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Electricity Investment in Sub-Saharan Africa: A Historical Overview and a Way Forward

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Abstract

Rising demand, failing infrastructure, and untapped potential for electricity generation in sub-Saharan Africa have created a substantial need for large-scale investment in the region. This paper identifies traditional providers of foreign and domestic investment in electricity generation in the region, discusses historical and recent trends, and assesses U.S. firms' position in this market.

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Introduction

While precise estimates vary, there is general agreement that maintaining and expanding the electricity generation infrastructure of sub-Saharan Africa (SSA) will require substantial investment in the future. However, artificially low tariffs (or electricity fees) across much of the region raise concerns among private investors about the financial viability of building new infrastructure to address this issue.[1]

According to some observers, in recent years SSA has invested just one-quarter of what it needs to sustain its electricity sector.[2] Yet in 2015 McKinsey estimated that SSA would need to spend $490 billion by 2040 to build new electricity generation infrastructure (or between $20 to $25 billion annually).[3] World Bank estimates the investment needs are even higher, suggesting that the SSA power sector must invest $33.4 to $63 billion annually between 2015 and 2040 to meet rising needs.[4] While costly, these improvements are critical to the region's economic development. Two-thirds of respondents in a recent PwC survey of SSA-based businesses cited "ageing or badly maintained infrastructure" in the power sector as a challenge to their businesses over the next five years.[5]

SSA countries have tremendous untapped potential for generating electricity. McKinsey estimates the total potential capacity for regional generation to be 1.2 terawatts (1,200 GW), or 10 terawatts (10,000 GW) if solar power is also included. Of the 1.2-terawatt (non-solar) estimate, SSA could generate 400 GW from gas-powered plants (predominantly in Mozambique, Nigeria, and Tanzania), 350 GW from hydropower (predominantly in the Democratic Republic of the Congo), and another 300 GW from coal power in countries like Botswana, Mozambique, and South Africa.[6]

As SSA looks for investors in its generation infrastructure, it may turn to historically important sources as well as to new ones. In the last quarter-century, SSA governments and their utilities accounted for two-fifths of all new generation added to the grid across the region (excluding South Africa), followed by independent power producers (IPPs),[7] which comprised another one-quarter share. Chinese investments as well as funding from official development assistance (ODA), development finance institutions (DFIs), and the Arab Fund for Economic and Social Development (Arab Fund) rounded out the remaining one-third share (table 1).[8] IPPs have long been investing in this sector, and Chinese investment has been growing since entities from that

[1] For more discussion on impediments to investment in SSA electricity generation projects, see Streatfeild, "Low Electricity Supply in SSA", June 2018.
[2] Foster and Briceño-Garmendia, *Africa's Infrastructure: A Time for Transformation*" 2010, 181.
[3] Castellano et al., *Brighter Africa*, 2015, 4.
[4] PPIAF, Linking Up: PPPs in Power Transmission in Africa, 2017, 12.
[5] PwC, *A New Africa Energy World*, 2015, 8.
[6] Castellano et al., *Brighter Africa*, 2015.
[7] IPPs are private power producers that sell power to a utility.
[8] Table 1 does not include South Africa, but it offers information on debt and equity levels as well as on GW added. These data are not available for table 2, which does include South Africa. Consequently, both tables are included in this report.

country first started funding SSA power projects in 2001.[9] However, even when including South Africa in the data, there was no new ODA and DFI funding in the SSA electricity generation sector during 2011–13 (table 2).

Table 1. Total investment in completed power generation plants in SSA (excluding South Africa), 1990–2013

Type of investment	Debt and equity (billion $)	% of total investment funds	GW added	% of total GW
Government and utilities	15.9	50.67	8.7	43.66
IPPs	7.0	22.17	4.8	23.99
China	5.0	15.98	3.3	16.45
ODA, DFI, and Arab funds	3.5	11.18	3.2	15.91
Total	**31.4**	**100.00**	**19.8**	**100.00**

Source: Eberhard et al., *Independent Power Projects in Sub-Saharan Africa,* 2016, xxv.

Table 2. Investments in completed and pipeline power generation in sub-Saharan Africa (including South Africa), 1990–2013 (billion dollars)

	Cumulative[a]					
Source of funding	1990–2000	2001–2010	2011	2012	2013	Total
IPPs	1.4	5.2	0.4	6.6	5.9	19.4
ODA (OECD[b])	0.3	0.5	–	–	–	0.8
DFI	0.9	3.7	–	–	–	4.6
Arab flows	0.1	1.1	20.5	–	–	1.2
China flows	–	5.6	1.2	1.5	2.1	10.4
Government and utilities						29.8
Total	**2.8**	**16.0**	**1.5**	**8.1**	**8.0**	**66.3**

Source. Eberhard et al., *Independent Power Projects in Sub-Saharan Africa,* 2016, 269. [a] These data do not include government and utilities because those data are not disaggregated by year.

