenges remain. PPPs offer risk-sharing relationships where some public service delivery responsibilities are assigned through a legal contract to a private party. Probably the most important factor for PPPs is project preparation (that is, concept development, due diligence on feasibility, project structuring, marketing, and transacting). Preparing packaged and bankable projects helps to ensure that contracts are structured in ways that take into account regulatory, legal, and capacity weaknesses of the host government, and confirm to potential private partners that projects are commercially viable.

There are two principal issues related to increasing PPI: (i) that PPP contracts are often complicated, requiring reforms, credible regulation, and technical assistance to facilitate and lessen and properly allocate the various risks; and (ii) more resources must be allocated to project preparation in order to increase the stock of bankable electricity projects that the private sector may undertake.

Electricity sector PPPs can be remarkably complex. Box 14 describes the development of the Bujagali Private Power Generation Project, the ways in which sector reform and credible regulation facilitated the project, and the complex financial structure developed in close collaboration by the World Bank, the IFC, MIGA, and other stakeholders that made the project possible.

Box 14. Complex Solutions for Complex Problems—Bujagali Private Power Generation Project, Uganda

Uganda's Bujagali hydropower IPP has been operational since 2012, after many years in the making.

Bujagali's development began in 1994 with a Memorandum of Understanding (MOU) between the Government and AES Nile Power (a subsidiary of the US-based AES Corporation). The 200MW project was attractive to the Government, representing a 70 percent increase in Uganda's installed generating capacity. It was the clear least-cost source power development, and there were limited power generation alternatives at the time. Further, as a run-of-the-river project it would not require a traditional dam; the Government hoped this would avoid some of the controversy often associated with hydropower projects.

Years of negotiations followed. The project was marred by tales of corruption, poor planning, overpricing (the PPA was not made public), and claims of environmental damage. In 2002, a

Government minister revealed that he had received a payment from a private party. The World Bank promptly suspended its support and, in 2003, AES announced its withdrawal.

However, in 2004, the World Bank and the Government renewed their commitment to Bujagali and a competitive bidding process was initiated; in 2005 the preferred bidder was announced—Industrial Promotion Services (IPS)—and in 2007 Bujagali reached financial closure. Bujagali had become a build-operate-transfer (BOT) project of 250MW worth US$860 million, based on a 30-year PPA signed with the Government-owned electricity transmission company.

The sector and regulatory framework reform facilitated the transaction; Uganda had, with help from the World Bank, implemented various power sector reforms. Opening the country's distribution company to private management had brought cash into the sector, and a clear tariff structure had been formulated, aimed at establishing cost recovery tariffs.

The Bujagali deal was complex, partly because of the supporting arrangements required. The World Bank, IFC, and MIGA worked closely together and with other stakeholders on the contractual structure. Debt financing was provided by: IFC (US$130 million), EIB (US$130 million), AfDB (US$110 million), and European Development Finance Institutions (DFIs) (US$142 million). Lending by commercial banks was backed by a World Bank partial-risk guarantee against an IPS debt service default resulting from government failure to meet its PPA obligations (US$115 million). The IPS co-sponsor retained MIGA's political risk insurance against government breach of contract (US$115 million). The Government also contributed US$20 million in equity—about 12 percent of total equity —and agreed to security measures such as a liquidity facility, a debt service reserve account with escrow features, and a sovereign guarantee backing the PPA.

Source: World Bank and UNECA 2011.

