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Powering Africa: Challenges of and U.S. Aid for Electrification in Africa

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Summary

The largest infrastructure deficit in sub-Saharan Africa, a region mostly made up of low income developing countries, is in the power sector, according to the World Bank. Rates of access to electricity in Africa are very low by global standards, notably in rural areas. About 57% of Africans, or about 621 million people, lack access to electricity (also referred to as "power" in this report). Whether measured in terms of generation and distribution capacity, electricity consumption, or security of supply, Africa's power sector delivers a fraction of the service needed or found elsewhere in the developing world. Power consumption is a tenth of that found elsewhere in the developing world, and per capita access is gradually falling, because new power infrastructure construction has not kept up with growing populations and electricity demands. The contrast between Africa and the developed world with respect to power capacities is particularly stark. Africa has a generation capacity of about 106 megawatts (MW) per million people, while that of the United States was about 3,320 megawatts MW per million people

The lack of power constrains development in the region in multiple ways: It limits economic production, growth, and commerce; undermines human resource development and hinders improved quality of life potentials; and limits the quality of social services and public safety. It also spurs the use of alternative, often highly polluting biomass energy sources (e.g., wood and charcoal) for cooking and lighting. Estimates of African power requirements and the corresponding need for financing vary widely, but are invariably high. The U.S. Agency for International Development (USAID) reports that about $15 to $20 billion in annual investment through 2030 may be needed to achieve universal access to electricity, a figure roughly in line with a 2012 International Energy Agency (IEA) estimate.

The United States has long provided varied technical and other assistance to increase access to power in Africa, but new U.S. efforts in this area are under way. The Electrify Africa Act of 2014 (H.R. 2548), which sought to increase U.S. support for electrification, was introduced in the 113th Congress, in June 2013. Days later, President Obama announced the Power Africa initiative, which seeks to achieve similar ends. Broader U.S. policy interests linked to Power Africa include U.S.-African trade and investment expansion and U.S.-African cooperation focused on development and poverty alleviation. The House passed H.R. 2548 in May 2014. A Senate bill, S. 2508 (Menendez, the Energize Africa Act of 2014) was also introduced in the 113th Congress. Similar new bills, H.R. 2847 (Royce, the Electrify Africa Act of 2015) and S. 1933 (Corker, the Electrify Africa Act of 2015) have been introduced in the 114th Congress.

U.S. agencies participating in Power Africa have committed up to $9.71 billion to the initiative through 2018, in the form of technical aid, grants, export and trade capital and risk mitigation tools, loans, and other resources. Power Africa is also designed to enhance power sector institutions and address constraints to investment; aid in regional energy resource development; and enhance energy sector governance. Twelve U.S. agencies play a role in Power Africa and coordinate their efforts through an inter-agency forum chaired by White House National Security Council staff and USAID. The main project-implementing Power Africa agencies are USAID; the Overseas Private Investment Corporation; the U.S. Export-Import Bank; the Millennium Challenge Corporation; the U.S. Trade and Development Agency; and the U.S. African Development Foundation. In general, Power Africa agencies use their existing authorities, funding sources, and program processes to determine project eligibility or selection under the initiative. This report discusses Power Africa; policy problems and challenges related to power sector development in Africa; long-term perspectives on energy poverty, need, and future development; and raises some possible oversight questions and issues for Congress.

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Introduction

Sub-Saharan Africa is the most electricity-poor region globally, which has had profound impacts on economic growth and development prospects. In recent years, U.S. policymakers have sought to help increase access to electricity in sub-Saharan Africa in order to spur economic growth, reduce poverty, and for socio-economic development generally in the region; and to expand U.S. and other international trade with and investment in Africa. Efforts to achieve these goals have taken the form of Power Africa, a major, multi-agency Obama Administration initiative to increase African access to electricity (also termed "power" in this report); and two congressional bills (one in the House and one in the Senate; see below). The latter seek to establish as a U.S. policy priority a benchmarked, multi-year, market-driven and strategy-based program of power capacity-building aid and development partnership. It would be broadly analogous to that pursued under Power Africa, but extend beyond the five-year duration of Power Africa and differing in scope. They also set out mechanisms to support congressional oversight of all such activities, among other ends.

Recent Key Developments

Congressional Initiatives

Two bills to increase access to power in sub-Saharan Africa ("Africa" in this report, unless otherwise stated) have been introduced in the 114th Congress. In June 2015, the Chairman of the House Foreign Affairs Committee (HFAC), Representative Edward Royce, introduced H.R. 2847, the Electrify Africa Act of 2015.[1] It seeks, among other ends, to make U.S. policy efforts, in partnership with sub-Saharan African countries and other partners, "to promote first time access to electricity and power services for at least 50 million people in sub-Saharan Africa by 2020, encourage installation of at least 20,000 additional megawatts (MW) of electricity, encourage necessary in-country reforms," and promote an energy development strategy that uses a wide range of fossil fuel and renewable energy sources. On August 4, 2015, Senator Bob Corker, the Chairman of the Senate Foreign Relations Committee, introduced S. 1933, the Electrify Africa Act of 2015.[2] The bill seeks "to establish a comprehensive United States Government policy to encourage the efforts of countries in sub-Saharan Africa to develop an appropriate mix of power solutions, including renewable energy, for more broadly distributed electricity access in order to support poverty reduction, promote development goals, and drive economic growth," among other ends.

The two bills are broadly similar in their approaches. The main numerical policy targets of the two bills are nearly identical, and the broad approaches they lay out to achieve the ends they set out, which include an Executive Branch multi-year strategy, reporting to Congress on strategy implementation and progress, and U.S. leveraging of international support for this purpose are very similar, albeit not identical in their specifics. Title II of both Acts would extend the issuing authority of the U.S. Overseas Private Investment Corporation (OPIC) to 2018 and set out a number of provisions to foster OPIC-administered power sector investment assistance in Africa. There is substantial similarity between several of the two titles' Africa-related provisions,

[1] Other original co-sponsors included three HFAC Members Representatives Eliot Engel, Christopher Smith, and Karen Bass. As of August 7, there were nine other co-sponsors. The bill has been referred to HFAC.

[2] Other original co-sponsors included the SFRC Ranking Member, Senator Ben Cardin; seven other SFRC Members, Senators Cardin, Coons, Gardner, Isakson, Markey, Menendez, Murphy, and Shaheen; and Senators Alexander, Boozman, Collins, Durbin, Graham, Kirk, Murray, and Schumer. The bill has been referred to SFRC.

although they also substantively differ in important ways. Both titles also contain additional general OPIC provisions that are not necessarily related to Africa, of which some are roughly identical, but in other cases dissimilar.

The introduction of the two bills followed passage by the House during the 113th Congress of H.R. 2548 (Royce), the Electrify Africa Act of 2014, and the introduction and reporting out of committee in the Senate, also during the 113th Congress, of S. 2508 (Menendez), the Energize Africa Act of 2014.

Power Africa: Key Achievements and Critiques

If enacted, the congressional proposals described above would, in effect, extend and govern the implementation of activities currently being pursued under Power Africa, launched in mid-2013. Its goals are to add 30,000 MW in additional electricity generation capacity; support power connections for 60 million or more household and business; and facilitate significant U.S. and international public and private sector investments in the sector in Africa.[3]

In late July 2015, during President Obama's third trip to sub-Saharan Africa as president, the U.S. Agency for International Development (USAID) released its second annual report on Power Africa. The report stated that Power Africa had to date helped to reach the "critical, difficult milestone" of "financial close" (essentially, a situation where a project is fully financed and can be implemented) for power project transactions capable of delivering 4,129 MW. These projects had the reported potential to enable about 4 million new electricity (also termed "power" in this report) connections. In addition, activities under Beyond the Grid and the U.S.-Africa Clean Energy Finance initiative (ACEF), a Power Africa project aimed at boosting innovation and financing for off-grid and small-scale energy production and distribution—generally using clean energy technologies—were projected to create one million new connections.

Funding for Power Africa comes from many sources. Initially when Power Africa was announced, most of the funding came from U.S. agency commitments totaling $7.81 billion, complemented by a reported $9 billion worth of private sector project commitments. The amount has since grown. In late July 2015, the White House released information indicating that a total of nearly $31.5 billion had been committed to Power Africa by the private sector ($20 billion, representing over 100 firms and other entities) and by donor governments and multilateral agencies ($11.5 billion).[4] In addition, in July 2015, the Administration announced that OPIC had committed an additional $1 billion through 2018. Added to an earlier, August 2014 announcement of increased USAID's funding for the initiative—increasing to $300 million annually from the initial $285 million total USAID share of Power Africa commitment, starting in FY2016—this commitment brought total U.S. agency-pledged funding for Power Africa to $9.71 billion.

This funding, slated to be provided through 2018, is for technical aid, grants, export and trade credit services, and loans capital from various U.S. agencies (see below). In addition to facilitating new transactions and project financing and aiding the completion of planned projects, key current Power Africa activities include work on developing new power sector financial

[3] These goals were announced in August 2015, during the U.S.-Africa Leaders Summit (ALS). The initial goals, announced in 2013, included the addition of 10,000 megawatts (MW) in capacity and 20 million power connections, principally in six "focus countries" (Ethiopia, Ghana, Kenya, Liberia, Nigeria, and Tanzania), through efforts to marshal investment in the sector and the provision of U.S. loans or other credit services; technical assistance aimed at facilitating power sector transactions, reforming the power regulatory environment, and building institutional, governance, and other related energy-related capacities; and spurring innovation and entrepreneurship in the sector.

[4] White House, "Fact Sheet: Power Africa," July 25, 2015; and White House, "Fact Sheet: Powering Africa: Increasing Access to Power in Sub-Saharan Africa," August 5, 2014.

models and spurring crucial legal and regulatory reforms needed to enhance sectoral technical operations and investment. Further information on the status of Power Africa is provided later in this report.

Despite such progress, press analyses have periodically highlighted the arguably slow pace and partial attainment of Power Africa goals. One recent *New York Times* article pointedly noted that Power Africa "has yet to deliver any electricity." While such criticisms may be empirically justified, Power Africa has a five-year time span, and initiative projects are being undertaken in the very financially and operationally challenging power sector environment that Power Africa is designed to reform and improve.

Power Africa officials note that the current power financing environment makes the attainment of financial deal closure very slow. In addition, many of the types of transactions that are being pursued represent the kind of very expensive, technically, legally, and regulatory complex projects that often take years to complete the world over.[5] Power Africa activities also take place in contexts where broader challenges—including political uncertainty and crisis, corruption, human resource and education weaknesses, and other diverse socio-economic development challenges that affect sector potential—are common.

The potential for Power Africa to achieve its goals in the area of project financing may also be inhibited by a congressionally-driven outcome: the July 1, 2015 lapse of the charter of the U.S. Export-Import Bank (Ex-Im, the official U.S. export credit agency), due to congressional non-extension of its operating authority.[6] Of the Administration's initial $7.81 billion Power Africa commitment, the Bank had committed up to $5 billion.

Background

Electricity Deficits in Africa

According to the World Bank, the largest infrastructure deficit in sub-Saharan Africa is in the electrical power sector.[7] Rates of access to electricity in the region are very low, both in comparison to other developing-country regions and to the developed world. About 57% of Africans, or about 621 million people, lack access to power, notably in rural areas.[8] In addition,

[5] An example of the complexity such projects is illustrated in a case study of the Power Africa Cenpower deal, a 350 MW gas-fired power plant project in Ghana. See USAID, "Power Africa's Toolbox at Work," *Power Africa Annual Report*, July 2015.

[6] The charter lapsed after Congress did not extend the bank's general statutory charter by the end of a previous nine-month extension, through June 30, 2015, resulting in the expiration of key Bank statutory authorities. While the Bank is able to administer existing loans and credit services, the lapse makes the Bank unable to issue new loans, guarantees, or insurance commitments. The lack of a congressional reauthorization is due to increasing disagreement among Members in recent years about the roles and impacts of the Bank, and over whether the Bank should continue to exist. The Bank's supporters argue that it promotes U.S. exports and job growth by providing credit assistance that the private sector is not willing or able to offer; helps U.S. exporters compete against foreign firms backed by their countries export credit agencies; and provides net positive flows of earnings to the U.S. Treasury. Critics assert that the Bank crowds out private sector finance; creates an unlevel playing field by favoring the firms to which it provides support; provides assistance that functions, essentially, as corporate welfare; and puts taxpayer dollars at risk. See CRS In Focus IF10017, *Export-Import Bank (Ex-Im Bank) Reauthorization*, by Shayerah Ilias Akhtar. See also Jackie Calmes, "Its Charter Expired, Export-Import Bank Will Keep the Doors Open," *New York Times*, June 30, 2015

[7] World Bank, *Fact Sheet: Infrastructure in Sub-Saharan Africa*, 2013, http://go.worldbank.org/SWDECPM5S0.

[8] According to the International Energy Agency (IEA), in 2012, about 1.3 billion people globally—nearly 99.9% of whom lived in the developing world—lacked access to electricity. Of these, 621 million people, or about 48.4% of the

even in some of the region's most developed urban areas, supplies are not reliable and blackouts occur. Whether measured in terms of generation and distribution capacity, rates of consumption, or security of supply, the power sector in Africa—which is largely made up of low income developing countries—delivers only a fraction of the service in other global regions.

The contrast between Africa and the developed world with respect to power production and capacity is especially stark. In 2012, all 48 sub-Saharan African countries (all except South Sudan, with a combined population of more than 912 million) produced about 422 terawatts (Tw), less than the 564 Tw produced by France, with a population of just under 66 million.[9] Similarly, in 2012 Africa had a generation capacity of about 106 MW per million people, while that of the United States was about 3,320 MW per million people.[10]

In 2012, power consumption, at nearly 540 kilowatt-hours (kWh) per capita per year (just under the amount of electricity needed to power one 100-watt light bulb per person for 15 hours a day), is only 24% of that found elsewhere in the developing world, and about 4% of that in the United States.[11] However, residential use is far smaller (317 kWh per capita per year for Africa, or 225 kWh excluding South Africa), as much capacity is used for industrial and other non-residential needs.[12] Per capita access is also gradually decreasing, because new power infrastructure is not being built fast enough to keep up with growing populations and electricity demands.

Power generation is also costly in much of the region. Many small African countries rely on small-scale diesel or highly polluting heavy fuel oil generation technologies that can cost up to $0.40 per kWh in operating costs alone, about three times as high as those faced by countries with larger scale (above 500 MW) power systems.[13] African demand for power, due to growing needs and a lack of infrastructure maintenance and new construction, consistently outstrips supply—and, at present supply rates, is projected to do so for decades.

The tables below illustrate Africa's relative electricity deficit, as well as disparities in access within the region. **Table 1** shows comparisons of electrification rates between Africa and other world regions. **Table A-1**, *Electrification Rates and Use of Traditional Biomass in Africa, 2012*, in Appendix A, shows similar information for individual African countries. South Africa, the most industrialized African country, has the most electricity generation and accounts for almost two-thirds of Africa's generation. Amounts of power generation from renewable electric technologies

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global total, lived in sub-Saharan Africa. About 80% of those without access to electricity in the region lived in rural areas. In addition, 67% of sub-Saharan Africans, about 728 million people, used polluting, particulate-generating biomass (e.g., wood) for cooking heat. See Chapter 2, *World Energy Outlook (WEO) 2014*; and *Africa Energy Outlook* (*AEO*) *2014*. Other sources estimate that a greater share of sub-Saharan Africans lack access to electricity; the World Bank's World Development Indicators database (WDI), for instance, puts the number at 64.6% in 2012. WDI estimated the share of those without access to power in South Asia, the region with the next-highest non-access rate, at 22.0%.

[9] South Africa—which is currently facing major production deficits, resulting in regular rolling blackouts (called load shedding)—accounts for about 60% of the sub-Saharan gross production total. If South Africa's production is discounted, the contrast is even more striking. In 2012, the entire remaining region, of 860 million people, produced 164 Tw, just under the 167 Tw produced by Sweden, with a population of just under 10 million. IEA, "Table 1.1. World electricity production, imports, exports, final consumption, 2012 (Tw)," *Electricity Information 2014*; "Total Population (in number of people)," WDI database; and CRS calculations.