Some observers argue that relying on IPPs and China for a large share of investment in electricity generation entails some risks. For example, a McKinsey report proposes attracting "critical" IPP investments to this sector, but cautions that taking advantage of such investments requires utilities to build up their capacity to mitigate political and financial risks.[10] Chinese companies' propensity to build large generation projects across SSA has raised concerns about transparency and corruption during the tender and construction process. Concern has also been expressed that the projects' size may strain the ability of some SSA governments to manage and maintain the new infrastructure once completed.[11]

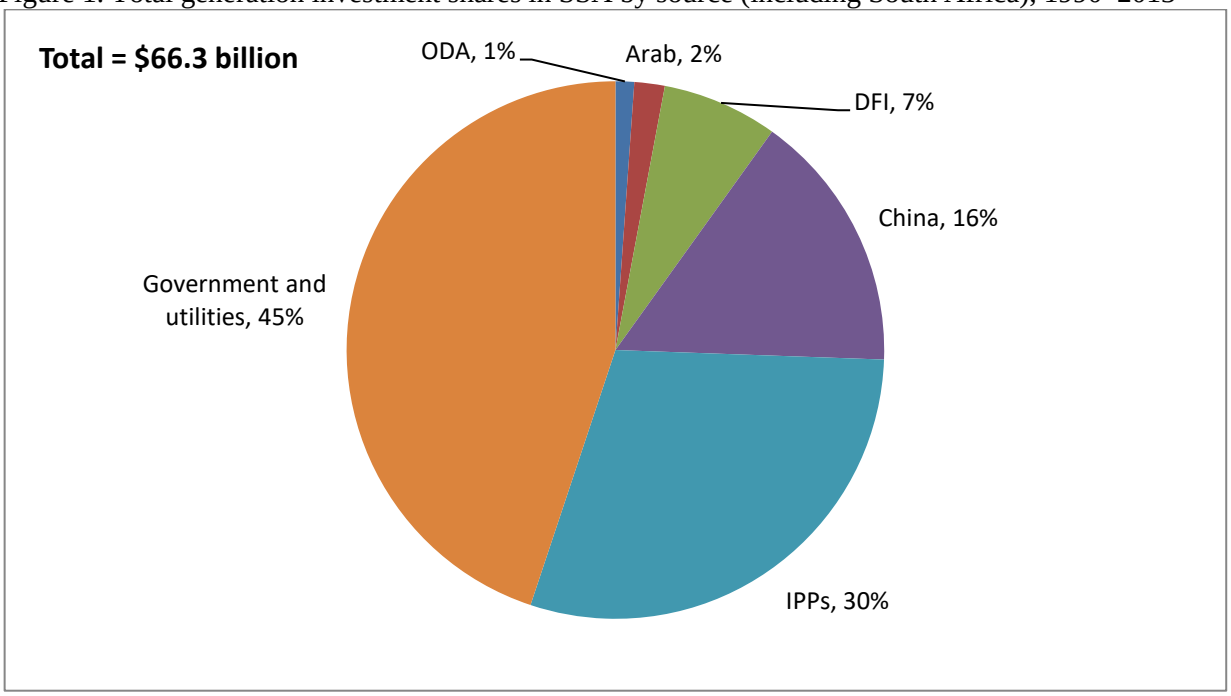
[9] When possible, this paper discusses both completed projects and those that have been started but not yet completed (pipeline projects) to get a sense of total investment funds in the sector.
[10] Castellano et al., *Brighter Africa*, 2015.
[11] IEA, *Boosting the Power Sector in SSA,* 2016, 8, 25.

This paper identifies the domestic and foreign sources of investment in completed and pipeline generation projects[12] across the region, including investment by U.S. and other foreign firms. It also provides insight into how participation by these investment sources has evolved over the last quarter-century. Finally, it briefly discusses the prospects for future investment in the SSA electricity sector.

Sources of Generation Investments in SSA

Between 1990 and 2013, according to a source that includes South African data, investment in SSA electricity generation projects (including both pipeline and completed projects) totaled $66.5 billion. SSA governments and their utilities accounted for the largest share of such investment, with 45 percent of the total (figure 1). IPPs comprised an additional 30 percent share, and China—which did not begin investing in the SSA power sector until 2001—accounted for 16 percent of all investments during the period. Donors such as Arab, DFI, and ODA funds[13] accounted for the remaining 10 percent of the total. ODA funds could include funding from the U.S. government, while IPP funds could include U.S. private investments, although this information is not broken out in the data.

Figure 1. Total generation investment shares in SSA by source (including South Africa), 1990–2013



Source: Author's calculations from Eberhard et al., *Independent Power Projects in SSA*, 2016, 269.

[12] Pipeline projects are projects that have been planned and financed and on which construction has begun, but that have not yet been completed.

[13] ODA funds could include funding from the U.S. government, while IPP funds could include funds from U.S. private investments, although this information is not broken out in the data.

Government Investment

From 1990 to 2013, 39 SSA governments and their utilities spent a total of $29.6 billion on 18.8 GW in electricity generation investments. Completed projects accounted for $15.9 billion (for 8.7 GW) of the total, while projects in the pipeline accounted for the remaining $13.7 billion. The largest share of these investments were made in South Africa, which accounted for $14.0 billion, or 47.2 percent, of all generation investments initiated in SSA (table 3). The next-largest markets—Ethiopia and Nigeria—followed at a distance with 9.5 percent and 6.9 percent of the regional total, respectively.[14]

[14] The costs of government-invested generation capacity vary significantly across SSA. During 1990–2013, the regional average investment cost per MW stood at $1.58 million, but ranged from $1.01 million in Sudan and South Sudan to $6.23 million in Sierra Leone. High investment costs in some countries may limit utilities' appetites for constructing more generation plants.