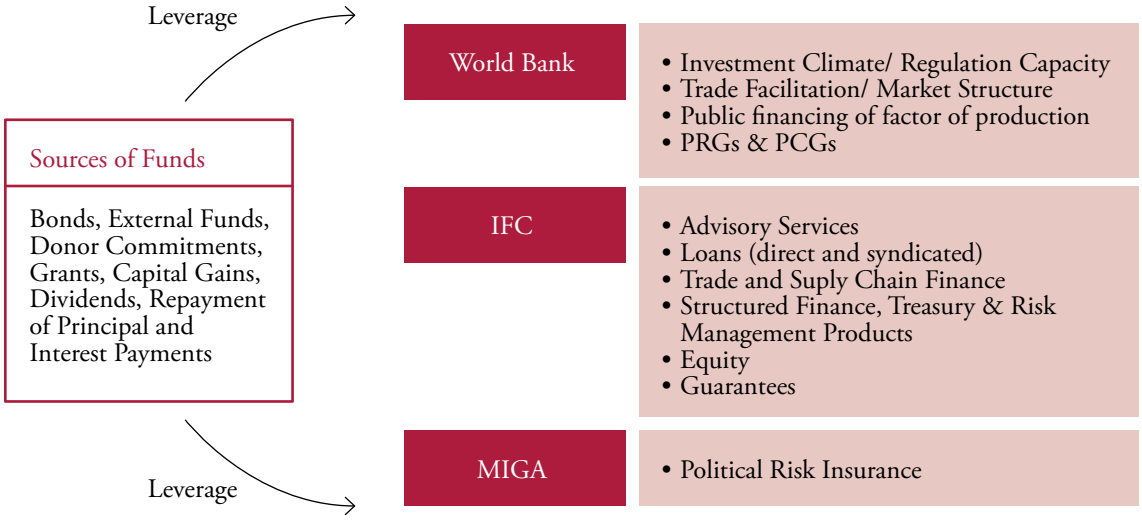
A shortage of bankable projects precludes private investment in African energy infrastructure, and Project Preparation Facilities (PPFs) can help develop bankable projects. A key constraint to private sector participation in African energy infrastructure projects is the lack of well-packaged and bankable projects in which to invest. PPFs—typically holders of significant, non-allocated funds that can be drawn down to fund infrastructure project preparation activities (from concept development to feasibility, structuring, and transacting)—fill an important gap in the broad project development landscape. Funding for PPFs rose substantially from 2005 to 2010 but now appears to be declining. Commitments to PPFs in 2005 were around US$10 million, and grew to around US$80 million by 2010. Spending peaked in 2009, 2010 and, by 2011, had dropped back to 2008 levels. However, even at the their peak, PPFs could only cover a small portion of the needs, as the preparation costs of large energy infrastructure projects can run in the dozens of millions of dollars

and PPFs accounted for only around 20-30 percent of the total funding for project preparation in Africa.[7]

The World Bank will continue to support clients in delivering key sector and utility reforms that contribute to improving the viability of incumbent utilities, as well as to endorse reforms that aim to improve overall investment climates—and hence creditworthiness and access to domestic and international private capital. The World Bank will also help clients to improve their institutional capacity for project development. The World Bank Group can assist in increasing the pool of bankable projects, leveraging new options, developing innovative financial instruments, and partnering with emerging investors.

By leveraging the resources of the entire World Bank Group—that is, IDA's sector engagement along with IFC's lending and MIGA's insurance—effective conditions can be created to leverage and scale up the mobilization of private capital in the energy sector. For example, IDA, IFC and MIGA are using their comparative advantages in implementing a joint energy business plan for Nigeria to offer a one-stop shop solution to the Government of Nigeria in assisting with sector reforms and the privatization process.

Figure 10. Using Comparative Advantage to Leverage Capital



Source: World Bank Group (2012).

7 This figure is for all infrastructure and is not limited to energy infrastructure. See the Infrastructure Consortium for Africa (ICA) report "Tunnel of Funds: Overview of the Assessment of Project Preparation Facilities for Infrastructure in Africa." The study found that most of the money spent on project preparation came from development funds from the multilateral development banks (MDBs) and the European Commission, MDB loans, development-agency funded programs, national budgets, bilateral trust funds held at MDBs, and the private sector.

It is also important to focus on mobilizing domestic capital markets to provide additional sources of financing for the energy sector. For example, the Kribi Gas Project in Cameroon included an IDA PRG (US$82 million) and an IFC loan (US$86 million) to mobilize private capital for the development of Cameroon's first gas-to-power IPP. However, more needs to be done in order to develop and promote capital markets in Africa so that domestic savings, pension funds, and the like are attracted by the prospect of participating in energy infrastructure investments. Other partnerships, such as with sovereign wealth funds and non-traditional donors, should be explored further. Finally, South-South cooperation with emerging financiers should also be pursued and promoted.

6.2
Responding to Emerging Sector Challenges

Efficiency, effectiveness, and sustainability are the challenges that lie ahead in this effort to promote energy development in Africa. Success will depend not only on the effective structuring and organization of tasks, but also on the ability to navigate upcoming obstacles:

a. **Integrating response to climate change**. The World Bank will integrate frameworks for action to balance energy development needs and environmental objectives. It will partner with countries to achieve cleaner development paths and to shift to a sustainable energy mix, while taking into account affordability and reliability considerations. In doing this, intermittent renewable energy needs will be packaged with the requisite amount of back-up generation and appropriate transmission and distribution investments. This will require a focus beyond individual projects. Climate investment funds can help to define low-carbon investments. The World Bank will play a critical role in supporting regional power trade, which allows unlocking and efficiently developing the renewable energy potential in the trading area.

b. **Harmonizing aid**. The World Bank will continue to engage at the international level in an effort to catalyze new commitments, attract new partners, and design new approaches to energy development. To avoid the duplication of efforts, the World Bank will work to strengthen coordination among partners and help focus on areas in which parties can work together effectively, complementing existing structures and processes and adding value to energy development. The focus will be on reducing transaction costs for clients in dealing with multiple parallel donor bureaucracies, especially on large transformative projects.