[10] IEA, Annex A, "Electrical capacity (GW)," entries for the United States and sub-Saharan Africa, *World Energy Outlook 2014*; "Total Population (in number of people)," WDI database; and CRS calculations.

[11] "Electric power consumption (kWh per capita)," WDI; and CRS calculations.

[12] This residential rate is about 50% of that in China, 20% of that in Europe, and 7% of U.S. usage. Chapter 1, "Energy in Africa Today," *AEO 2014*, page 32.

[13] World Bank, *Fact Sheet*, op. cit.; and World Bank, *Underpowered: The State of the Power Sector in Sub-Saharan Africa*, 2008 (AICD).

are also shown in the table, with hydropower being the largest renewable source of electricity.[14] All of sub-Saharan Africa combined in 2012 had roughly 7.7% of U.S. installed capacity and 9.9% of U.S. net generation.[15]

Table 1. Comparison of Electrification Rates by Global Region, 2012

Region or Aggregate Category	Population Lacking Electricity, Millions	Aggregate Electrification Rate, Percent	Urban Electrification Rate, Percent	Rural Electrification Rate, Percent
Sub-Saharan Africa	621	32%	59%	16%
North Africa	1	99%	100%	99%
Developing Asia	620	83%	95%	74%
Latin America	23	95%	99%	82%
Middle East	18	92%	98%	78%
Developing countries (all)	1,283	76%	91%	64%
Transition economies & OECD	1	100%	100%	100%
World	1,285	82%	94%	68%

Source: Adapted from IEA, "Electricity access in 2012—Regional aggregates," IEA, *World Energy Outlook 2014*, http://www.worldenergyoutlook.org/media/weowebsite/WEO2014Electricitydatabase1.xlsx.

[14] Wind turbines, solar photovoltaic panels, and steam plants on geothermal reservoirs are examples of other technologies used to generate renewable electricity.

[15] Installed capacity is the maximum electricity output of an electrical power generating unit, usually expressed in megawatts (MW). Net generation refers to the gross, or total, amount of electric energy produced by a generating unit minus any electric energy consumed by the unit or its components in producing gross electricity output. Electrical energy is the "ability of an electric current to produce work, heat, light, or other forms of energy," and is usually measured in kilowatt-hours (kWh). A watt (W) is a small unit of electrical current measured by the strength of its capacity to overcome resistance. A kilowatt-hour (kWh) is a unit of energy—the capacity to exert a certain amount of force or the kinetic expression of such force—equivalent to the energy that would be released by the flow of one kilowatt (1,000 watts) expended over one hour. For further technical details on and definitional equations for these and related terms and concepts, see U.S. Energy Information Administration (EIA), Glossary, http://www.eia.gov/tools/glossary/. Data from EIA, International Energy Statistics, Electricity, http://go.usa.gov/3HEcR

Power Sector Historical Trends and Impacts

History is a key factor underpinning Africa's lack of power infrastructure. Electrical system development was limited during European colonial rule, largely as a result of economic development policies pursued by colonial governments. These favored the use of Africa as a source for raw, unprocessed materials, largely in the agricultural and extractive mineral sectors, and the use of African indigenous populations as sources of cheap labor and tax revenues. Large-scale power infrastructure was built mainly to support targeted, often geographically limited industrial projects. Development of residential power infrastructure was limited, except in South Africa and in some colonies where such infrastructure was built primarily to serve the needs of European settler populations.[16] During the first decades of the post-colonial period, a number of large-scale power projects were built, but several decades of economic stagnation in multiple countries and persistent political corruption contributed to negative foreign perceptions of Africa's business environment, thus likely reducing investment generally, including in the power and other infrastructure sectors.[17] Such perceptions are rapidly changing in the face of substantial economic growth in the region and the growing engagement of non-western, often state-aided foreign firms (e.g., from China, other Asian countries, and Brazil) in African markets—often in the electricity and other infrastructure sectors.[18] Still, power needs and unmet capacities remain large.

Lack of Power: Development Impacts

Africa's lack of power negatively affects the region in multiple ways: It constrains economic production, growth, and commerce.[19] It also undermines human resource development and hinders improved quality of life potentials (e.g., it limits light for education and access to power for refrigeration and digital communications devices); and limits the quality of social services and public safety. Uneven distributions of power also cause unbalanced sub-national patterns of development, notably between urban and rural areas. Lack of access also has direct negative effects on public health. It limits capacity to store vaccines and other medical drugs and the operation of medical equipment and health facilities generally. It also spurs the use of biofuel sources for cooking and lighting. Such sources—including wood, charcoal, kerosene, and even dung—are less costly than electricity but are frequently still relatively expensive (e.g., for urban consumers) and are often highly polluting. Harvesting of wood and its use or processing into charcoal also leads to deforestation in some areas. The use of such fuels is viewed as often disproportionally affecting women. Due to the predominance of traditional gender roles in many African countries, many females breathe particulates associated with their use during cooking and expend significant amounts of time gathering fuel.

[16] Kate B. Showers, "Electrifying Africa: An Environmental History With Policy Implications," *Geografiska Annaler* (93:3), 2011; A. Adu Boahen, ed., *Africa Under Colonial Domination, 1880-1935, UNESCO General History of Africa*, Vol. VII (Abridged), Currey, 1990; and Catherine Coquery-Vidrovitch, "Electricity Networks in Africa: A Comparative Study, or How to Write Social History from Economic Sources," in Toyin Falola and Christian Jennings, eds., *Sources and Methods in African History: Spoken, Written, Unearthed*, University of Rochester Press, 2003.

[17] U.S. Chamber of Commerce Africa Business Initiative, *Inside the Boardroom: How Corporate America Really Views Africa*, May 2009; Nicole Gaouette, "Kerry Calls for U.S. Investment in Africa, Warns on Corruption," Bloomberg News, May 3, 2014; and AFP, "US Investors Avoid Africa Over Corruption Fears," April 14, 2013. Various academic studies have studies have questioned the degree to which corruption may reduce investment, but most agree that corruption has a number of negative effects on both business climates and economic growth rates.

[18] Rene Vollgraaff and David Malingha, "African Development Bank Steps Up Funding As China Boosts Role," Bloomberg News, May 18, 2014, among others.

[19] In most of Africa, particularly among lower-income countries, infrastructure is a major constraint on doing business, and is found to depress firm productivity and increase investment costs. For an important subset of countries, a power deficit is the most limiting factor, and is cited by more than half of firms in more than half of African countries as a major business obstacle. For most countries, the negative impact of deficient infrastructure is at least as large as that associated with corruption, crime, financial market, and red tape constraints. World Bank, *Underpowered*, op. cit.

Barriers to Power Generation, Distribution, and Service Delivery

Common key challenges characterizing power delivery and supply in the region include the following:

- limited availability and unreliability of power transmission and distribution services and infrastructure;
- high power prices and the existence of a variety of regulatory interventions that distort market mediation of power demand, supply, and pricing (e.g., tariff rates);
- technically weak power generation, distribution, infrastructure servicing, and service payment systems, which often result in infrastructure underuse or unreliable power service;
- limited sectoral (generation, distribution, and regulatory) institutional capacity;
- underinvestment in regional generation and distribution infrastructure and cross-border electricity trading;
- lack of public funding and of access to private finance to fund sector investments in current and new power infrastructure; and
- the existence of large rural, often poor populations who frequently live in remote, dispersed locales to which centralized power and other public services are expensive to deliver, and large impoverished, underserved urban populations who may be unable to pay for electrical service.

Increasing Access: Potential Scope and Costs

Estimates of African power requirements and the corresponding need for financing vary widely due to differences in the models, scenarios, and assumptions used to project them.[20] In addition to the types and mixes of technologies and energy resources to be used[21] and levels and types of energy use (discussed further below), are examples of variables used to make such projections include the following:

- power plant outage rates associated with current infrastructure capacities, and estimates of consequent suppressed and unmet demand;
- population increases, urbanization rates, and types of development and economic growth; and
- rates of cross-border energy trade and potential savings from investments in increased maintenance and efficiency gains arising from the use of newer, more effective technologies.

While cost estimates vary, they are invariably high. USAID reports that about $15-$20 billion in annual investment through 2030 would be needed to achieve universal energy access. This figure dovetails with a 2012 International Energy Agency (IEA) estimate. The IEA projected a need for $385.3 billion in total spending, or about $19.3 billion annually, on average. Other studies project higher spending needs. One major study estimated total current power sector spending in Africa at $11.6 billion per year, of which 60% is skewed toward operation and maintenance due to the

[20] For a discussion of possible needs in the focus countries, see Todd Moss, "How Much Power Does Power Africa Really Need?" [blog] Center for Global Development, October 10, 2013. See http://www.cgdev.org/blog/how-much-power-does-power-africa-really-need.

[21] Variables such as centralized grids versus distributed or decentralized generation and distribution systems, and fossil fuels versus various renewables, and associated tradeoffs.

use of aging and often high-cost generation technologies, such as diesel generators. It estimated that a total of $40.6 billion in annual investments may be needed. Based on current spending patterns—and assuming that demand is fully met, that power utility operating inefficiencies are addressed, and that improved cost recovery could save $5.8 billion a year—this would leave an unmet annual spending deficit of $23.2 billion. There are both higher and lower estimates of spending requirements.[22]

Long-Term Perspectives: Energy Poverty, Need, and Future Development

Energy Poverty, Demographic Trends, and Development Needs

According to the IEA, access to electricity is necessary for economic growth and is "particularly crucial to human development," as it is "indispensable for certain basic activities, such as lighting, refrigeration and the running of household appliances, and cannot easily be replaced by other forms of energy." In addition, the IEA reported, "individuals' access to electricity is one of the most clear and undistorted indication[s] of a country's energy poverty status."[23] Africa has the poorest energy development rates globally; 26 of the 32 countries with the lowest scores on the IEA's Energy Development Index (EDI) 2010 are in Africa.[24]

With respect to electricity, relative energy poverty is also determined by how electricity needs and demands are defined. According to one source, there are three different levels of "electricity access": (1) basic human needs, (2) productive uses, and (3) modern society needs. The per capita consumption for level 3 can be as much as 20 times that for level 1.[25] Assumptions about relative electricity access uses and other factors that affect demand can influence the power system architecture needed to provide a certain level of service. For example, basic human needs for lighting and other services might be adequately provided by a localized solar photovoltaic (PV) or

[22] World Bank, "Power: Catching Up," Chapter 8, *Africa's Infrastructure Annual: A Time for Transformation*, 2010; and IEA, "Measuring Progress Towards Energy for All," Chapter 18, *World Energy Outlook 2012*.

[23] The IEA defines national energy poverty status as "a lack of access to modern energy services," which include access to electricity and "clean cooking facilities (e.g., fuels and stoves that do not cause air pollution in houses)." Organization for Economic Co-operation and Development / International Energy Agency, *World Energy Outlook 2012*, Access to Electricity, 2012, http://www.worldenergyoutlook.org/resources/energydevelopment/accesstoelectricity/.

[24] The EDI is a "composite measure of a country's progress in transitioning to modern fuels and modern energy services." It reflects household access to electricity and clean cooking facilities and to community access to energy for public services and for productive uses. It is a ranking of 80 developing countries, and includes scores for 32 sub-Saharan African countries. Measures of these indicators are averaged to yield a country score of between zero and one. The EDI 2010, the most current such measurement, is a spreadsheet published as part of IEA, *World Energy Outlook 2012*. See http://www.iea.org/media/weowebsite/energydevelopment/2012updates/WEO2012EDIdatabase_WEB.xlsx.

[25] *Basic human needs* refer to access to electricity for lighting, health, education, communication, and community services at a certain minimal level (50-100 kWh per person per year) and use of modern fuels and technologies for cooking and heating. Modern fuel or improved biomass cook stoves produce energy equivalent to that yielded by 50-100 kilograms of oil. *Productive uses* employ electricity, modern fuels and other energy services to improve productivity, rather than human labor, draft animals, raw biomass, and other more basic energy sources, in agriculture (e.g., irrigation water pumping, fertilizer, mechanized tilling), and commerce (e.g., agricultural processing, cottage industries, and transport (use of fuel). *Modern society needs* use modern energy services to fuel domestic appliances, increased requirements for cooling and heating (space and water), and private transportation, with electricity usage at around 2000 kWh per person annually. Y. Sokona, Y. Mulugetta, and H. Gujba, "Widening Energy Access in Africa: Towards Energy Transition," *Energy Policy* (47), 2012.

a micro-hydroelectric system. While new and emergent technologies may make distributed (decentralized or dispersed, often small-scale) power systems more economically feasible in the future, productive uses and modern energy services typically still employ more complex, large-scale, integrated systems to meet electricity needs. The IEA reports that as of 2010, 6 of the 10 countries with the largest populations without access to electricity were in the region.[26] (See **Table 2**, showing population without access to electricity by country, with the absolute number and proportion of the total population shown.) These countries represent about 50% of the African population lacking access to electricity.

Table 2. African Countries with Largest Populations Lacking Access to Electricity

(as of 2012)

Country	Population Lacking Access to Electricity (millions)	Population Lacking Access to Electricity (percent)
Democratic Republic of Congo	60	9%
Ethiopia	70	23%
Kenya	35	20%
Nigeria	93	45%
Tanzania	36	24%
Uganda	31	15%

Source: Adapted from IEA, "Electricity access in Africa - 2012," table; published with *Africa Energy Outlook 2014,* http://www.worldenergyoutlook.org/media/weowebsite/africa/Africa_Energy_Outlook_2014_Electricity_database.xlsx.

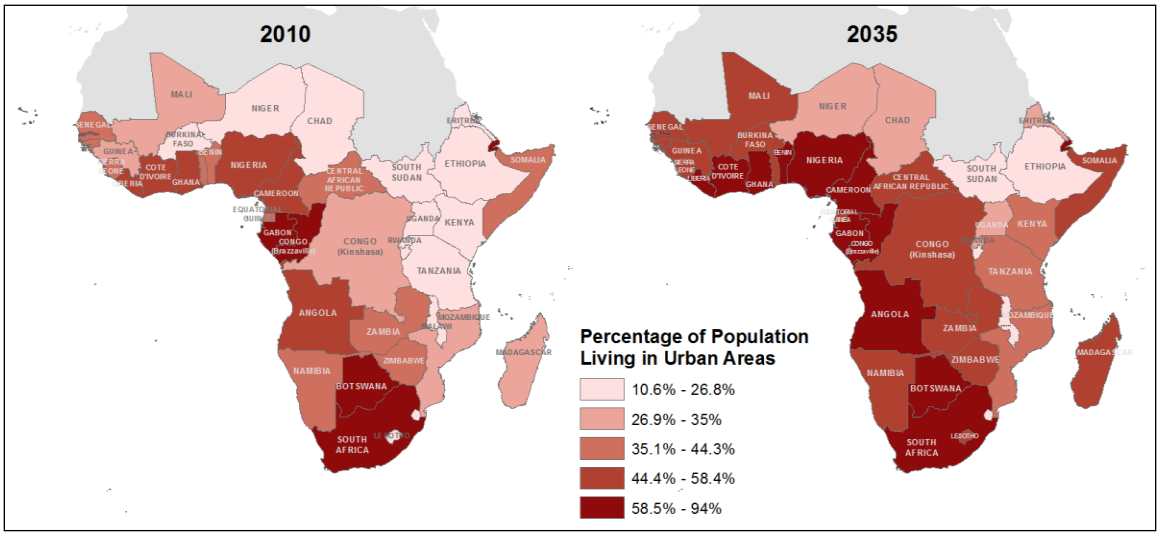
Demographic Trends

Demographic trends are an important parameter in the evaluation of pathways for reducing energy poverty and pursuing power sector development in Africa. According to the United Nations (U.N.), Africa's population is steadily urbanizing; up to 56% of its population will reside in urban areas by 2050—up from 36.3% in 2010.[27] **Figure 1** illustrates expected demographic shifts in Africa from 2010 to 2035. As populations become more urban and concentrated, more centralized power generation and distribution architectures may become more cost-effective. However, while urbanization trends in Africa are increasing, rural electricity demand will also likely grow, since the total population, including the absolute number of rural dwellers, is expected to grow.