Table 3. Government investments in electric power generation, cumulative, 1990–2013

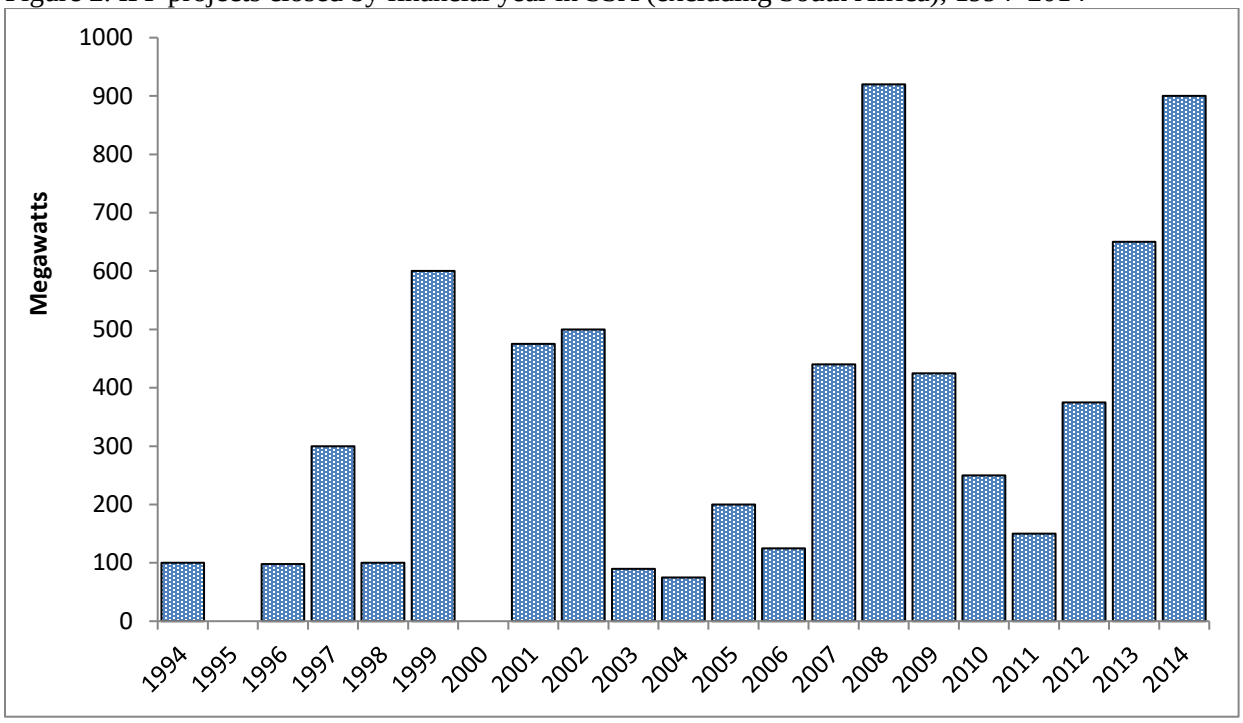
Country	MW of investments	Investment (million $)	million $/MW
South Africa	10,098	13,954	$1.38
Nigeria	1,298	2,044	$1.57
Ethiopia	1,048	2,818	$2.69
Angola	841	1,809	$2.15
Tanzania	726	1,323	$1.82
Sudan and South Sudan	502	508	$1.01
Kenya	464	1,022	$2.20
Republic of the Congo	390	609	$1.56
Ghana	379	547	$1.44
Cameroon	307	444	$1.45
Madagascar	300	550	$1.83
Zambia	285	763	$2.68
Senegal	250	361	$1.44
Namibia	238	261	$1.10
Burkina Faso	177	279	$1.58
Malawi	166	444	$2.68
Mauritius	156	225	$1.44
Benin	145	190	$1.31
Guinea	99	156	$1.58
Chad	99	143	$1.45
Equatorial Guinea	93	127	$1.36
Uganda	90	130	$1.44
Botswana	76	317	$4.17
Cabo Verde	74	94	$1.27
Mali	73	105	$1.44
Niger	62	90	$1.46
Seychelles	62	90	$1.45
The Gambia	60	87	$1.44
Rwanda	59	100	$1.69
Eritrea	38	58	$1.53
São Tomé and Príncipe	24	38	$1.58
Mozambique	24	35	$1.47
Comoros	22	31	$1.42
Mauritania	13	19	$1.45
Somalia	10	15	$1.45
Sierra Leone	7	44	$6.23
Burundi	2	3	$1.45
Saint Helena	2	3	$1.45
Western Sahara	2	3	$1.45
Total	18,761	29,839	$1.59

Source: Eberhard et al., *Independent Power Projects in SSA*, 2016, 271–72.