c. **Improving responsiveness to client and stakeholder demand**. In order to address the multifaceted energy challenge, the World Bank is strengthening integration across all sectors and expanding technical skills. For example, our energy sector teams and water resource management teams cooperate closely when working on managing river basin-wide issues related to hydropower development, as do our energy sector teams working with finance and

private sector development teams and colleagues at IFC and MIGA to promote private capital mobilization for energy investments.

d. **Increasing South-South cooperation**. South-South cooperation has two main components: (i) South-South investment and (ii) knowledge sharing among developing countries. With emerging financiers playing an increasing role in Africa's power sector, borrowers, traditional donors, and International Financial Institutions (IFIs) must learn to work with new actors, interests and modalities. The World Bank will need to partner with these emerging financiers to leverage funding for critical large-scale investments, as well as to help financiers and borrowers alike in maintaining high standards when it comes to transparency, public scrutiny, and environmental and social responsibility. The Bank will support South-South cooperation to channel knowledge and capacity exchange from utilities that operate in similarly governance-challenged and difficult political economy settings. Some initial experiments in knowledge sharing have successfully concluded in Brazil, China, and India.

The control room at the power station at Takoradi, Ghana, June 21, 2006. Photo: Jonathan Ernst/World Bank

7 Conclusions

Efforts to develop regional markets and institutions are essential, and political economy matters. Incentives for cooperation will vary by country, and a balance must be reached where regional trade produces the benefits of lower cost of supply without increasing domestic energy security risks. Good governance and improved capacity among utilities and regulatory institutions are critical to ensuring sustainable outcomes when it comes to access, services, and financial viability. Quality and realism in project preparation must remain high to ensure success in public-private partnerships and deliver sustainable outcomes.

To accelerate progress, all stakeholders (including government, private investors, donors, and international institutions) must come together to scale up finance, raise the capacity for project preparation and execution, and improve the investment climate. A broad consensus is necessary if regional transformational projects and needs are to translate into cohesive regional planning, consistent national plans, and high quality preparatory work. Realism must be injected into project preparation; the upstream work requirements are high, but with a focus on multiyear planning and by allocating adequate resources to project preparation, complex and transformational projects can be made sustainable.

There is an urgent need to do more for the energy sector's development, and to do it faster. While the World Bank will work on leveraging financing, this alone will not deliver results; effective partnerships must also be fostered and nurtured to guarantee results. These partnerships should focus on African institutions and actors, and collective efforts should mirror each party's comparative advantage.

Workers maintain the power station at Takoradi, Ghana, June 21, 2006. Photo: Jonathan Ernst/World Bank

Annex

Energy and the Millennium Development Goals

MDG	Linkage with Energy
Eradicate extreme poverty and hunger	Increased energy is essential for generating jobs, industrial activities, transportation, and modernized agriculture in Africa (energy for irrigation, for instance, can help improve food production and promote better nutrition). Household lighting allows income generation during the evening hours.
Achieve universal primary education	Household lighting can create more time for studying in the evening and promote better school performance. Electricity in educational facilities enables the use of modern teaching equipment and can help retain quality teachers.
Promote gender equality and empower women	Lack of access to modern fuels and electricity affects women and so leads to gender inequality.
Reduce child mortality	Respiratory illnesses caused by indoor air pollution from traditional fuels and stoves directly contribute to infant and child mortality.[8]
Improve maternal health	Women are disproportionately affected by indoor air pollution and water- and food-borne illnesses. Lack of electricity in health clinics, poor illumination during night deliveries, and daily household chores contribute to poor maternal health, especially in rural areas.
Combat HIV/AIDS, malaria, and other diseases	Electricity for communication (radio and television) is needed to spread important public health information to combat deadly diseases. Electricity is needed for illumination, refrigeration, sterilization, etc. for effective health services.
Ensure environmental sustainability	Energy production, distribution, and consumption in Africa have many effects on the local, regional, and global environment, including indoor and outdoor air pollution and land degradation. For instance, improved agricultural practices (requiring electricity) will reduce the need to expand the quantity of land under cultivation, thus reducing pressure on the environment.

8 Indoor air pollution is one of the main contributing causes of respiratory disease, which accounts for up to 20 percent of the 11 million child deaths per year (WHO 2006, Fuel *for Life: Household Energy and Health).*

MDG	Linkage with Energy
Develop a global partnership for development	The World Summit for Sustainable Development called for partnerships between public entities, development agencies, civil society, and the private sector to support sustainable development, including the delivery of affordable, reliable, and environmentally sustainable energy services.

Source: Adapted from the Forum of Energy Ministers in Africa (2006), United Nations (2005), and Barnes et al. (2010).

Night street scenes on High Street in the James Town neighborhood of Accra, Ghana, June 13, 2006.
Photo: © Jonathan Ernst/World Bank

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