[26] International Energy Agency, *Measuring Progress Towards Energy for All*, 2012, http://www.worldenergyoutlook.org/media/weowebsite/energydevelopment/2012updates/Measuringprogresstowardsenergyforall_WEO2012.pdf.

[27] United Nations Department of Economic and Social Affairs Population Division, *World Urbanization Prospects: The 2011 Revision*, October 2012.

Figure 1. Urbanization Trends in Sub-Saharan Africa



Source: CRS adaption of data from United Nations Department of Economic and Social Affairs, *World Urbanization Prospects: The 2011 Revision*, October 2012.

Better understanding and characterizations of rural population development needs may also influence decisions about optimal power delivery architectures. For example, extending grid access to rural populations that are 20 miles from a grid access point may be economically viable, while extending access to populations that are more than 200 miles from an access point may not be. Such rural spatial distribution differences have not generally been addressed in research assessing the implications of future rural/urban population shifts for electrification. Generalized assumptions about prospective power sector development in Africa, however, should be pursued with caution. Each African country is different in terms of population size, urbanization, existing infrastructure, local energy resources, and financial capacities, among other factors. How a given country's power sector actually develops will likely be based on policies, investment, and regional partnerships developed at the country level.

Potential Energy Resource Development

While rates of power access are low, Africa is also seen as having a large potential for power sector development due to its large fossil (e.g., oil, natural gas, and coal) and renewable or non-carbon-based (e.g., water, wind, geothermal, and solar) resources. Developing these resources in a sustainable, cost-effective manner, however, involves complex calculations and trade-offs associated with varying factors, such as cost, technical complexity and feasibility, scale, pollution, and other negative ecological and social impacts.

Hydropower

Water is essential for producing hydroelectric and thermal (steam-powered) electricity using fossil fuels and, to a lesser extent, some other types of renewable energy generation technologies.[28] Africa's water resources are abundant, although supplies are subject to high levels of variability in many countries. Hydroelectric plants have a number of advantages. Electricity from hydropower is relatively low cost per unit of generation when compared to other electric power technologies. Plants can be ramped up and down rapidly to adapt to changing power

[28] See CRS Report R43199, *Energy-Water Nexus: The Energy Sector's Water Use*, by Nicole T. Carter.

demands, and they do not require fuel to run. This makes them non-polluting and relatively inexpensive and cost-predictable to operate, as they do not require variable fuel supplies and are thus not subject to fuel price and supply volatility. Once built, hydroelectric dams also require relatively limited maintenance and labor inputs and have long operating lives. Large hydroelectric dams can also support power-intensive industrialization and multiple water caching-related purposes, such as irrigation, consumer water supply, flood control, and aquaculture.

Disadvantages include high initial capital construction costs and submersion of large upstream land areas, which dislocate human and animal populations and destroy ecologically or agriculturally valuable land, and disrupt riverine and other environmental systems, both upstream and downstream. Human dislocation frequently creates potent political challenges for dam advocates, as do decisions over changes in water flows and control of water—which can generate political and even interstate military conflict. Dams also typically create silt build-ups. This eventually can reduce their power generation and water storage potential, build pressure on dams, and sometimes lead to a concentration of toxins, as well as prevent the transmission of silt, which is often a natural source of soil replenishment downstream. Organic material silting can also be associated with generation of methane, a greenhouse gas (GHG).[29] Hydroelectric power is also subject to variability in water supplies, which is common in some African countries due to huge swings in precipitation across areas and seasons, and over time—and may be exacerbated by climate change. Hydropower shortages due to a lack of water are common in some African countries. Dam failure, which can cause highly damaging water deluges, is another risk. Critics of dams also assert that their construction can generate substantial growth in unsustainable national debts, often while benefitting political or private corporate interests.[30] Often financed by western donors and multilateral financial institutions and built by western firms, in Africa such projects have often been designed to provide power to large mining and other industrial operations and to capital cities, and have frequently bypassed small urban areas and rural populations.

Despite such criticisms, hydroelectric dams have long been a major source of power in Africa. In the post-colonial era, notably from the 1960s through the 1980s, many African governments—like many others around the world—pursued the development of hydroelectric dams and other large-scale energy projects. The development of new dams remains a key focus of some African governments' efforts to expand power generation capacity. Several large hydroelectric dams are currently or prospectively being developed, most notably in the Democratic Republic of the Congo (DRC) and Ethiopia. Ethiopia has recently built several large hydroelectric projects, often backed by substantial Chinese technical and financial inputs, and is continuing to develop more, most notably the massive Grand Ethiopian Renaissance Dam. Ethiopia says it wants to share the potential benefits of the latter dam with its neighbors, but because the project would dam the Blue Nile River, which supplies several downstream, water-poor countries or regions, Ethiopia's development of the project has generated substantial regional opposition. In the DRC, there have long been plans to construct a massive addition to the two Inga dams on the Congo River, but the financial costs have hindered the proposed project. Recently there have been indications that the

[29] Methane and carbon dioxide emissions from hydroelectric dam reservoirs can result where vegetation was not removed prior to the flooding of reservoirs. The decomposition of vegetation is the cause of these GHG emissions, which appear to be more prevalent from reservoirs in warmer climates. See http://www.sciencedirect.com/science/article/pii/S0301421596001255.

[30] In a late 2013 letter written to World Bank President Jim Yong Kim, the International Rivers and 18 other U.S., African, and European civil society organizations and networks asserted that "the reality of large-scale dams seldom matched their expectations, mostly adding to debt problems and allowing powerful companies to cheaply exploit and export Africa's vast natural resources." John Vidal, "DR Congo Waits on Funding for World's Largest Hydropower Project," *The Guardian*, May 21, 2013.

project may move forward.[31] Despite challenges, there is much additional potential for the development of hydroelectric and related infrastructure in Africa. The region's water resources are considered highly underutilized as compared to those in other parts of the developed and developing world; only 8% of its economically feasible hydropower potential is used.[32]

Traditional Fossil Fuels and New Natural Gas Discoveries

Africa has substantial reserves of oil and coal, which are seen as key potential sources of electricity generation, but are viewed as relatively highly polluting. New oil- and coal-fired plants often face opposition from environmental activists, but market demand for these resources is fairly strong. For many opponents of such technologies, a more attractive fossil fuel is natural gas, which, while carbon-producing, is regarded as a much more clean-burning energy source than other fossil fuels. Most of the region's known natural gas resources are associated with oil reserves, and almost 90% of the region's most well-assessed natural gas reserves are in its two biggest oil-producing countries, Nigeria and Angola. However, in recent years, massive natural gas discoveries have been made in some countries that are not significant oil producers, primarily Mozambique and Tanzania. Some other African countries are also thought to contain large natural gas fields, but these resources remain largely unassessed or undiscovered, or are associated with potential environmental risks or other extraction challenges. Low world oil prices since mid-2014 has caused companies to scale back exploration and development efforts, particularly in challenging environments.

Africa's natural gas finds may one day underpin relatively inexpensive, large-scale power generation, but local use of natural gas is limited in much of the region due to a lack of gas utilization infrastructure (e.g., pipelines), and in many producing countries, substantial quantities of gas are flared as a by-product of oil extraction. Most sub-Saharan countries that produce natural gas consume it domestically, although the amounts tend to be small. Nigeria is by far the largest producer and exporter of natural gas in Africa, sending over 80% of its production overseas (representing more than half of all of Africa's natural gas production).

There have been some new gas finds in West Africa, notably in Ghana, which is building a national gas utilization infrastructure. Until recently, East Africa was considered poor in traditional energy resources, but starting in 2010, natural gas discoveries in Tanzania, Mozambique, and other countries have made East Africa a hotbed of natural gas exploration and development.[33] Some southern African countries also have significant shale gas potential that hydraulic fracturing ("fracking") technology may make commercially viable to develop.

There is very little intra-African trade in natural gas because of limited pipeline infrastructure to move natural gas between countries. As shown in **Figure 2**, electric power plants are often located at a distance from new natural gas resources. Transporting natural gas by large diameter

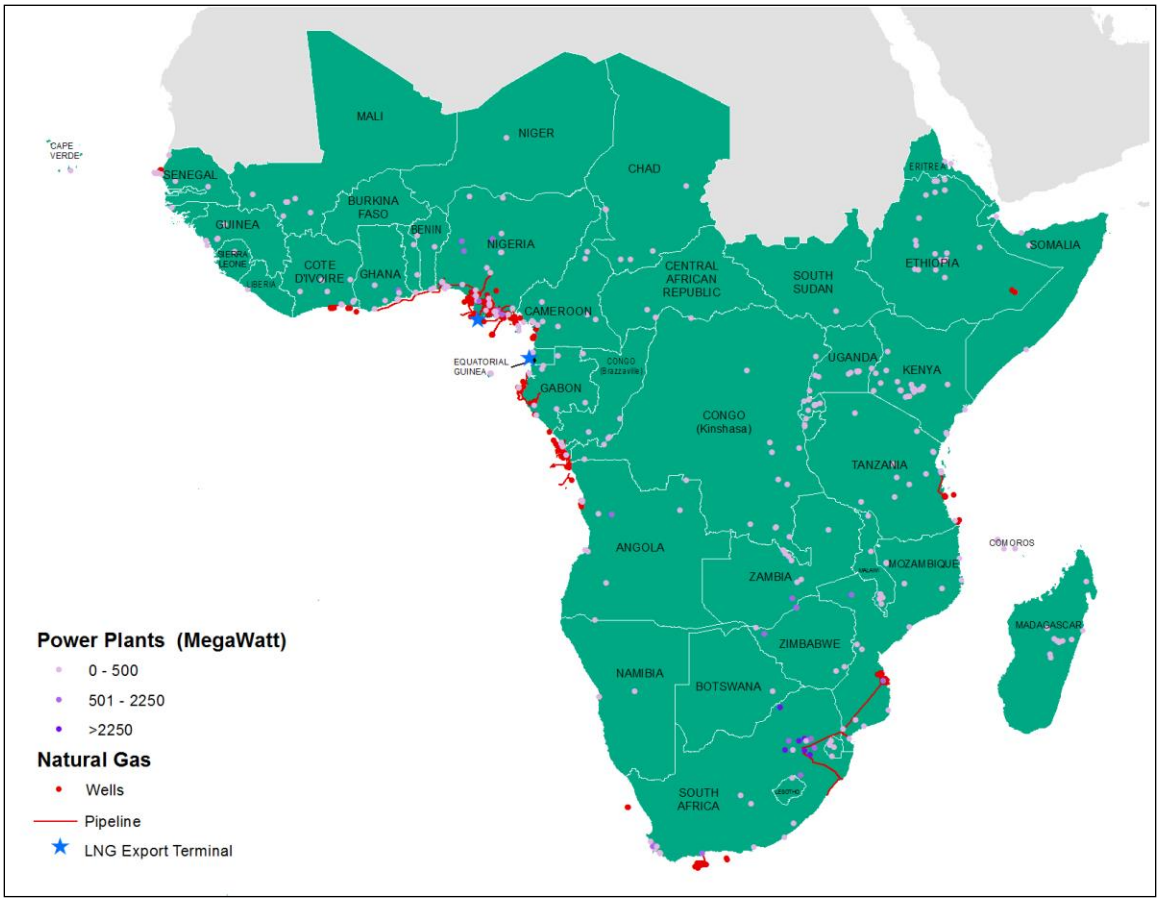
[31] South African Government, "South Africa: SA, DRC Sign Grand Inga Project Treaty," October 30, 2013.

[32] U.N. World Water Assessment Program, *Water and Energy*, Volume 1, *World Water Development Report 2014*, and prior editions of this annual report; see also Seline van der Wat, "Hydro in Africa: Navigating a Continent of Untapped Potential," *HRW-Hydro Review Worldwide*, October 22, 2013, among others.

[33] Mozambique's gas reserves are thought to be especially large. Its proven gas reserves (gas that can be viably commercially produced using existing technology at current prices with a 90% certainty) are limited to 4.5 trillion cubic feet (Tcf), making them roughly the 60th largest globally, but new discoveries and assessments continue to be made. Discovered resources (fields that have been discovered but not fully-assessed or proven) are thought by some analysts to total as much as140 Tcf, and possibly much more. If such estimates are proven, Mozambique's reserves may rank among the top ten globally. U.S. Energy Information Administration (EIA), Emerging East Africa Energy, May 23, 2013; EIA, International Energy Statistics, Natural Gas, Reserves (online database); and KPMG, *Oil and Gas in Africa Africa's Reserves, Potential and Prospects*, 2013.

pipelines over long distances is expensive, and Africa's current natural gas market is very small. Exporting natural gas by sea is also costly, particularly due to the need to liquefy it for shipment, which is part of the reason that two-thirds of the natural gas produced in the world is consumed domestically. Even so, natural gas reserves in East Africa and in several West African countries are large enough that energy firms involved in developing them have justified the cost of and are building several large, capital intensive liquefied natural gas (LNG) plants (called trains, which condense gas and transform it into a liquid state by removing certain compounds and cooling it). Most of resulting LNG is currently expected to be exported, much of it to Asia, but there is a potential for some of this gas production to be used to fuel power generation plants in Africa. Smaller offshore and inland gas reserves may also be attractive for use in local power production, especially in cases where their size or the distance from export processing facilities terminals would make them economically unviable sources of production for export. However, not all such reserves may be prime candidates for use in local power production. If the gas is not located near to where it will be used within the region, the costs of either investing in lengthy pipelines or power transmission lines—if an electricity generating plant is built near to the gas reserves—could outweigh the potential benefits of tapping these energy sources. On the other hand, if the gas reserves at issue are sizable enough to fuel large amounts of power generation for a lengthy period, large investments in the infrastructure necessary to tap them as a source of power and to achieve economy of scale cost advantages. Such investments may also be justified by the large size of Africa's large unmet power needs, which represent potentially massive untapped market demand.

Figure 2. Select African Energy Infrastructure



Source: Compiled by CRS using data from IHS 2012 and Esri, date: October 23, 2013.

Note: Map does not show new gas fields off Ghana and northern Mozambique.

Regional and Country-Specific Approaches to Power Sector Development

Improved power connections among the regions of Africa and the development of regional projects that exploit economies of scale could generate substantial increases in African power generation and distribution capacity. Greater regional power supplies could potentially produce more socially equitable access to power infrastructure (e.g., bring power to populations that are underserved or have been entirely bypassed by current power distribution networks). The cost of building large regional energy projects, however, can be substantial. This is also true of the costs associated with constructing transmission and distribution networks necessary to reach small, often remote communities that lack access to power. Maintaining this new infrastructure would also be a major challenge. While hydropower projects remain controversial, several large hydroelectric dams are currently or prospectively being developed in the region. A host of other cost-benefit factors associated with large pan-regional projects must also be weighed in any consideration of efforts to scale up power capacity in Africa:

> By creating large regional markets for electric power, greater cross-border trade could help stimulate needed investment in low-cost generation. Four regional power pools already operate in Sub-Saharan Africa, but the quantities of electricity production traded between

> countries are still very small. Most of today's trade occurs within the Southern Africa Power Pool (SAPP). The main exporting countries generate electricity from hydropower (the Democratic Republic of Congo [DRC], Mozambique, Zambia), natural gas (Côte d'Ivoire and Nigeria), or coal (South Africa).
>
> Despite limited progress, the potential benefits of increased trade are significant. For example, in the SAPP alone, the volume traded internationally could rise ... with additional investments in the regional transmission lines needed to bring cheaper power to consumption centers. Although the overall savings in the annualized cost of the power sector under trade are relatively small, at less than 10 percent, the gains from cheaper power may be substantial for individual countries. Under trade, most countries would see reductions in the average cost of power of a few cents per kilowatt-hour (kWh), representing savings of 20–60 percent. For a handful of countries, the gains would be as much as $0.10 per kWh, representing a saving of more than 60 percent.
>
> The main effect of increased cross-border trade in power would be to support the development of large-scale hydropower schemes that would not be viable at the national level. The additional hydropower would displace natural gas generation in Eastern Africa and coal generation in Southern Africa. A related consequence would be to increase the share of power coming from key export countries such as Ethiopia in East Africa and the Democratic Republic of Congo in Southern Africa.[34]

Centralized Power Generation

Historically, centralized large-scale power generation has generally been the most efficient and economic approach for delivering electricity to consumers throughout the developed world. However, centralized power generation is most ideally suited for populations that are concentrated. Africa has a large rural population—approximately 64% in 2010—although the U.N. indicates that the general trend for this region is towards more urbanization (see above).[35] According to one source, some policy-makers in African countries have advocated the construction of large power grid networks that would span the entire continent as a means of providing a solution to energy poverty in Africa. Initially, the focus was on the creation of regional power pools in the South, West, Central, and East parts of the continent.[36] A 2010 World Bank-led study compared the economics of centralized power generation and grid extension with distributed electricity generation in Africa. Using Ethiopia, Kenya, and Ghana as case studies, the authors compared the economics of delivering consistent and reliable power—24 hours each day—through a grid expansion approach and a decentralized approach. The decentralized approach included an evaluation of renewable sources of power with electricity storage as well as diesel generators. One of the study's conclusions was that the "economics of grid-supplied electricity in more densely populated areas remain compelling, especially as the concentration of population in Africa is likely to increase rather than diminish."[37] It also concluded that

[34] AICD, op. cit.