Independent Power Producers

IPPs completed 4.8 GW in new SSA generation projects between 1990 and 2013, comprising nearly one-fifth ($7 billion) of the value of all new generation during that period. Annual project completion rates fluctuated widely, as 1995 and 2000 saw no power project completions, while 2008 and 2014 saw approximately 1 GW of completed IPP projects (figure 2). Since 2013, IPPs have completed an additional 6 GW in generation, reaching a total of 11 GW for the time span between 1990 and 2016. IPP-invested generation projects have been constructed in 18 SSA countries, with 43 percent of the investments concentrated in South Africa.[15]

Figure 2. IPP projects closed by financial year in SSA (excluding South Africa), 1994–2014



Source: PPIAF, *Linking Up: PPPs in Power Transmission in Africa*, 2017, 31.

Although South Africa is the largest market for completed as well as uncompleted IPP projects, most of the largest individual projects, in terms of funding size, have been in three West African countries: Ghana, Nigeria, and Côte d'Ivoire. The largest IPP investments, in terms of MW of capacity, are in the Nigerian power sector: the Afam project (gas), which will add 630 MW of installed capacity, and the Okpai project (gas), which will add 480 MW (table 4). Large IPP-invested projects in East Africa include an $861 million, 300 MW wind power facility on Lake Turkana in Kenya, and a hydropower facility in Uganda amounted to $860 million to add 250 MW.

[15] PPIAF, *Linking Up: PPPs in Power Transmission in Africa*, 2017, 30.

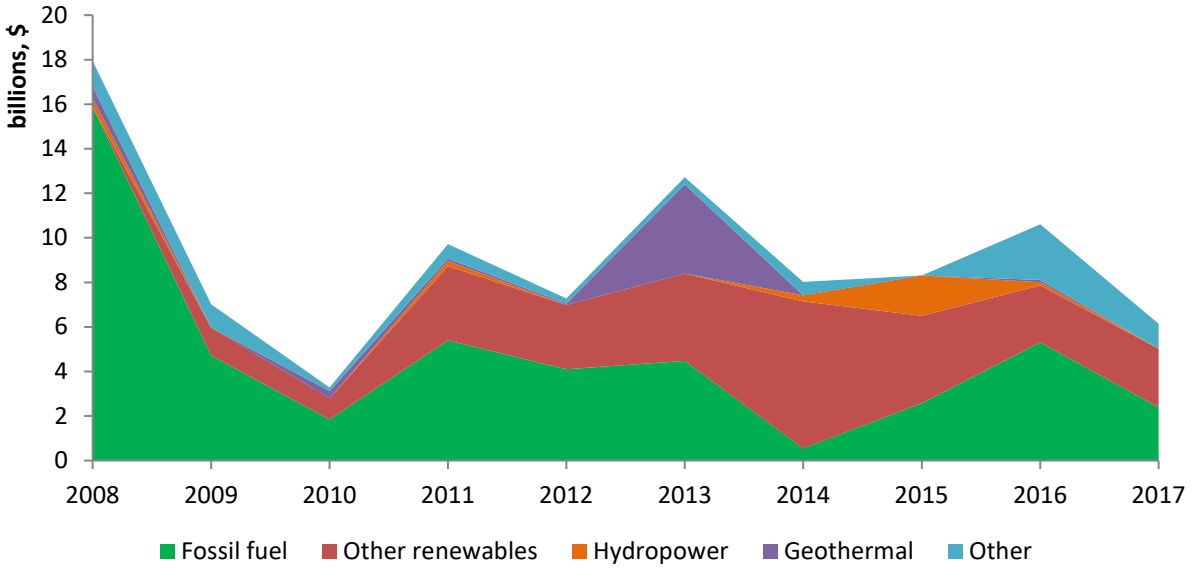
Table 4. Largest IPP investments in SSA electricity generation projects, 1994–2014

Project	Country	Investment (million $)	Capacity (MW)
Afam	Nigeria	540	630
Okpai	Nigeria	462	480
Azito	Côte d'Ivoire	430	434
Kpone IPP	Ghana	900	350
Takoradi II	Ghana	440	330
Lake Turkana Wind Power	Kenya	861	300
Bujagali Hydro Project	Uganda	860	250
Aba Integrated	Nigeria	460	141

Source: Eberhard et al., *Independent Power Projects in SSA*, 2016, 25.

Annual greenfield[16] FDI commitments by IPPs in the SSA electricity generation sector have fallen sharply in recent years, from almost $18 billion in 2008 to $6 billion in 2017 (figure 3). Notably, fossil fuel facilities declined as a share of these greenfield commitments, from 89 percent to 39 percent in 2017. Renewables accounted for an increasing share of new investment, reaching as high as 82 percent of all IPP greenfield FDI in 2014. Planned investment in hydropower, which has high fixed costs that require a longer term to recoup, has been relatively low in most years (with the exception of 2015).

Figure 3. Greenfield investments by IPPs in SSA electricity generation by type (estimated), 2008–17



Source. Author's calculations from fDiMarkets.com. fDiMarkets.com data offer a useful indication of future greenfield investments; however, they signal planned levels of FDI rather than completed financial outlays. The values presented in figure 3 should thus be treated as approximations.

[16] Greenfield or green field investments occur when a parent company builds new production facilities and other investments in another country, from the ground up (Investopedia, "Green Field Investment", (accessed May 21, 2018).

China

Between 2001 and 2013, China completed 3.3 GW in generation projects in SSA, at a combined cost of $5 billion. Since it first entered the SSA generation market, the rate of Chinese construction has accelerated, and it is estimated that 17 GW of Chinese-invested generation capacity will be completed between 2010 and 2020, across 96 projects. As of 2016, 54 of these 96 Chinese generation projects had been completed, another 25 were under construction, and 17 had been planned and financed.[17]

Chinese state-owned enterprises have been contracted to construct more than 90 percent of these new projects, and five state-owned companies—Sinohydro, China Gezhouba Group, China National Electric Engineering, China International Water and Electric Corporation, and Shandong Electric Power Construction Company—have been contractors on three-quarters of the projects (table 5). All of these companies have funded projects through loans from the Export-Import Bank of China. They have been able to build electricity generation plants at a lower cost than non-Chinese sources—in part because they have smaller management teams than other domestic and foreign contractors.[18]

Table 5. Five largest Chinese companies investing in SSA generation

Company	No. of completed/ pipeline projects	Average size (MW)	Total capacity added (MW)
Sinohydro, China	24	160	3,832
Gezhouba Group, China	7	379	2,654
China National Electric Engineering	5	204	1,020
China International Water and Electric Corporation	5	368	1,838
Shandong Electric Power Construction Company	4	448	1,790

Source. IEA, *Boosting the Power Sector in SSA*, 2016, 21.

The average size of Chinese-invested electricity generation projects in SSA during 1990–2014 was 226 MW, more than double the average size of IPP investments (98 MW). There have been large Chinese-funded projects across the continent, with hydropower, combined-cycle gas turbine/open-cycle gas turbine, and coal-powered plants accounting for the majority (table 6).[19] About 20 percent of the projects built by Chinese firms are designed to provide dedicated power to a single enterprise, most often in the mining sector. For example, the Morupule facility provides electricity to a coal mine, and Mchuchuma in Tanzania will provide 300 MW to an iron mine upon its completion in 2019.[20]

[17] IEA, *Boosting the Power Sector in SSA*, 2016, 7 and 12.
[18] IEA, *Boosting the Power Sector in SSA*, 2016, 8, 20, and 26.
[19] Eberhard et al., *Independent Power Projects in SSA*, 2016, 280–81.
[20] IEA, *Boosting the Power Sector in SSA*, 2016, 28.

Table 6. Largest Chinese-funded electricity projects in SSA, 2001–14

Project	Country	Investment (US$, mil)	Capacity (MW)
Karuma Hydropower Project	Uganda	1,688	600
Zungeru Hydropower Project	Nigeria	1,293	700
Morupule B Power Station	Botswana	970	600
Omotosho Power Plant II (NIPP)	Nigeria	660	513
Memve'ele Hydropower Project	Cameroon	637	201
Bui Hydropower Project	Ghana	621	400
Soubré Hydropower Project	Côte d'Ivoire	571	270

Eberhard et al., *Independent Power Projects in Sub-Saharan Africa*, 2016, xxviii.

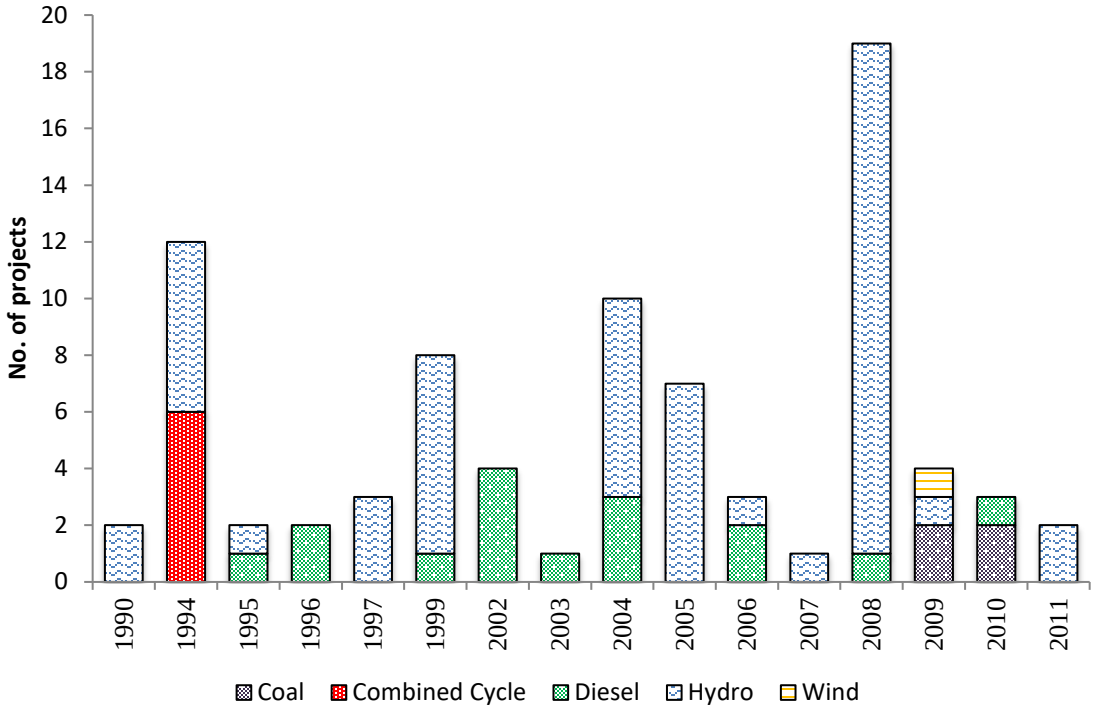
Some Chinese-invested generation projects have garnered a degree of controversy. For example, Gibe III—a Chinese-built hydropower facility on the Omo River in Ethiopia and Africa's tallest dam—was completed in December 2016. The Ethiopian government has expressed hopes that this facility will provide 15 GW per year.[21] However, there are concerns that the project could completely dry up Lake Turkana in Kenya, exacerbating water scarcity issues in a drought-prone region. The lake has already receded by 1.5 meters in the 18 months since the Gibe III reservoir began to form.[22] After three decades of delays, another Chinese-funded hydroelectric project is due to break ground in Nigeria, which would add 3 GW to the grid. However, there are concerns that the project could be subject to political violence, as the project is expected to necessitate the displacement of about 100,000 people.[23]