[35] United Nations Department of Economic and Social Affairs Population Division, *World Urbanization Prospects: The 2011 Revision*, October 2012.

[36] Power pools are systems that tie two or more utilities together, allowing for better balancing of electrical loads across large power grids, greater service reliability, and redundancy and cost savings in generational capacity. They also support market-based allocations of energy supply and demand by enabling trade in electricity. Pools are often legally and regulatorily complex to establish and administer. A.B. Sebitosi and R. Okou, "Re-Thinking the Power Transmission Model for Sub-Saharan Africa," *Energy Policy*, 2010.

[37] U. Deichmann, C. Meisner, S. Murray, and D. Wheeler, "The Economics of Renewable Energy Expansion in Rural Sub-Saharan Africa," Energy Policy, October 13, 2010.

> stand-alone renewable energy technologies will be the lowest-cost option for a ***significant minority*** [emphasis added] of households in African countries. These will be mostly in rural and more remote parts of the country, but stand-alone technologies are also an option for hard-to-reach pockets in more densely populated demand areas that are otherwise grid connected.[38]

The World Bank analysis does not suggest that a centralized power generation and grid expansion approach is the only highly feasible solution for increasing electricity access in Africa. Rather, it indicates that there are economic merits associated with this approach. While the analysis clearly states that decentralized (also known as "distributed") renewable power in Africa "cannot provide a universal solution to universal access," it does indicate that decentralized power may play an important role in providing power to rural Africa.[39] It is important to recognize that the World Bank analysis is static and is based on cost and performance assumptions that were available as of 2010. This is important, because technological innovation—and consequent implications for associated cost and planning assumptions—are subject to change. Over the last three years, for instance, purchase prices for solar PV equipment have declined considerably. The performance for wind power technology has improved as well. How much these cost and technology improvements may affect the World Bank analysis results is not clear, but such factors merit consideration when evaluating various policy options.

Distributed Power and Renewable Electricity

An alternative to the centralized grid expansion approach is a distributed power-generation architecture that uses locally available renewable energy sources (e.g., wind, solar, small hydro, geothermal). Proponents of this approach argue that the rural nature of African populations results in significant costs associated with grid extension to communities located in remote areas. In light of these grid extension costs, distributed generation using renewable energy sources may in some instances be cost-beneficial for many rural communities.

Proponents of this approach also cite recent cost/price reductions for renewable electricity generation equipment, most notably solar PV panels, as part of the economic justification for selecting distributed generation (DG) over the grid expansion approach. Some analysts argue that centrally managed power grids are obsolete and that micro-electronics and smart-grid technologies can enable a distributed generation architecture that may better serve Africa's energy-poor population.[40] Solar PV, for example, is often cited in the literature as an important source of distributed power that could potentially be used by rural African populations. Electricity services provided by all-renewable distributed generation systems may be limited, however, due to the daily variability of some renewable sources of power. In addition, some solar-only distributed generation solutions may only provide lighting, phone charging, and other basic services. Other services, such as continuous refrigeration for medical supplies and water pumping for sanitation and agricultural usage, may be limited with a solar-only DG architecture.

Distributed generation systems that include a combination of solar PV and diesel generation—and possibly other technologies such as battery storage—are an option for providing 24-hour energy service to some isolated populations.[41] While this approach is not a completely renewable DG

[38] Ibid.

[39] Ibid.

[40] A.B. Sebitosi and R. Okou, "Re-Thinking the Power Transmission Model for Sub-Saharan Africa," *Energy Policy*, 2010.

[41] Y.Azoumah, D. Yamegueu, P. Ginies, Y. Coulibaly, and P. Girard, "Sustainable Electricity Generation for Rural and Peri-Urban Populations of Sub-Saharan Africa: The "Flexy-Energy" Concept," *Energy Policy*, October 8, 2010.

solution, it is an approach that could provide consistent energy services, especially given the variable and intermittent nature of many renewable power generation technologies. However, like most technologies, it has downsides—fuel, for instance, must be transported at potentially considerable costs, and simply buying the fuel in the first place represents a recurrent cost. In some locales, other technologies, such as small hydro systems—encompassing mini-hydro, often defined as providing less than 1,000 kW of power, and micro hydro (less than 100 kW)—may be appropriate, and can be combined with other renewable energy source technologies.

Combining Centralized and Distributed Generation

One of the common themes in the literature on electricity access in Africa is that a combination of centralized and distributed generation technologies is likely to be needed to satisfy the electric power needs of the entire continent—and can contribute to the reliability and resilience of national power systems. One study that assessed China's national electrification strategy notes that while China emphasized grid expansion, the country also instituted programs to provide decentralized power generation to serve rural populations.[42] Along similar lines, a 2011 European Commission (EC) Joint Research Center (JRC) report analyzed different options for delivering electric power throughout Africa.[43] The report includes an assessment of different renewable energy resources in Africa and provided a comparative cost analysis of certain renewables, distributed generation, and grid extension as possible solutions for improving energy access on the continent.

Renewable Electricity Generation Potential

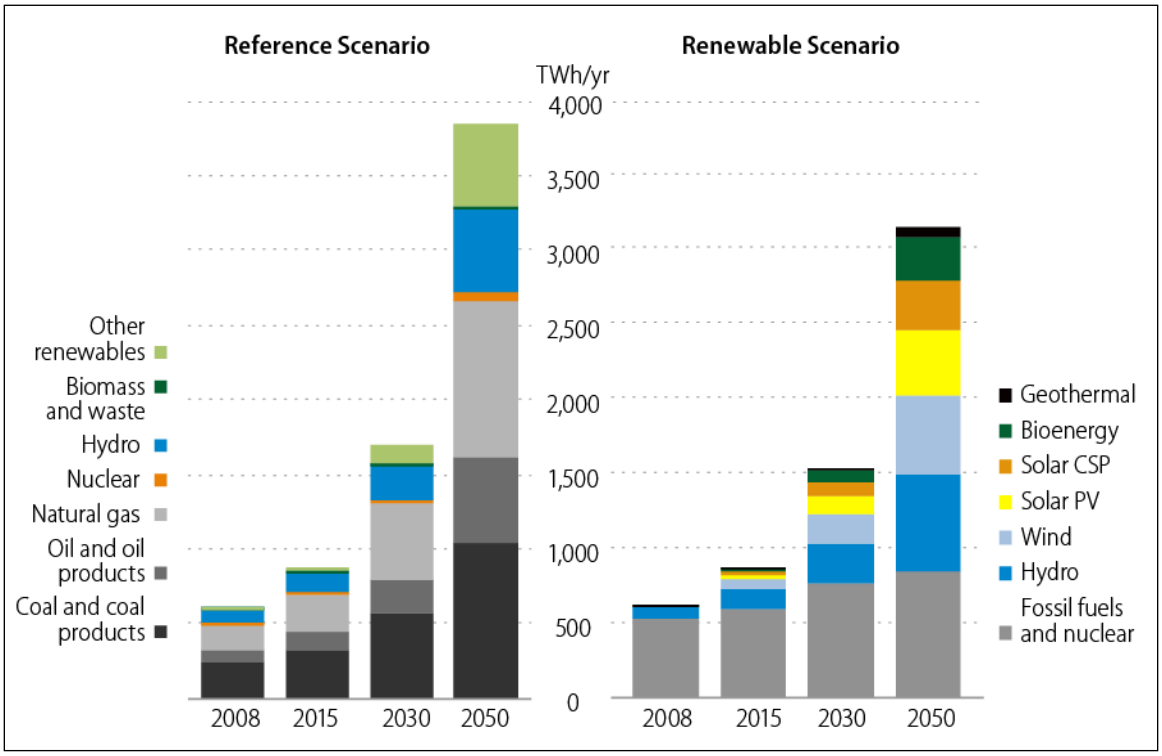
The relative potential of renewable power sources to contribute to achieving universal energy access goals is uncertain, and projections of the role that renewables might make toward achieving this goal depend significantly on policy assumptions used to forecast power sector development. The International Renewable Energy Agency (IRENA), which has analyzed varying scenarios for electric power deployment in Africa, has concluded that "renewable power generation technologies alone will not meet Africa's energy challenges," but asserts that they can play a significant role. IRENA's analysis includes two scenarios: (1) a reference scenario, and (2) a renewables scenario. **Figure 3** shows the comparison of the two IRENA scenarios. According to the study, the reference scenario reflects "a continuation of existing economic, demographic and energy sector trends" and policies, under which "universal electricity access is not achieved and access reaches only 43% in 2030." The "Renewable" scenario "assumes concerted government action in the area of efficiency standards and programmes," as well as rapid, persistent, and large-scale pursuit of investments in renewable-based electricity systems and simultaneous reductions in the use of fossil fuels, especially in the in the 2030 to 2050 timeframe. It would achieve African "electricity access for all by 2030." Another key assumption under the "Renewable" scenario is that each individual country government would issue national efficiency use technology standards. These standards would reduce total demand (not shown) from the reference scenario.[44]

[42] I.H. Rhman et al., "Understanding the Political Economy and Key Drivers of Energy Access in Addressing National Energy Access Priorities and Policies," *Energy Policy*, April 18, 2012.

[43] A. Belward et al., "Renewable Energies in Africa," European Commission Joint Research Center, 2011.

[44] International Renewable Energy Agency, *Prospects for the African Power Sector*, 2011.

Figure 3. IRENA Scenarios for Africa Power Sector Development, 2008-2050



Source: International Renewable Energy Agency, "Prospects for the African Power Sector," 2012.

Notes: PV = photovoltaic; CSP = concentrated solar power.

Renewables currently make up about a quarter of African energy sources, and renewables are generally viewed as playing an important role in future power development. A frequent theme in the energy literature is that hydropower can potentially provide significant amounts of low-carbon electric power. As indicated in **Figure 3**, hydro is expected to contribute much towards African electrification regardless of the policy assumptions used for a particular forecast. One source indicates that approximately 220 gigawatts of hydropower potential remains unexploited in Africa and that "tapping hydropower sources could help greatly in achieving full access."[45] However, U.S. assistance to develop Africa's hydroelectric sector may be constrained if congressional limitations on funding for that end were to be imposed.[46]

Power Africa Presidential Initiative

In June 2013, days after the introduction of H.R. 2548, the Electrify Africa Act of 2013 (later amended to "of 2014"), President Obama announced the establishment of Power Africa while in South Africa on a trip to Africa (which also included stops in Senegal and Tanzania). The initial key goals of the initiative were to increase access to power by expanding power generation capacity by 10,000 megawatts (MW) and 20 million new power connections, among other ends.

[45] The 220 giga-watt figure represents potential generation. Actual generation would vary according to annual rainfall totals, the amount of water catchment capacity, and other factors. Bazilian et al., "Energy Access Scenarios to 2030 for the Power Sector in sub-Saharan Africa," *Utilities Policy*, November 1, 2011.

[46] Section 7060 of P.L. 113-76 (Consolidated Appropriations Act, 2014) discouraged U.S. support for IFI hydroelectric dam construction projects. P.L. 113-235 (Consolidated and Further Continuing Appropriations Act, 2015) does not contain that limitation.

President Obama expanded the initiative's core aims during the U.S.-Africa Leaders Summit (ALS) in August 2014, increasing the new electricity generation capacity goal to 30,000 megawatts (MW) and setting a new target of 60 million new power connections.

Goal and Focus

The initiative is designed to achieve these ends by providing U.S. technical and financial assistance to help spur construction and improvements to electricity generation, transmission, and distribution infrastructure. It is also intended to build the capacity of power sector institutions and overcome barriers to investment in the sector, aid in the development of regional energy resources, and enhance energy sector governance. The initiative was designed to build "on Africa's enormous power potential, including new discoveries of vast reserves of oil and gas, and the potential to develop clean geothermal, hydro, wind and solar energy" and to help "countries develop newly-discovered resources responsibly, build out power generation and transmission, and expand the reach of mini-grid and off-grid solutions."[47] Power Africa is related to Trade Africa, a separate, complementary USAID-led initiative,[48] both administratively and in terms of their shared focus on regional integration and trade, investment, and economic growth.[49]

While led by USAID, Power Africa is a whole-of-government effort designed to increase access to and supplies of reliable and affordable electricity using "cleaner, more efficient," lower carbon emissions sources of supply and technologies "when possible"; and to "ensure responsible, transparent, and effective management of energy resources" in the region. Power Africa aid was initially targeted toward six "focus countries": Ethiopia, Ghana, Kenya, Liberia, Nigeria, and Tanzania.[50] It remains active particularly in those countries, but has since expanded, notably to Guinea, Sierra Leone, Malawi, Zambia, Rwanda, and Uganda, among other countries—a total of 43.[51] It is also providing technical assistance to selected regional institutions, including the

[47] White House, "Fact Sheet: Power Africa," June 30, 2013.

[48] Trade Africa seeks to increase U.S. trade and investment with and trade capacity building in Africa, including in the power sector, as well as foster regional integration, intra-regional and international trade, and related goals, beginning in East Africa. Trade Africa was announced by the President in Tanzania on July 1, 2013, a day after he launched Power Africa. See CRS Insight IN10015, *Trade Africa Initiative*, by Nicolas Cook and Brock R. Williams.

[49] As of mid-August 2015, Power Africa and Trade Africa (PATA) had a single USAID Coordinator, Andrew M. Herscowitz, who holds a Deputy Assistant Administrator (DAA)-level rank under the Assistant Administrator for Africa. The two initiatives are administered separately, however; in the region, Trade Africa is headquartered in Nairobi, Kenya, while Power Africa is based in Pretoria, South Africa, and administered from Washington, DC by separate teams. USAID plans call for the two initiatives to be formally separated; Trade Africa will be headed by a dedicated DAA-level Coordinator, while Herscowitz will remain Power Africa Coordinator. Originally, there was to have been a single PATA office in Nairobi, but the Power Africa was moved to Pretoria for security and operational reasons, including the fact that major Power Africa private sector financial partners and several Power Africa agencies and activities are based there. USAID response to CRS query, August 13, 2015.

[50] According to the White House, the focus countries "have set ambitious goals in electric power generation and are making the utility and energy sector reforms to pave the way for investment and growth." White House, "Fact Sheet: Power Africa," op. cit.

[51] As of July 2015, other countries included Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Brazzaville), Cote d'Ivoire, Democratic Republic of the Congo (DRC), Djibouti, Gabon, Gambia, Guinea-Bissau, Lesotho, Madagascar, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Sao Tome and Principe, Senegal, Seychelles, South Africa, Swaziland, and Togo. USAID, "Where We Work; Power Africa works in all of Sub-Saharan Africa, "http://www.usaid.gov/powerafrica/wherewework, and "Power Africa Assistance in Sub-Saharan Africa: Categorized by U.S. Government Agency," Annex 4, *Power Africa Annual Report*, July 2015.