Foreign Donors

Foreign donors—specifically ODA, DFIs, and Arab funds—accounted for 11 percent of completed SSA electricity generation projects during 1990–2013, with investments totaling $3.5 billion. ODA and DFIs accounted for investments in 64 generation projects during those years, but there was a marked decline in new projects after 2008, with no new funds allocated by these sources during 2012–13 (figure 4). However, OECD data indicate that in 2015, five countries in SSA received ODA-sourced hydropower investments of at least $10 million, with the total ODA hydropower investment in SSA amounting to $192 million in that year.[24] One-third of those investments were directed towards projects in the Democratic Republic of the Congo, and another third was split between Cameroon and Mozambique. Overall, hydropower accounted for the largest number of ODI- and DFI-funded projects, followed by diesel and coal.

[21] Meseret, "Ethiopia Opens Massive Gibe 3," 2016.
[22] The Economist. "Ethiopia Opens Africa's Tallest … Dam," 2016..
[23] Monks, "Nigeria Announces $5.8 Billion Deal," 2017.
[24] OECD, International Development Statistics, 2017.

Figure 4. ODA and DFI Investments in electric power, number of projects, by year



Source: Eberhard et al., *Independent Power Projects in SSA*, 2016, 273–78.

The Democratic Republic of the Congo was the leading recipient of ODA funds in 2015 due to one particular investment. The Inga mega-hydropower project is projected to cost $100 billion and generate up to 40 GW, or almost double the output of the Three Gorges Dam project in China. It would be capable of meeting two-fifths of Africa's electricity needs, reaching almost 500 million people.[25] The initial phase, Inga 3, would cost $14 billion and provide 4.8 GW, more than half of which (after accounting for any systems losses) would be exported to South Africa.[26] However, these investments face opposition, as they would displace 60,000 people and disrupt a large stock of fish. Further, the government does not plan to conduct an environmental or social impact assessment, which violates national law as well as World Bank and Chinese policies, and could add to delays.[27] Citing the lack of impact studies, the World Bank has held up funding for the Inga 3. As a result, the project will not produce power before 2024, at least three years later than the previously cited start date of 2021.[28]