Economic Community of West African States (ECOWAS), the East African Community (EAC), the African Union Commission, and the East and West Africa Power Pools.

Funding

When the initiative was announced, Power Africa participating U.S. government (USG) agencies (see "Agency Roles," below) committed to provide up to $7.81 billion in various types of technical assistance, grants, export and trade finance risk mitigation tools, loans, and other resources toward meeting initiative goals. These activities are accompanied by a variety of diplomatic, trade promotion, and advisory efforts to enhance African power sector capacity. Of the total, $285 million took the form of USAID allocations to support its Power Africa coordinating and program activities.

Over time, the size of the initiative has expanded. During the August 2014 U.S.-Africa Leaders Summit, the Obama Administration announced that private sector commitments to the initiative totaled $20 billion, and existing and new international agency and donor commitments to Power Africa totaled $8.67 billion. During the ALS summit President Obama also "pledged a new level of $300 million in assistance per year to expand the reach of Power Africa across the continent." This funding would be additional to $285 million previously allocated to USAID for Power Africa, and obligations of the increased funding would begin in FY2016.[52] Allocation breakouts of the initial $285 million and the $300 million expansion are set out in **Appendix B** of this report. In late July 2015, the White House reported that the European Union (EU) and Power Africa had formed a new partnership during the global Financing for Development Conference in Ethiopia, under which the EU had committed to fund more than $2.8 billion in sustainable energy activities in Africa, bringing total non-U.S. government commitments to nearly $31.5 billion.[53] Also in July 2015, the Administration announced that OPIC had committed an additional $1 billion through 2018. This amount, when aggregated with prior U.S. Power Africa pledges, brought total U.S. government agency Power Africa commitments to $9.71 billion.

[52] USAID briefings to congressional staff and information provided to CRS by USAID and the State Department indicate it is being drawn from accounts administered by these agencies, and will fund USAID Power Africa activities. An August 16, 2015 provisional State Department planning projection, provided in response to a CRS inquiry, identifies just under $300 million to fund the new commitment—a tranche of $299.98 million in funding drawn from multiple fiscal years (FY2010 through FY2016). This funding is projected to be drawn from the Development Assistance, Economic Support Fund (ESF), and ESF-Overseas Contingency Operations (OCO) accounts. It would include funds sourced from base year appropriations for these accounts and, where applicable, through various account appropriation transfers: from International Narcotics Control and Law Enforcement (INCLE) to ESF; and from INCLE-OCO and Foreign Military Financing (FMF)-OCO to ESF-OCO. On OCO funding, see CRS In Focus IF10143, *Foreign Affairs Overseas Contingency Operations (OCO): Background and Current Status*, by Susan B. Epstein, among other CRS products.

[53] Commitments announced during the August 2014 summit included $5 billion in technical aid and financing from the World Bank; $2.67 billion in current and planned African Development Bank (AfDB) support; and a Swedish government commitment of $1 billion to support various power goals. Both the World Bank and AfDB receive large U.S. contributions, and the United States, as a top shareholder, exerts influence over both institutions' lending decisions. This $8.67 billion total, together with the $2.8 billion 2015 EU commitment and the $20 billion in private sector commitments brought the total non-U.S. government total to $31.47 billion. The World Bank also provides other grant and loan support for power projects in Africa. The United States, as a top shareholder in both the World Bank and AfDB, provides significant funding to and exerts influence over both institutions' lending decisions. White House, "Fact Sheet: Power Africa," July 25, 2015 and White House, "Fact Sheet: Powering Africa: Increasing Access to Power in Sub-Saharan Africa," August 5, 2014.

Program Approach

Power Africa reflects the view that the costs of reaching universal power access goals are so great that meeting them is unlikely through public sector funding alone. As a result, it prioritizes efforts to use public resources to create enabling policy and regulatory environments necessary to overcome constraints and attract private power sector investment, and on using public resources to leverage and facilitate specific investment deals. Key Power Africa program approaches and activity areas include the following:

- **Transaction Support:**[54] Targeted activities to bring new, planned, or partially completed power projects to financial close[55] and, if applicable, to construction.
- **Power Sector Reform Advocacy:** Advocacy and technical capacity-building centered on the promotion of power sector policy and regulatory reform in order to attract private sector investment and accelerate project development and implementation.
- **Legal Assistance:** Capacity-building to increase host country government power sector expertise and negotiating capacity in structuring, financing and closing power transactions, including the production and release in March 2015 of handbook entitled *Understanding Power Purchase Agreements.*
- **Energy Service Delivery Capacity-Building:** Deployment of transaction and other technical advisors, to help governments improve basic energy service delivery, use data and analytically focused decision-making tools, and advance power sector and investment regulatory reforms and expedite priority power sector projects in focus countries.
- **Private Sector Finance and Investment Mobilization:** Power Africa agency efforts to build cooperation and collaboration between focus country governments, private sector investors, and multilateral development banks (MDBs) centering on mobilizing finance for the power sector by, for instance, addressing constraints on due diligence, financial approvals, and state-owned enterprise (e.g., utility) procurement processes, and otherwise reducing sources of investment risk.
- **Regional Electricity and Energy Trade Expansion:** Technical and policy assistance to expand cross-border electricity connections and trade to increase power supplies and reduce energy costs, focused especially on regional power pool operations, cost structures, and sustainability, initially in East and West Africa. Support for regional planning and national capacities related to spot trading and eventual real-time electricity markets will also be provided.
- **Support for Low Emission Energy Development and Clean Energy:** Support for country-focused, data- and analysis-driven Low Emission Development Strategy (LEDS) planning and implementation efforts tied to broad long-term

[54] USAID defines a Power Africa transaction as a project supporting power "generation, transmission, distribution or energy efficiency" or development of "gas or geothermal production projects and concessions, gas pipelines and associated infrastructure" (e.g., capture of gas associated with oil extraction or the reduction of gas flaring).

[55] USAID defines a "financial close" as a project benchmark at which conditions necessary to allow a project's financing—such as a "credit agreement … either satisfied by the project company, as borrower, or waived by the project lender(s)"—have been met. Closed projects are also expected to incorporate provisions for "a complete package of permanent financing" offered on sustainable terms to allow projects to meet their long-term goals.

economic and investment planning; and related support for low carbon, greenhouse gas-reducing clean energy technologies "when appropriate."[56]

Agency Roles: USAID

Power Africa is led by the Power Africa Working Group (PAWG), a 12-member inter-agency forum chaired by staff in the White House National Security Council and USAID. Power Africa is led in the field by USAID, with headquarters in Pretoria, South Africa. USAID's Power Africa roles are diverse, spanning a range of technical, legal, regulatory, policy, financial, investment and other program service and support functions in countries across Africa. Its key task areas are set out in a 2013 USAID request for proposals (RFP) for the Power Africa Transactions and Reforms Program (PATRP), a multi-year project which is now being implemented by a contractor (see below) in coordination with agency personnel. According to the RFP, key USAID Power Africa responsibilities are to support work in four main task areas:[57]

- **Program Implementation Institutional Coordination, and Related Functional Support.** This work centers on collaborating and coordinating with and tracking of the activities of other USG Power Africa agencies, MDBs, regional entities, and other public and private sector Power Africa partners, as well as energy and power sector trends and developments in focus countries and regions. Other activities include varied types of program support (e.g., conferences and training programs); communications and outreach support targeting the U.S. public, Congress, and various initiative partners and like-minded donors, among others; and Power Africa project implementation technical and advisory services, including monitoring and evaluation.
- **Transaction Support Related to 10 MW+ Projects.** This task area centers on developing a series of power generation projects, from the conceptual phase through late stage transactions, and efforts to bring existing late stage projects to completion.
- **Support for Small Scale Projects (under 10 MW), Rural Electrification, and Mini-Grids.** This activity area seeks to increase private and other investment in small-scale, clean energy projects, including distributed generation, off-grid or mini-grid development projects, and provide support to rural electrification initiatives worth an aggregate of $50 million per year.[58]

[56] Such activities support country-focused, data and analysis-driven Low Emission Development Strategy (LEDS) planning and implementation efforts. USAID, *Request for Proposal (RFP) No. SOL-623-14-000001 Power Africa Transactions and Reforms Program (PATRP) Project, Amendment 2*, November 15, 2013/issued December 6, 2013; and USAID/Power Africa, "U.S. Government Support Capabilities," n.d. On LEDS, see USAID, "Low Emission Development: EC-LEDS," January 27, 2014, http://www.usaid.gov/climate/low-emission-development-strategies.

[57] The following descriptions are brief USAID Power Africa activity summaries drawn from USAID's Power Africa RFP, the source of direct quotations in some of the descriptions. The RFP describes these activities in greater depth and sets out a wide range of illustrative program activities, goals, and qualitative and quantitative program benchmarks.

[58] An alternative to the centralized grid expansion approach is a distributed power-generation architecture that uses locally available renewable energy sources (e.g., wind, solar, small hydro, geothermal). Proponents of this approach argue that the rural nature of African populations result in significant costs associated with grid extension to populations located in remote locations. In light of these grid extension costs, distributed generation using renewable energy sources may be a more economically attractive option for a number of people living in rural areas. Distributed generation can include fossil-fueled power plants which are not connected to a grid. These facilities serve small communities, industrial facilities, and institutions. See discussion in the "Distributed Power and Renewable Electricity" section, below.

- **Provision of Regulatory and Institutional Strengthening and Policy Reform.** Work in this area centers on supporting regulatory, legal, and policy-making capacities and frameworks of country governments and regional institutions to create enabling environments conducive to long-term sector investment and development. It would seek to foster project execution capacities centering on issues like "tariff modeling, project selection, competitive procurement, contracting and post-award monitoring" and project construction in a "standardized, transparent and replicable" manner. Core targets of work in this area may include regional power pools, natural gas power project development, and project finance mobilization, including through policy and regulatory reform necessary to both attract private investment and protect consumers.

According to USAID's RFP, initial USAID-specific goals that were expected to be met as a result of USAID's activities included an increase in power generation capacity by 5,000 MW; the facilitation of up to $6 billion in power sector investments; an increase by 10 or more in the number of countries trading in power at the regional level; a reduction of technical and commercial electricity losses; and at least one million new urban and rural household and commercial power grid connections. Others included enhancements to power sector enabling policy environments in focus countries and legal and regulatory frameworks for energy, including for natural gas in at least two focus countries. Improved power distribution and transmission services and increased use of non-GHG intense, low-emission, and renewable energy, notably in the long-term, are other goals. Power sector financial performance was another target of technical assistance under PATRP, along with increased use of data and analytical tools for decision-making, along with the use of long-term, integrated resource planning that pays heed to both large consumers, communities, and other sub-national populations.[59] CRS has not located any detailed descriptions of how, if at all—in contrast to funding increases—the expanded goals set out by President Obama in August 2014 may alter this basket of activities.

USAID Power Africa Progress

USAID's headquarters in South Africa supports a "one-stop-shop" approach allowing access to the largest PAWG players: MCC, OPIC, Ex-Im, and USTDA, and the Commerce Department and its U.S. Foreign Commercial Service. USAID has deployed more than 25 advisors across Africa. A major technical assistance component of USAID's Power Africa work is the Power Africa Transactions and Reforms Program (PATRP), a three- to five-year, $64 million contract implemented by Tetra Tech and awarded in 2014.[60] Other USAID contractors have been also involved in various aspects of Power Africa at earlier stages. Power Africa also helps coordinate PAWG agency contributions to multilateral power projects[61] and inputs to Power Africa from

[59] Integrated Resource Planning involves detailed planning to meet forecasted annual peak energy demands, and takes into account specified reserve margins and reliability criteria; demand-side management; supply options, fuel prices, environmental costs and constraints, evaluation of existing resources; and a variety of other factors and assumptions.

[60] According to a 2013 USAID Request for Proposal (RFP), PATRP is a cost-plus, fixed-fee contract (i.e., a contract allowing for payment of permitted expenses under a set ceiling plus an additional profit payment). Tetra Tech, "Tetra Tech Wins $64 Million USAID Power Africa Contract," July 14, 2014; USAID communication with CRS; and USAID, *Request for Proposal (RFP) No. SOL-623-14-000001 Power Africa Transactions and Reforms Program (PATRP) Project, Amendment 2*, November 15, 2013/issued December 6, 2013.

[61] Key examples include the African Development Bank (AfDB)-hosted African Legal Support Facility, which supports African governments in the negotiation of complex commercial transactions; the AfDB's Sustainable Energy Fund, a multi-donor facility that supports small and medium clean energy projects; and the African Union's previously primarily European-backed Geothermal Risk Mitigation Facility, which funds selected geothermal development

various USAID initiatives that are global in nature or support multiple USAID projects and initiatives.[62]

As of July 2015, Power Africa had provided transaction support for 11 projects across Africa that had reached USAID's key transactions criteria, financial closure. An additional one had reached a first stage of closure (Azura-Edo, in Nigeria) and had been slated to reach final closure, but an unforeseen regulatory hurdle hindered that outcome.[63] The 12 transactions had an estimated project value of $6.9 billion and were projected to be capable of generating 4,120 MW, using diverse types of energy resources and technologies, and supporting 4 million new grid connections.[64] In addition, as of late July 2015, USAID's Development Credit Authority had mobilized $171 million in private finance in support of power projects, and had a pipeline of more than $300 million in additional new projects.[65] USAID has also played key roles in advancing initiative mini-grid and off-grid power generation and distribution projects; see text box.

Focus on Mini-Grid and Off-Grid Capacity-Building

Beyond the Grid. Beyond the Grid (BTG) is a peri-urban and rural off-grid and mini-grid (200-watt to 10-MW) strategy that promotes clean and hybrid energy technologies and innovation in investment partnerships and other projects. A USAID-led Power Africa-initiated coordinating mechanism that brings together various resources and capacities provided by USG Power Africa agencies, the World Bank Group, the African Development Bank, the Swedish government, African governments, and diverse other public and private sector partners. As of November 2014, BTG was helping to facilitate more than 25 small-scale energy projects; had facilitated more than $1 billion in new private sector investments by more than 40 private and public sector organizations. Key BTG goals are to increase use, construction, or access to access to off-grid and mini-grid power and technologies by generating

activities. Another is the World Bank's Africa Renewable Energy and Access program (AFREA), which supports increased access to power by funding service delivery enhancement projects and work to scale-up use of innovative electric, lighting and cooking technologies; increase access to low carbon power supplies, and improve state power sector institution capacities. A third is the Private Financing Advisory Network (PFAN), a multilaterally backed initiative that provides varied business and financial mobilization support for early stage clean energy projects and efforts to transfer clean, renewable, energy-efficient technologies to developing countries

[62] Key examples include USAID's Development Credit Authority (DCA), which uses partial credit guarantees to mobilize local financing in developing countries by encouraging private lenders to finance underserved borrowers in new sectors and regions; and USAID's Global Development Alliance mechanism, which helps create public-private development partnerships. Others include USAID's Development Innovation Ventures (DIV), a competitive sourcing mechanism for scaling up innovative technologies; and USAID's Powering African Agriculture program, which seeks to make renewable energy technologies accessible to farmers and agribusinesses in low-income countries with the goal of increasing farm output rates, production quality, and market access.

[63] Nigeria's Justice Minister reportedly rejected a request from the government-backed Nigerian Bulk Electricity Trader (NBET), the government-owned contractual recipient of the plant's power production, to waive sovereign immunity in relation to the project. Such a waiver would potentially have made the government liable for payment in the event of a default by NBET and/or other parties in the deal, a requirement of some project participants, but the minister viewed the demand as an unacceptably potentially open-ended legal claim on the government. USAID reports that it is testing a possible solution in Nigeria to this challenge: "a Put-Call Option Agreement, in which the host government will purchase an asset at an agreed price in the event of default. Although still a contingent liability to the host government, this provides adequate comfort to investors to help deals move forward." Olusola Bello and Badejo Ademuyiwa, "Justice ministry turns clog in Azura, Mobil power projects," Businessdayonline.com, May 4, 2015; OPIC, "Azura Power West Africa Limited," Opic Public Information Summary; and USAID, *Power Africa Annual Report*, July 2015.

[64] USAID response to CRS query, August 13, 2015; and White House, "Fact Sheet: Power Africa," July 25, 2015.

[65] DCA loans assume a portion of risk taken by private lenders providing development program loans or activities. The $171 million helped spur financing of two projects in Nigeria ($90 million for on-lending to distribution and generation firms and a $50 million distributed solar-battery hybrid power systems project portfolio); two in Tanzania (two separate $11 million and $12 million 10 MW hydroelectric projects); and one in Kenya, an $8 million for retail loans financing household power grid connections.

power generation growth of by 250 MW or more in such contexts; mobilize off-grid and mini-grid private sector and other investment commitments of $500 million or more. Others are to use such technologies to increase economic productive uses of electricity by businesses and households and increase access to power by at least 2 million households, businesses, and/or public sector actors. Promotion of rural women's access to power and participation in power development projects is an additional key BTG goal. BTG also seeks to foster regulatory and policy regimes conducive to small-scale energy sector project development, investment and operation; and making a range of BTG "tools" available to support development of the sector.[66]

Off-Grid Challenge. The U.S. African Development Foundation (USADF), USAID, and GE Africa have sponsored a project called the Off-Grid Energy Challenge. It provides $100,000 grants to finance projects that support innovative, sustainable approaches to increase unserved and underserved communities' access to power generated and delivered through off-grid or micro-grid technologies and applications. Now in its third round (with a total of nearly 50 grants), and funded at $5 million, the Challenge seeks to support projects that are financially sustainable; use renewable energy resources; and support applications that spur economic productivity (e.g., agro processing, farm production, and other business activity). Recipients are 100% African owned and managed enterprises, associations or organizations and funded projects are short term, no longer than 12 months. While winners receive $100,000, projects may be funded at a higher rate if applicants can marshal additional sources of capital. Technologies supported are diverse, ranging from generation using renewable to metering, payment collection, and systems transmission solutions.[67]

Other Agencies and Power Africa Commitments and Progress[68]

Twelve USG agencies play a direct or supporting role in Power Africa and participate in PAWG activities. Of the initially announced projected $7.81 billion in U.S. public Power Africa commitments, USAID was originally to provide $285 million in technical assistance. As earlier noted, in August 2014, the Administration announced a new level of $300 million per year that appear likely to primarily fund USAID activities.[69] About $6.5 billion of the initial $7.81 billion pledge was slated to take the form of U.S. export and overseas investment agency loans or related financial services. In the absence of borrower defaults, many of these outlays would be repaid to the originating agency and, in some instances, would generate agency income (e.g., service fees, collections, and other transactional charges).

In some cases, Power Africa activities build on past agency projects relating to the African electricity sector, and in many instances, transaction assistance has centered on aiding the finalization of deals that were under way prior to the initiative's launch. In general, Power Africa agencies use their existing authorities, funding sources, and administrative or regulatory processes in determining project eligibility or selection under the initiative but, where applicable, pursue initiative activities in conjunction with USAID and/or other PAWG agencies. Several

[66] These tools focus on early stage transaction support; finance; capacity building; partnerships; legal assistance; policy/regulatory design and reform; and informational resources. These resources are provided by varying combinations of USG Power Africa agencies, the World Bank Group, the African Development Bank, the Swedish government, African governments, and diverse other public and private sector partners. See USAID, "The Power Africa Toolkit," May 28, 2015; USAID, "Beyond the Grid Partner Commitments," November 19, 2014; USAID, "Beyond the Grid Increasing Access through Off-Grid & Small-Scale Energy Solutions," n.d.; and DOE, "Highlights of Deliverables ... ," op cit.

[67] Funding totals $5.65 million, of which $5 million is for grants and $650,000 is for supervision and support. Funding providers are USADF ($2.6 million), and USAID ($2.1 million), and GE ($950,000). USADF, "Power Africa Off-Grid Energy Challenge," and "Off-Grid Energy Investment Summary"; the latter contains descriptions of 28 Round I and II grants; and funding information provided to CRS by USADF, August 2015.

[68] USAID/Power Africa, "U.S. Government Support Capabilities," n.d.; and White House, "Fact Sheet: Power Africa," op. cit.; and agency background materials.

[69] For a breakout of planned USAID funding, see Appendix B.

PAWG agencies have specially-dedicated coordinators or staff teams to manage their initiative activities.

OPIC, Ex-Im Bank, and MCC

Under Power Africa, the Overseas Private Investment Corporation (OPIC) initially committed to provide up to $1.5 billion worth of financing, insurance, and other risk mitigation assistance to support U.S. private sector investment in African energy projects. OPIC also committed to co-host with USAID a 2014 African energy and infrastructure investment conference focused on pairing African power sector investment opportunities with USG agency finance support tools and sources of finance. It also participates in the in U.S.-Africa Clean Energy Finance Initiative (see below). In late July 2015, the White House stated that OPIC expected to exceed its initial commitment by 2016, and that it had committed an additional $1 billion to Power Africa through 2018.[70]

The U.S. Export-Import Bank (Ex-Im) pledged to provide up to $5 billion worth of financing, loan guarantees, and credit insurance to boost U.S. power project exports to Africa. However, because the Bank's financing is entirely demand-driven, it is unable to proactively program financing, which in the case of Power Africa is solely dedicated to financing African demand for American power products. This means that its $5 billion on potential commitment can only be fully used if there is business demand for it. In addition, as noted at the outset of this report, unless and until the Bank's lapsed charter authority is renewed, much of the Bank's Power Africa potential financing for the initiative (which makes up 64% of the initial aggregate multi-agency $7.81 billion Power Africa commitment) may not be realized. As of early August 2015, Ex-Im had seven authorized Power Africa-attributed projects worth $131.5 million on its books. Its Power Africa commitment remains at $5 billion. Ex-Im has a number of projects at early stages in its approval process pipeline (including a possible $2 billion in projects under a declaration of intent signed with South Africa's Industrial Development Corporation) that could potentially go forward if its charter were renewed.[71]

Under Power Africa, the Millennium Challenge Corporation (MCC) initially pledged to fund up to $1 billion worth of power system and related regulatory and institutional capacity-building projects, and related technical assistance under MCC Compacts (multi-year development agreements signed with eligible countries).[72] In late July 2015, the White House reported that the MCC expected to have committed a total of almost $2 billion to Power Africa goals by the end of 2015, nearly double its original commitment level.[73] Prospective Compacts that might make up that total include current compacts in Ghana and Malawi and prospective ones in Benin, Liberia, Sierra Leone, and Tanzania, although that end may prove challenging in some cases.

[70] White House, "Fact Sheet: Power Africa," July 25, 2015.

[71] Ex-Im Bank, "Ex-Im Bank To Assist in Financing Up to $2 Billion of U.S. Exports to South Africa's Energy Sector," August 7, 2012; and Ex-Im Bank response to CRS query, August 11, 2015

[72] On the operations of OPIC and Ex-Im, see CRS Report R43581, *Export-Import Bank: Overview and Reauthorization Issues*, by Shayerah Ilias Akhtar, and CRS Report 98-567, *The Overseas Private Investment Corporation: Background and Legislative Issues*, by Shayerah Ilias Akhtar,. On the MCC, see CRS Report RL32427, *Millennium Challenge Corporation*, by Curt Tarnoff.

[73] White House, "Fact Sheet: Power Africa," July 25, 2015.

Selected Current and Prospective MCC Compacts

Current Power-Focused Compacts

Ghana. In August 2014, the MCC signed a $498 million, five-year MCC power sector Compact with Ghana's government, which will invest $37.4 million of its own funds in the initiative, bringing total Compact value to $535.6 million. The MCC predicts that Compact projects will "catalyze at least $4.6 billion in private energy investment and activity from American firms in the coming years." The project focuses entirely on "financially viable" power sector capacity building, especially through private investment in order to meet current and future household and commercial demand for power and, more broadly, reduce poverty. The broad objective is to support power sector technical capacity building and "reforms needed to transform [the ...] sector and put it on a path to profitability and sustainability, ultimately creating a climate that will attract private investment."[74] Compact components include projects to

- increase legal connections to the power system by small and medium enterprises (SMEs);
- financially and operationally reform the Electricity Company of Ghana (ECG) and Northern Electric Distribution Company; and reduce ECG power losses from distribution systems (due to system flaws, theft, and meter manipulation), and reduce outages, among other efforts;
- enhance energy efficiency and demand-side management, and facilitate investments aimed at balancing power supply and demand (e.g., energy-efficient standards and labelling; energy audits; energy efficiency public-awareness; and pilot projects to introduce distributed off-grid power access using solar systems);
- facilitate private independent power producer investment and associated generation, transmission, distribution and demand-side management projects; operationalize gas to power plans; commercialize Ghana's gas sector; and build regulatory and power tariff review capacities and processes.

Malawi. Malawi was awarded a $21 million Millennium Challenge Corporation (MCC) Threshold program in 2005. It focused on enhancing good governance and fighting corruption. The MCC approved a $350 million, 5-year MCC compact for Malawi in January 2011, but little progress was initially made due to concern over the government's policies, which led the MCC to suspend the project.[75] The Compact was reinstated in June 2012. The Compact focuses on improving the national power grid and hydropower generation efficiency; institutionally and financially rebuilding the national power utility and supporting regulatory reforms; and mitigating and managing environmental constraints (sediment and weeds growth) on hydropower facilities. The goal is to reduce energy costs and enhance economic productivity.

Selected Prospective Power Compacts

Benin. In June 2015, the MCC Board of Directors approved a five-year, $375 million power sector Compact with the government of Benin, which will invest $28 million in national funds in the Compact. The Compact supports power generation expansion using solar, thermal, and small-scale hydroelectric technologies; power distribution upgrades; off-grid power access; and policy reform and institutional strengthening. Particular reform targets include utility governance and administrative; payment of public arrears to the utility; and policy change centering on tariff structures, private sector power generation investment facilitation, and off-grid electrification.[76]

Tanzania. In late 2014, the MCC agreed to provide an additional $9.78 million to support further feasibility studies and other work linked to the development of a second Compact focused on the power sector.[77] While that work continues, in June 2015 the MCC Board stated that a second Compact "will not be considered for approval until, among other pending items," Tanzania's government "makes progress on energy sector reform commitments made in 2014. Once the Compact is ready, the MCC will scrutinize the government's track record on good governance, including control of corruption and freedom of expression."[78]

Liberia. Liberia completed an MCC Threshold Agreement in late 2013 and has been eligible for compact development each year since. The MCC reports that it is working with Liberia's government to on the design of a Compact projects focused on electricity generation and access and policy reform, and potentially on road planning and maintenance. In late 2014 MCC sent Congress a notification reporting an intended $2.8 million obligation to support development and implementation of a prospective Compact. The notification stated that "it is unclear how much time will be required for Liberia to effectively control the situation and for the resumption of 'normal' business and substantive bilateral engagement" in the wake of the Ebola epidemic.

USTDA and USADF

Under Power Africa, OPIC and the U.S. Trade and Development Agency (USTDA) committed to facilitate provision of support to qualifying projects using $20 million in initial U.S.-Africa Clean

Energy Finance Initiative (ACEF) project assistance funds. ACEF funds are provided by the State Department, which in August 2014 pledged an additional $10 million for the initiative. Under ACEF, with support from the U.S.-Africa Clean Energy Development and Finance Center (CEDFC) in South Africa, USTDA provides project assistance grants to selected OPIC-eligible private sector renewable, energy efficiency, and greenhouse gas-reducing technology projects.[79]

As of late July 2015, ACEF's initial $20 million had funded grants in support of 32 renewable energy projects in 10 African countries designed to expand clean energy generation and reduce greenhouse gas emissions.[80] CEDFC, a joint USTDA-OPIC-Ex-Im initiative, is designed to foster clean-energy project development in Africa. Housed in the U.S. Consulate General in Johannesburg, South Africa, and able to draw on other U.S. government agency resources, it acts as a clearing house for U.S. and African energy sector business developers aimed at helping them to identify and access USG clean energy export, investment, and financing support. It also coordinates with multilateral and local development banks, private banks, and private equity firms. A key CEDFC aim is to expand U.S. private sector participation in African economic development, as well as further Commerce Department Doing Business in Africa Campaign goals. Target technologies include solar, wind, biomass, geothermal, hydropower, ocean, cogeneration, natural gas (including biogas), distributed generation, energy efficiency, and smart grid development.[81]

Recent annual budget justifications and annual reports also indicate that USTDA has made African energy sector investments an increasing target of its activities. Its 2014 annual report

[74] MCC, "Ghana Power Compact Program Overview," August 5, 2014.

[75] The Compact was suspended in February 2011 based on U.S. concerns about governance trends under late President Bingu wa Mutharika. The compact was ultimately signed in April 2011, but MCC officials expressed lingering concerns about recent changes to Malawi's penal code and related issues of freedom of expression and human rights and indicated that they would continue to monitor the government's commitment to good governance over the course of the compact. The compact is designed to improve electricity delivery by increasing existing power generation and upgrading the transmission and distribution network. MCC, "Quarterly Status Report Malawi Compact," December 2013.

[76] MCC, "Millennium Challenge Corporation Board of Directors Approves Benin Power Compact,' June 22, 2015

[77] MCC, 'MCC Provides Funding to Tanzania to Develop Compact Focused on the Power Sector," November 14, 2014, and "Tanzania II Compact,' Quarterly Status Report, December 2014.

[78] MCC, "Readout of the June 2015 MCC Board of Directors Meeting," June 19, 2015.

[79] For eligibility criteria, see http://www.ustda.gov/program/regions/subsaharanafrica/cleanenergy/usacef/.

[80] According to the White House, the 32 projects "have the potential to generate more than 300 MW of new renewable power in sub-Saharan Africa and mobilize more than $1.3 billion in project capital, a leverage ratio of $65 for every $1 in ACEF funding." The White House also reports that two projects of the projects, an 8.5 MW solar project in Rwanda undertaken by Gigawatt Global (a renewable energy firm) and a micro-lending program for solar home systems undertaken by the Participatory Microfinance Group for Africa (PAMIGA, a microfinance institution advice and financial service provider) "have received full debt financing." White House, "Fact Sheet: Power Africa," July 25, 2015; see also Gigawatt Global, "Gigawatt Global launches East Africa's First Solar Field," February 8, 2015 and OPIC, "PAMIGA: Finance for micro-irrigation and home solar kits," 2015.

[81] Another CEDFC role is to support implementation of a 2012 Ex-Im Bank-Industrial Development Corporation of South Africa agreement under which the Ex-Im Bank agreed to potentially finance up to $2 billion worth of U.S. technology goods and services in support of South Africa's Integrated Resource Plan (IRP) and the South African Renewable Initiative (SARi). The IRP is a 20-year national power sector development plan. SARi is a South African government initiative, backed by European partner governments, to scale up the country's renewable energy industry, largely by facilitating access to finance and supporting renewables procurements under the IRP. Ex-Im Bank, "Ex-Im Bank To Assist in Financing Up to $2 Billion of U.S. Exports to South Africa's Energy Sector," August 7, 2012; USTDA, U.S.-Africa Clean Energy Development and Finance Center Fact Sheet, n.d.; State Department, "State Department To Invest $10 million to Extend the U.S.-Africa Clean Energy Finance Initiative," August 7, 2014; and SARi and IRP materials.

indicates that about 73% of its FY2014 projects in or related to Africa supported energy projects, almost all in the power sector. USTDA has provided more than $17 million in support of 29 projects projected to increase African power supplies by more than 660 MW and leverage an estimated $3.8 billion in private and public financing, a 200:1 ratio. It plans $10 million more in project planning commitments to advance early-stage clean energy projects toward financial close and project implementation.[82]

Another Power Africa program is the "Off-Grid Energy Challenge" (see textbox above, under USAID program discussion) initially a three-year competitive grant program funded at $2 million, later raised to $5 million, being implemented by the U.S. African Development Foundation (USADF) with co-funding and assistance from General Electric-Africa and USAID. The total grant level was later raised to $5 million. Its goal is to spur access to small and off-grid power for rural or otherwise marginalized communities, agribusinesses, small businesses, and other local actors lacking such access to power.