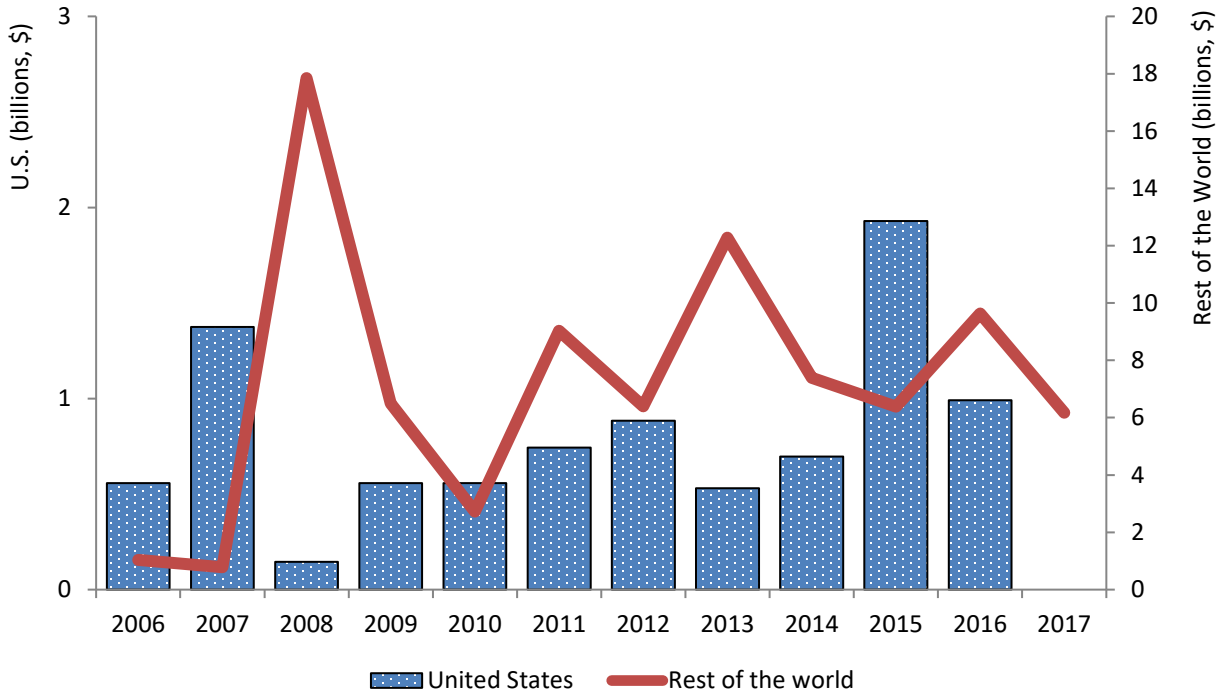
U.S. Firms

Although Chinese state-owned companies have taken a leading role investing in SSA electricity markets, U.S. firms have also announced sizable greenfield projects across the region, with its share rising to 23 percent of the total in 2015 (figure 5). U.S. firms announced a total of almost

[25] Kermeliotis, "Will World's Biggest Hydro Power Project Light Up Africa?" 2013.
[26] Wernick, "Congo Pushes for a Mega-dam Project," 2016.
[27] Vidal, "Construction of World's Largest Dam in DR Congo," 2016.
[28] Ross, "DRC Delays Inga 3 Hydro Project to 2024/5," 2017.

$3 billion in projects between 2015 and 2016, including large projects in Tanzania (Symbion Power), Nigeria (ExxonMobil), and Cameroon and South Africa (both by AES Corporation).[29]

Figure 5 U.S. greenfield investments in SSA electricity generation (estimated), 2006–17



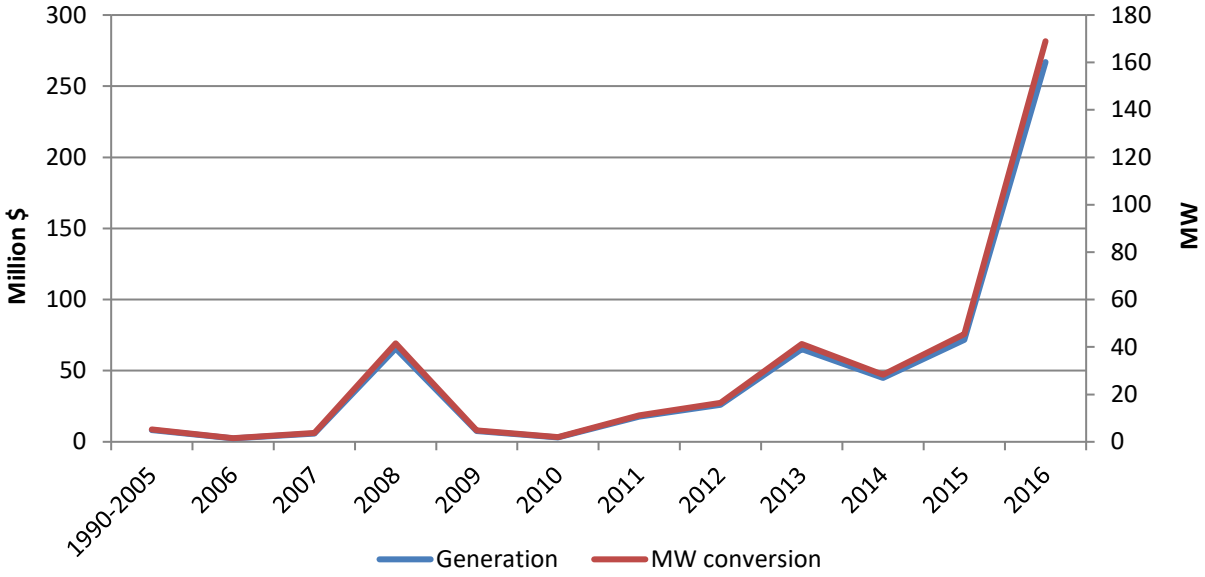
Source. Author's calculations from fDiMarkets.com. fDiMarkets.com data provide a useful indication of future greenfield investments; however, they signal planned levels of FDI rather than completed financial outlays. The values presented in figure 3 should be treated as approximations.

U.S. Foreign Aid

U.S. foreign aid expenditures on SSA power projects amounted to more than $850 million during 1990–2013 and $850 million during 2014–16, totaling over $1.7 billion across this timespan (figure 6). Of that total, $585 million was invested in generation projects,[30] contributing to the development of approximately 370 MW in power generation capacity, based on a conversion of $1.6 million per MW. The recent increase in electricity infrastructure investments coincides with the U.S. government's Power Africa program, which began in 2013. This program aims to increase installed capacity in SSA by approximately 1.7 GW per year through 2030 (30 GW in total) and add 3.3 million new electricity connections per year.[31]

[29] fDiMarkets.com (accessed May 2, 2018).
[30] The remaining funds are spent on transmission and distribution.
[31] USAID, "Power Africa," 2016, 4.