The State and Treasury Departments

In addition to funding the U.S.-Africa Clean Energy Finance initiative (ACEF), as previously noted, the State Department plays a number of Power Africa support roles. A key one is the pursuit of economic diplomacy, in coordination with other PAWG agencies, to foster the adoption of investment-friendly policies and governance reforms likely to spur power sector development and investment. In some countries, it also provides deal-specific transaction support. There is at least one State Department-funded transaction specialist based in Rwanda, and the department facilitates power sector commerce through its Business Information Database System (BIDS). BIDS is an "open, internet-based platform to aggregate information on tender opportunities and trade leads, and make that information available to U.S. business."[83] The department also provides enabling operational support to other Power Africa agencies, facilitating and sometimes hosting their in-country representatives and activities.

Most of the power sector work that the State Department supports, however, is pursued under initiatives that may address power sector challenges in Africa, but are global in scope and/or address broad energy development work that is not limited to the power sector. For such reasons, State Department program descriptions generally have not characterized these other initiatives as being conceptually synonymous with Power Africa, even though they may contribute to its objectives. At least one, such program, however, the Energy Governance and Capacity Initiative (EGCI), has been referenced as a State Department contribution to Power Africa in some initiative documents. In addition, those elements of State Department energy programs that relate directly to Power Africa activities or goals (such as regional power pool technical assistance) are closely coordinated with relevant Power Africa agencies.

[82] White House, "Fact Sheet: Power Africa," July 25, 2015.

[83] On BIDS, see State Department, http://bids.state.gov/. Additional information from Commerce Department in response to CRS query, January 2014.

State Department Programs Complementary to Power Africa

State Department programs that are complementary to Power Africa include assistance and contributions to the United Nations-led Sustainable Energy For All (SE4ALL) global energy initiative, which in 2014 signed a cooperation agreement with Power Africa; the Power Sector Program (PSP); and the Unconventional Gas Technical Engagement Program (UGTEP). EGCI is a State Department-led interagency effort to provide regulatory and legal reform assistance to countries that are significant emergent or likely oil and gas producers. SE4ALL seeks to provide universal access to modern energy services, and double global energy efficiency and the proportion of renewable energy used globally. The Power Sector Program (PSP) provides technical assistance to expand energy access, including through renewable energy development and promotion of more effective technology. It helps to build power sector financial viability in recipient countries or regions in order to attract investment, especially by strengthening regulatory and economic frameworks—in a manner closely akin to that pursued under Power Africa. A key example of PSP work in Africa is its support to the Southern Africa Power Pool (SAPP). PSP helps build the capacity of national regulators in the SAPP region who are slated to oversee the pool, and supports efforts to harmonize and improve country and regional regulatory frameworks and rules in order to support regional power trading and to enable private investment in SAPP members' national power sectors, with a focus on power generation projects. In FY2016, PSP may also provide interconnection coordination support and related assistance to the Eastern Africa Power Pool (EAPP) and the West Africa Power Pool (WAPP). In Africa, the department has requested funds to support UGTEP technical work with South Africa focused on the analysis and potential development of its unconventional gas resources, which could, in the long term, power electrical generation.[84]

The Treasury Department's Power Africa role centers on collaboration with the MDBs, in particular through its role as the U.S. representative on the World Bank and African Development Bank executive boards, to advance Power Africa-aligned MDB power sector development activities. Other Power Africa-related Treasury roles include the provision of policy advice and capacity-building assistance to ministries of finance, economy, and budget in focus countries. Such work centers on the macroeconomic aspects of policy-making, investment climates, and financing for infrastructure investments, specifically including Power Africa projects.[85] Treasury officials also participate in Power Africa-relate events and site visits to promote the initiative.

Commerce and Energy Departments

The Commerce Department (USDOC) is supporting Power Africa primarily by promoting U.S. international sales and marketing opportunities and providing information to firms about how to access U.S. trade financing related to Power Africa projects and transactions.[86] U.S. Foreign Commercial Service officers are active in this area. Another example of such efforts was a May

[84] HFAC, Subcommittee on Africa, Global Health, Global Human Rights, testimony of Robert Ichord, Bureau of Energy Resources at hearing entitled *The Future of Energy in Africa*, November 14, 2014; State Department, *Foreign Operations Congressional Budget Justification*, Appendix 2, FY2016; State Department, "Notice of Meeting: Signing of a Cooperation Understanding Aide Memoire between Power Africa and Sustainable Energy for All," September 20, 2014; State Department, *U.S. Clean Energy Efforts that Help Advance Sustainable Energy for All*, Progress Report, May 2015; and information at http://www.se4all.org.

[85] For examples of the kinds of Power Africa-related programmatic collaboration that the United States is pursuing with the African Development Bank (AfDB), see AfDB/USG, *Power Africa Initiative*, 2013.

[86] Among USDOC tools for doing so are Doing Business in Africa (DBIA) campaign, which seeks to help spur U.S. private investment in Africa, including through trade assistance, efforts to aid U.S.-Africa firm networking, and a reduction of trade and investment barriers; and Global Markets (GM), a U.S. Commercial Service program and USDOC's International Buyer's Program (IBP). The IBP and GM, which has formed a team devoted to Power Africa, promote U.S. overseas exports and investments, among other goals, particularly by matching U.S. firms with commercial opportunities and buyers overseas. They disseminate "trade leads/opportunities" and sponsoring trade missions and commercial shows, and by using such tools as the relatively new State Department BIDS system (see above). On DBIA, see http://trade.gov/dbia/; on the GM program, see USDOC, http://www.trade.gov/markets/; and on IBP, see http://export.gov/ibp/index.asp. Additional information provided by USDOC to CRS in January 2014.

2014 West Africa energy trade mission to Ghana and Nigeria led by Secretary of Commerce Penny Pritzker.[87] A second major USDOC Power Africa actor is its Commercial Law Development Program (CLDP), which is promoting power sector capacity-building focused on the adoption and application of power purchase and other model agreements as a means of promoting power sector investment. A key output is a handbook called *Understanding Power Purchase Agreements*, the roll-out of which has been accompanied by professional workshops across Africa.[88]

Department of Energy (DOE) contributions focus on the provision of technical advice to other USG Power Africa agencies and African governments regarding energy sector development and modernization. DOE advisory work relating to Power Africa focuses on increasing access to clean and renewable energy technologies, as through the work of DOE's National Renewable Energy Laboratory, and related training programs, including in Africa; and advice on related policy and regulatory reforms and analyses related to energy markets, growth models, and private investment.[89] DOE also hosted a U.S-Africa Energy Ministerial meeting in early June 2014 in Ethiopia, alongside which was held a commercial exposition showcasing U.S. energy technologies and services. One Ministerial "deliverable" was the announcement of collaboration between Power Africa and the Clean Energy Solutions Center, a project of the Clean Energy Ministerial (a high-level global forum promoting clean energy technology applications and policies). Under this effort, free advice and consultation services are targeted toward African governments, and access to a Center global database of best practice resources and related webinars is provided to Power Africa's "network of local contacts across" Africa.[90]

Additional Agency and Private Sector Roles

Several agencies that possess capabilities germane to Power Africa goals have been designated initiative support agencies or will perform narrow work in support of specific project activities, as needed. One is the Agriculture Department, which possesses a wide range of policy, regulatory reform, and technical assistance knowledge related to supporting energy development, especially as related to agriculture, environmental, and trade challenges. It also provides training and other capacity-building assistance to support community and business associations, financing mechanisms, and engineering and construction technical and managerial training in such areas as

[87] The trip was intended, in part, to highlight Power Africa and promote exports of U.S. private sector power generation, transmission, and distribution technology. One concrete trip outcome was a deal between the Electricity Company of Ghana and U.S. firm SEWW focusing on a seven-year, $25 million per year upgrade of electricity transmission and distribution infrastructure in and around Ghana's capital, Accra. Commerce Department, "Secretary Pritzker Discusses Trade and Investment with Ghanaian President Mahama and Other Officials," May 19, 2014. See also Commerce Department, "U.S. Secretary of Commerce Penny Pritzker Concludes Successful Africa Trade Mission," May 27, 2014.

[88] CLDP, U*nderstanding Power Purchase Agreements*, November 3, 2014–November 7, 2014, http://cldp.doc.gov/programs/cldp-in-action/details/1378.

[89] Technical training has been provided, for instance, in support of solar installations in Angola, geothermal energy development in Djibouti, Ethiopia, and Kenya, and on natural gas development in East Africa. DOE, "Secretary Moniz's Remarks at the Powering Africa Summit in Washington, D.C.," January 29, 2015; White House, "Fact Sheet: Power Africa," July 25, 2015; and DOE response to CRS inquiry February 2014.

[90] The ministerial focused on diverse energy topics, including various energy resources and technologies, finance, environmental issues, Power Africa activities, and international energy development cooperation in Africa. Examples of Solutions Center advice to governments have included queries on concentrated solar power potential (Namibia); sustainable bioenergy (Cote D'Ivoire); and feed-in tariff design (Ghana). The Center was launched in 2011, initially for "major economy countries." See http://www.energy.gov/ia/initiatives/us-africa-energy-ministerial; DOE, "Highlights of Deliverables and Commitments," U.S.-Africa Energy Ministerial, June 3-4, 2014; and Sandra Reategui, DOE/NREL, "The Clean Energy Solutions Center," World Renewable Energy Forum, May 17, 2012.

environmental compliance and renewable and non-renewable energy sourcing. Another agency, the U.S. Army Corps of Engineers (USACE), which is available to provide engineering and technical analyses to USG agencies and eligible private sector firms related to Power Africa project planning, design, or construction on an as-needed, cost-reimbursable basis. USACE also helped respond to the ongoing Ebola outbreak in West Africa, providing power generation and other engineering outputs for Ebola Treatment Units (ETUs) in Liberia.

Possible Issues and Questions for Congress

As discussed in the introduction of this report, some Members may question whether it is appropriate for the United States to provide the types of funding and assistance that are already being furnished under Power Africa and are envisioned under H.R. 2847 and S. 1933. For supporters of these efforts, both the presidential initiative and prospective bill implementation may raise a host of appropriation and oversight issues. In addition, some Members may see a need for the bill—as it is designed as a longer-term effort than Power Africa—to address more fully the wide range of current Power Africa activities and the roles of all 12 agencies that are implementing the initiative, rather than the subset of agencies that the House-passed bill addresses. Below are some examples of issues that may draw congressional attention.

- **Investment Levels and Extent of U.S. Role.** A variety of projections, based on diverse assumptions and methodologies, have been made to arrive at estimates of the amount of funding necessary to meet the Power Africa and multilateral organization goal of achieving universal access to power in Africa.[91] Members may wish to determine the extent to which current and proposed funding and assistance under Power Africa may contribute toward meeting those goals—as well as the extent to which U.S. budgetary constraints, including unmet domestic infrastructure needs, might limit or pose potentially significant opportunity costs relative to such investments. Another issue for congressional consideration may include the relative extent, if any, to which the development of the African power sector can or should be left to the private sector and governments in the region. A further key issue for congressional appropriators is the question of what types and levels of additional funding, if any, may be needed to achieve the Administration's goals under Power Africa.
- **Project Determination and Metrics.** A reported $9 billion worth of mostly private sector project commitments attributed to Power Africa existed on the day the initiative was announced. The amount of such commitments had grown to $20 billion as of August 2014. Some Members may wish to determine the basis on which these projects or future have been or will be designated as Power Africa projects. In some respects, however, whether or not a project is new or is already under way but requires additional support (such as USAID transaction assistance) in order to reach completion is moot, since the end result—the generation of new power—is the outcome in either case.

  A more relevant question may be whether measuring success by numbers of projects for which financing is in place is an accurate gauge of success—given

[91] A U.S.-backed World Bank project, the *Sustainable Energy for ALL* (SE4ALL) initiative, seeks to track international efforts to achieve universal energy access, double renewable energy use, and improve energy efficiency. See *SE4ALL Global Tracking Framework*, http://www.worldbank.org/en/topic/energy/publication/Global-Tracking-Framework-Report; and State Department, "Sustainable Energy for All," n.d.

that projects may not go forward, may face technical challenges, or may produce well below their predicted level of output—or whether power as measured at the start of actual production is a better measure of success. Given the complex, long term nature of such projects, a mix of interim and final success benchmarks may best measure relative progress.[92]

Some Members may also see a need for the establishment of some sort of cost-benefit ratio or other functional or need-based criteria for selecting and measuring the progress of Power Africa. Others may be interested in determining whether a competitive bidding or otherwise equitable, transparent, public processes for awarding Power Africa transactional aid or other types of assistance—apart from normal eligibility processes employed by the trade and investment agencies charged with carrying out the initiative—might be warranted.

- **Oversight.** There is perennial congressional oversight interest in issues such as how efficiently and cost-effectively agencies function; efforts to avoid programmatic duplication; and how agencies (e.g., the development and trade agencies implementing Power Africa) achieve synergies when their missions overlap or complement one another.[93]

  In light of such concerns, many Members may be interested in determining how the interagency Power Africa Working Group (PAWG) and its functional sub-groups operate. Questions at issues might include whether and how PAWG may vet major projects; how agency roles are defined and assigned; and whether the interagency model of coordination is adequately effective with regard to an undertaking as complex as Power Africa. A particular matter that some may see a need to better clarify may be the degree to which Power Africa's transactional support approach is integrated with related activities under the Trade Africa initiative, especially given that USAID's new PATA office oversees both initiatives.

- Another oversight issue may arise if a provision in H.R. 2847 (Section 102(a)3) that applies a range of oversight and reporting requirements to all U.S. "programs and activities for increasing power generation and transmission in sub-Saharan African countries" is enacted. Questions may arise over whether programs that may only tangentially relate to this goal—or which predate Power Africa or are global in scope or apply to energy resources and technologies in addition to electricity—come under the scope of the bill.

- **Main Funding Agencies.** Congress may also see a need to determine whether the choice of Power Africa funding sources is ideal, and this issue will become critical if the Ex-Im Bank's authority is not reauthorized. One observer has argued that OPIC, rather than the Ex-Im Bank (the source of about 64% of the maximum planned U.S. commitment under Power Africa), would be a better

[92] USAID states that it recognizes "that stumbling blocks can occur even after financial close is reached. Power Africa closely monitors projects and provides support by engaging with local communities, resolving technical issues, and working with host governments to provide assistance, as needed. Power Africa continues to support transactions, investors, communities, and governments along the entire spectrum of project development through to power coming online and beyond." USAID, *Power Africa Annual Report*, July 2015

[93] On proposed trade agency reorganization and integration during the 112th Congress motivated by such concerns, see CRS Report R42555, *Trade Reorganization: Overview and Issues for Congress*, by Shayerah Ilias Akhtar.

source of U.S. credit support for the kinds of projects envisioned under Power Africa.[94]

- **Types of Energy Resources.** A final potential issue is the degree to which there is internal congressional agreement over what types of energy resources to invest in in the context of U.S. efforts to expand power generation in Africa. Some may argue that the development of conventional energy sources, like fossil fuel technologies, should not receive new U.S. funding because they are polluting or arguably already receive a lion's share of investment resources, relative to alternative energy sources. Others may argue that they should receive equal or greater investment because they are cheaper to implement, or because they can be tapped using newer, less polluting technologies.