Figure 6. U.S. foreign aid investments in SSA electricity generation (and MW estimates), 1990–2016

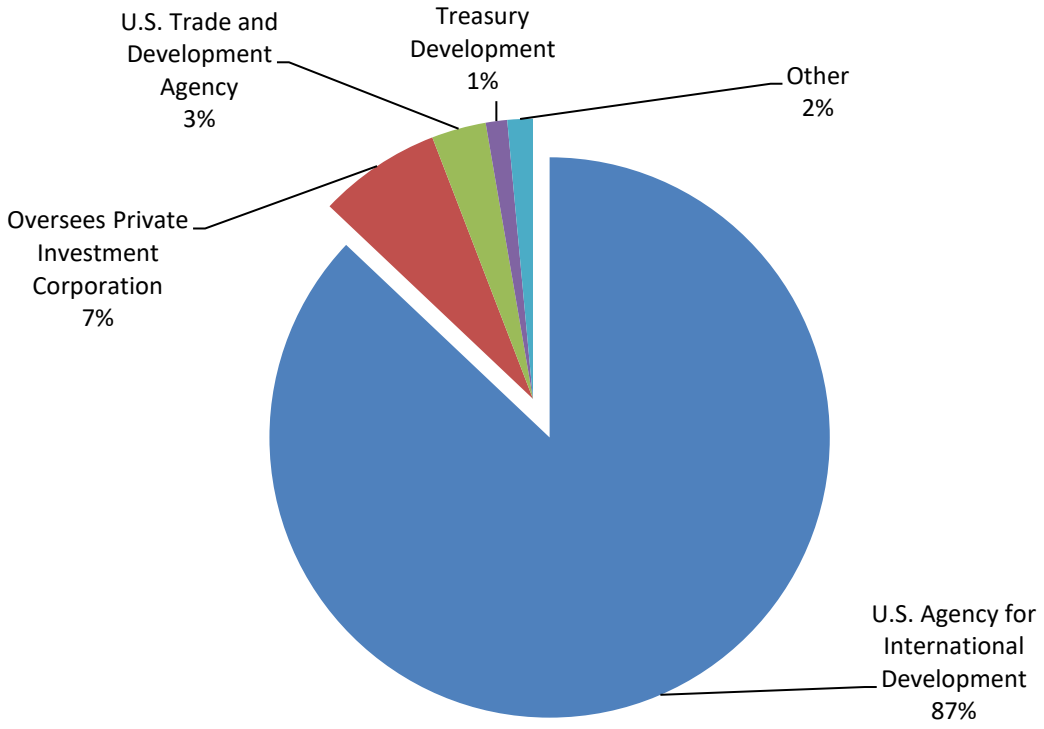


Source: USAID, Foreign Aid Explorer (accessed April 15, 2018).

In an effort to facilitate private sector investment in the SSA electricity sector, the United States plans to dedicate $9.7 billion towards technical assistance, grants, and loan capital through a range of government agencies under the Power Africa program.[32] USAID is expected to account for the vast majority of generation capacity developed under this program, followed at a distance by the Overseas Private Investment Corporation (OPIC) (figure 7). Projects financed through Power Africa are typically smaller than the SSA electricity infrastructure projects financed by China. For example, OPIC has committed $1.7 billion in debt financing for power projects, and the Millennium Challenge Corporation (MCC) will provide a $498 million grant to Ghana to attract private sector investment through institutional reforms that increase the sector's reliability.[33]

[32] Cook et al., *Powering Africa: Challenges of and U.S. Aid*, 2015.
[33] MCC, "Ghana Power Compact," updated January 31, 2018.

Figure 7. Shares of MW of potential installed capacity under Power Africa, 2013–16.



Source. Author's calculations from Moss, "Grading Power Africa," 2016, 7.

Outlook

There are strong signals suggesting future growth in the private sector's SSA electricity sector investment. Total annual greenfield FDI announcements for new generation projects in SSA averaged almost $10 billion over the last decade, and the recent U.S. Power Africa program promises to expand electricity investments across SSA. At the same time, several impediments may discourage the more widespread investment needed to remedy the region's electricity gaps. Although IPPs comprised almost three-quarters of all investment funds in the region's electricity generation in 2013, these private investors face persistent barriers to increasing their financial commitment, which may impede the progress of greenfield projects. Additionally, while SSA(?) governments have taken steps to fill the electricity investment gap, their low tariffs continue to dampen incentives to bring new projects online for fear that utilities cannot afford to meet their financial commitments to investors. As a result, utilities remain unreliable guarantors of private investment, thereby perpetuating the electricity shortage.[34]

[34] Some countries try to lessen the energy cost burden for their manufacturing sectors by lowering tariffs, but this is likely to increase utilities' financial losses.

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