  One particular resource/technology that may be the focus of congressional differences are potential future policy restrictions on or authorization for OPIC support for projects that increase greenhouse gas emissions (the so-called "carbon cap"). Debate in this respect might focus on whether potential restrictions might inhibit the agency's capacity to support the development of fossil fuel power generation plants in Africa[95]—a relatively small source of power generation-linked carbon emissions—including ones fueled by natural gas, which some analysts view as a "transition fuel."[96]

Outlook

Now into its second year of implementation, Power Africa represents a concrete new U.S. commitment to increase access to electricity in Africa in order to spur diverse developmental

[94] See Ben Leo, "Why Ex-Im Can't Be the Financing Cornerstone of Power Africa," CGD Blog, September 19, 2013. Leo argues that Ex-Im primarily focuses on providing credit to support the export of U.S. goods and services, rather than on expanding private sector-led development overseas. He also questions Ex-Im's record of supporting African power sector projects, arguing that it has backed relatively few. Lastly, he argues that Ex-Im "cannot provide long-term financing in many African markets," a key requisite for many energy sector investments, and can only finance discrete components of projects. By contrast, he sees OPIC as well-suited to achieve many of the ends that he contends Ex-Im may not be able or inclined to support—although he and his colleagues also assert that there is much scope to improve OPIC's operational and development capacities. See Benjamin Leo, Todd Moss, and Beth Schwanke, *OPIC Unleashed: Strengthening US Tools to Promote Private-Sector Development Overseas*, CGD, August 2013.

[95] Section 7086 P.L. 113-235, with some qualifications, suspended through the end of FY2015 funding to enforce certain rules, regulations, policies, or guidelines, including those that constitute the carbon cap. See Todd Moss, "Natural Gas vs Renewables for OPIC: What's the Tradeoff?," CGD Blog, January 30, 2014.

[96] The term "transition fuel" is applied to natural gas by some observers based on the contention that such gas is "a clean-burning source of energy" that is "less carbon-intensive than either coal or oil" and "emits scarcely half as much carbon as coal does for each unit of energy produced." Natural gas is also seen as a critical transition fuel because of the comparative expense of and challenges facing efforts to scale up renewable energy source technologies. Some advocates of a faster, more complete transition to renewable energy sources, by contrast, do not view natural gas as a true or appropriate "transition fuel." Some analysts who take this position question the application of the term to natural gas on the basis that doing so simply advances efforts to replace a more polluting energy sources with one that, while less polluting, still creates substantial pollution and greenhouse gases, and may economically and politically inhibit a complete or adequately rapid transition to predominant use of renewable energy sources. Some arguing from this perspective assert that this use of the concept strengthens vested interests in the natural gas sector that may oppose a shift toward greater investment in and policy incentives supporting large-scale development of fully renewable energy development—or may create economic disincentives for such ends. Initial quotes from Lester R. Brown, "Natural Gas: The Transitional Fuel" in Chapter 5, Building the Solar/Hydrogen Economy in *Eco-Economy: Building an Economy for the Earth*, Earth Policy Institute, 2001. See also Todd Myers, "Let's Embrace Natural Gas as a Transition Fuel," *The Experts* (*Wall Street Journal* blog), May 6, 2015; Eleanor Stephenson, Alexander Doukas, and Karena Shaw, "Greenwashing Gas: Might a 'Transition Fuel' Label Legitimize Carbon-Intensive Natural Gas Development?," *Energy Policy*, (46), July 2012; and Energy Justice Now, "No Such Thing as 'Transition" Fuels,'" n.d.

goals, including economic growth, increased investment, and enhanced education and health, among others. As an ad hoc presidential initiative, however, the future of Power Africa beyond the Obama Administration is not guaranteed. There are, however, some indications of bipartisan support among some Members for continuing U.S. assistance to aid increased electrification in Africa under programs broadly similar to those being pursued under Power Africa. Expressions of such support have taken the form of bills in the 113th and 114th Congresses, as discussed previously in this report, and statements by individual Members during hearings and in other fora. Some Members, however, may question the U.S. budgetary implications of such assistance, both actual and proposed, or the design, effectiveness, and cost-benefit outcomes of current or prospective programs to enhance access to electricity in Africa.

Appendix A. Electrification Rates and Biomass Use in Africa

Table A-1. Electrification Rates and Use of Traditional Biomass in Africa, 2012

(population in millions or percentage rates, as applicable)

	Electrification: Populations without Access to Electricity and Electrification Access Rates by Population				Traditional Use of Solid Biomass for Cooking/Heating*	
Region or Country	***Population Without Access***	***National Access Rate***	***Urban Access Rate***	***Rural Access Rate***	***Population using biomass***	***Population biomass use rates***
Africa	***622***	***43%***	***68%***	***26%***	***728***	***67%***
North Africa*	***1***	***99%***	***100%***	***99%***	***1***	***1%***
Sub-Saharan Africa	***621***	***32%***	***59%***	***16%***	***727***	***80%***
Angola	15	30%	46%	6%	12	56%
Benin	7	28%	55%	6%	9	94%
Botswana	1	66%	75%	51%	1	37%
Burkina Faso	14	16%	54%	2%	16	95%
Burundi	9	10%	34%	7%	10	98%
Cameroon	10	54%	88%	17%	16	75%
Cabo Verde	0	94%	100%	84%	0	31%
Central African Republic	4	3%	5%	1%	4	97%
Chad	12	4%	16%	0%	12	93%
Comoros	0	45%	72%	35%	1	71%
Congo	3	35%	52%	5%	3	76%
Côte d'Ivoire	15	26%	42%	8%	16	79%
Democratic Republic of Congo	60	9%	24%	1%	61	93%
Djibouti	0	50%	61%	14%	0	14%
Equatorial Guinea	0	66%	93%	48%	1	78%
Eritrea	4	32%	86%	17%	4	63%
Ethiopia	70	23%	85%	10%	87	95%
Gabon	1	60%	64%	34%	0	21%
Gambia	1	35%	60%	2%	2	95%
Ghana	7	72%	90%	52%	21	84%

	Electrification: Populations without Access to Electricity and Electrification Access Rates by Population				Traditional Use of Solid Biomass for Cooking/Heating*	
Region or Country	***Population Without Access***	***National Access Rate***	***Urban Access Rate***	***Rural Access Rate***	***Population using biomass***	***Population biomass use rates***
Guinea	10	12%	28%	3%	11	96%
Guinea-Bissau	1	20%	37%	6%	2	98%
Kenya	35	20%	60%	7%	36	84%
Lesotho	2	28%	55%	17%	1	62%
Liberia	4	2%	3%	0%	4	98%
Madagascar	19	15%	37%	4%	22	98%
Malawi	15	9%	33%	5%	15	97%
Mali	11	27%	55%	12%	15	98%
Mauritania	3	21%	47%	2%	2	56%
Mauritius	0	100%	100%	100%	0	0%
Mozambique	15	39%	66%	27%	24	96%
Namibia	2	30%	50%	17%	1	55%
Niger	15	14%	62%	4%	16	94%
Nigeria	93	45%	55%	35%	115	68%
Réunion	0	99%	100%	87%	0	10%
Rwanda	10	17%	67%	5%	11	98%
Sao Tome and Principe	0	59%	70%	40%	0	71%
Senegal	6	55%	90%	28%	8	56%
Seychelles	0	97%	97%	97%	0	0%
Sierra Leone	6	5%	11%	1%	6	98%
Somalia	9	15%	33%	4%	10	96%
South Africa	8	85%	88%	82%	7	13%
South Sudan	11	1%	4%	0%	11	97%
Sudan	24	35%	63%	21%	27	72%
Swaziland	1	27%	40%	24%	1	62%
Tanzania	36	24%	71%	7%	46	96%
Togo	5	27%	35%	21%	6	95%
Uganda	31	15%	55%	7%	35	97%
Zambia	10	26%	45%	14%	12	83%
Zimbabwe	8	40%	80%	14%	10	70%

Source: IEA, "Africa Energy Outlook 2014—Biomass database," and "Africa Energy Outlook 2014 Electricity database," *Africa Energy Outlook*, October 13, 2014.

* Solid biomass may include fuelwood, charcoal, agricultural residues, wood waste and other solid waste. According to the IEA, "traditional use of solid biomass refers to basic technologies used to cook or heat with solid biomass, such as a three-stone fire, often with no or poorly operating chimneys." In contrast, "modern use of solid biomass refers to improved cookstoves using solid biomass and modern technologies using processed biomass such as pellets." IEA, *Africa Energy Outlook*, October 13, 2014.

** Country entries for North Africa (Algeria, Egypt, Libya, Morocco, and Tunisia) are not included in this table.

Appendix B. Estimated and Projected Funding for USAID Programs Under Power Africa

As discussed in the body of this report (see "funding" under the Power Africa Presidential Initiative discussion), the Obama Administration initially allocated $285 million to support USAID Power Africa coordinating and program activities. During the August 2014 U.S.-Africa Leaders Summit, the Obama Administration announced a new annual level of $300 million to support such activities and expand Power Africa across Africa. The $300 million commitment is provisional, as it relies on planned transfers of funds among appropriation accounts and upon requested FY2016 funds, the possible appropriation of which would require congressional action.

Table B-1. Power Africa Initiative USAID Programs: Initial $285 Million and Projected $300 Million Expansion Commitments

(in thousands of dollars unless otherwise stated)

Commitments by Account	FY2012 & Prior Years	FY2013 Estimate	FY2014 Estimate	FY2015 Estimate	Total, $285M	Expansion via Account Transfer	FY2016 Request Total	Totals
$285 million Commitment	**57,511**	**90,214**	**60,300**	**76,975**	**285,000**	**—**	**—**	**285,000**
Development Assistance	*57,511*	*90,214*	*60,300*	*76,975*	*285,000*	—	—	—
$300 Million Expansion Projections						**223,300**	**76,675**	**299,975**
Development Assistance	—	—	—	—	—	—	*76,675*	—
Economic Support Fund[a]	—	—	—	—	—	*70,440*	—	*70,440*
Economic Support Fund-Overseas Contingency Operation[b]	—	—	—	—	—	*152,860*	—	*152,860*
Power Africa Total:					**285,000**	**223,300**	**76,675**	**584,975**

Source: CRS adaptation of State Department information provided to CRS on August 21, 2015

a. This funding is projected to be provided under the Economic Support Fund (ESF) account. It would be sourced from base year ESF appropriations and from transfers to ESF from the International Narcotics Control and Law Enforcement (INCLE) account.

b. According to the State Department, "Upon the exercise of section 610 and section 8003 authorities, it is anticipated that these funds will be available for obligation in FY2015. However, they may not be obligated until subsequent fiscal years consistent with varying periods of availability." These funds would be provided from the ESF-OCO account, including through direct appropriations to the ESF-OCO account and through transfers to ESF-OCO from INCLE-OCO and Foreign Military Financing (FMF)-OCO accounts. On OCO funding, see CRS In Focus brief IF10143, *Foreign Affairs Overseas Contingency Operations (OCO): Background and Current Status*, by Susan B. Epstein, among other CRS products.

Table B-2. Power Africa Initiative USAID Programs: Initial $285 Million Commitment Funding Estimates

(in thousands of dollars; information detailed by fiscal year, account, country or operating unit, and functional allocation)

Account, Country or Operating Unit, and Program Area Element[a]	FY2012 & Prior Years	FY2013 Estimate	FY2014 Estimate	FY2015 Estimate	Totals
Development Assistance	**57,511**	**90,214**	**60,300**	**76,975**	**285,000**
Democratic Republic of the Congo	—	***7,930***	—	—	***7,930***
Infrastructure	—	*7,930*	—	—	*7,930*
Ghana	***3,472***	***5,000***	***5,000***	***5,000***	***18,472***
Infrastructure	*3,472*	*5,000*	*5,000*	*5,000*	*18,472*
Kenya	***4,319***	***2,822***	—	—	***7,141***
Environment	*4,319*	*2,822*	—	—	*7,141*
Liberia	—	***14,331***	—	—	***14,331***
Infrastructure	—	*14,331*	—	—	*14,331*
Nigeria	***3,971***	***7,460***	—	—	***11,431***
Infrastructure	*3,971*	*7,460*	—	—	*11,431*
Tanzania	***3,400***	***10,000***	***5,000***	***5,000***	***23,400***
Infrastructure	*1,500*	*10,000*	*5,000*	*5,000*	*21,500*
Private Sector Competitiveness	*1,900*	—	—	—	*1,900*
USAID Africa Regional	***27,574***	***30,362***	***48,000***	***64,675***	***170,611***
Trade and Investment	*10*	-	-	-	*10*
Financial Sector	*1,702*	-	-	-	*1,702*
Infrastructure	*20,596*	*25,496*	*45,000*	*61,675*	*152,767*
Private Sector Competitiveness	*1,461*	—	—	—	*1,461*
Environment (attribution)	*3,805*	*4,866*	*3,000*	*3,000*	*14,671*
USAID East Africa Regional	***7,048***	***5,264***	***1,000***	***1,000***	***14,312***
Infrastructure	—	*3,353*	—	—	*3,353*
Environment (attribution)	*7,048*	*1,911*	*1,000*	*1,000*	*10,959*
USAID Economic Growth, Education & Environment	***2,000***	***700***	***300***	***300***	***3,300***
Environment	*2,000*	*700*	*300*	*300*	*3,300*
USAID West Africa Regional	***5,727***	***6,345***	***1,000***	***1,000***	***14,072***
Infrastructure	—	*4,434*	—	—	*4,434*

Account, Country or Operating Unit, and Program Area Element[a]	FY2012 & Prior Years	FY2013 Estimate	FY2014 Estimate	FY2015 Estimate	Totals
Environment (attribution)	*5,727*	*1,911*	*1,000*	*1,000*	*9,638*

Source: CRS adaptation of State Department information provided to CRS on August 21, 2015

a. All Power Africa activities are undertaken to advance the State Department/USAID *Foreign Assistance Standardized Program Structure* (SPS) U.S. foreign assistance development indicator objective of advancing economic growth (the fourth SPS Objective). Functional allocations listed in column one of the table represent the following SPS Economic Growth Objective Program Areas: 4.2 Trade and Investment; 4.3 Financial Sector; 4.4 Infrastructure; 4.6 Private Sector Competitiveness; and 4.8 Environment.

Table B-3. Power Africa Initiative USAID Programs Expansion Commitment: Provisionally Planned First Annual $300 Million Annual Increase

(in thousands of dollars; information detailed by fiscal year, account, country or operating unit, and functional allocation)

Account, Country or Operating Unit, and Program Area Element[a]	Expansion via Appropriated Fund Account Transfers	FY2016 Request
$299,975 Total	**223,300**	**76,675**
Development Assistance		**76,675**
Ghana	—	***6,000***
Infrastructure	—	*5,000*
Environment (attribution)	—	*1,000*
Kenya	—	***1,000***
Environment	—	*1,000*
Tanzania	—	***5,000***
Infrastructure	—	*5,000*
USAID Africa Regional	—	***64,675***
Infrastructure	—	*61,675*
Environment (attribution)	—	*3,000*
Economic Support Fund[c]	**70,440**	—
USAID Africa Regional	***70,440***	—
Infrastructure	*70,440*	—
Economic Support Fund-Overseas Contingency Operations[d]	**152,860**	—
USAID Africa Regional	***152,860***	—
Infrastructure	*152,860*	—

Source: CRS adaptation of State Department information provided to CRS on August 21, 2015

a. All Power Africa activities are undertaken to advance the State Department/USAID *Foreign Assistance Standardized Program Structure* (SPS) U.S. foreign assistance development indicator objective of advancing economic growth (the fourth SPS Objective). Functional allocations listed in column one of the table represent the following SPS Economic Growth Objective Program Areas: 4.4 Infrastructure and 4.8 Environment.

b.

c. This funding is projected to be provided under the Economic Support Fund (ESF) account. It would be sourced from base year ESF appropriations and from transfers to ESF from the International Narcotics Control and Law Enforcement (INCLE) account.

d. According to the State Department, "Upon the exercise of section 610 and section 8003 authorities, it is anticipated that these funds will be available for obligation in FY 2015. However, they may not be obligated until subsequent fiscal years consistent with varying periods of availability." These funds would be provided from the ESF-OCO account, including through direct appropriations to the ESF-OCO account and through transfers to ESF-OCO from INCLE-OCO and Foreign Military Financing (FMF)-OCO accounts. On OCO funding, see CRS In Focus brief IF10143, *Foreign Affairs Overseas Contingency Operations (OCO): Background and Current Status*, by Susan B. Epstein, among other CRS products.

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