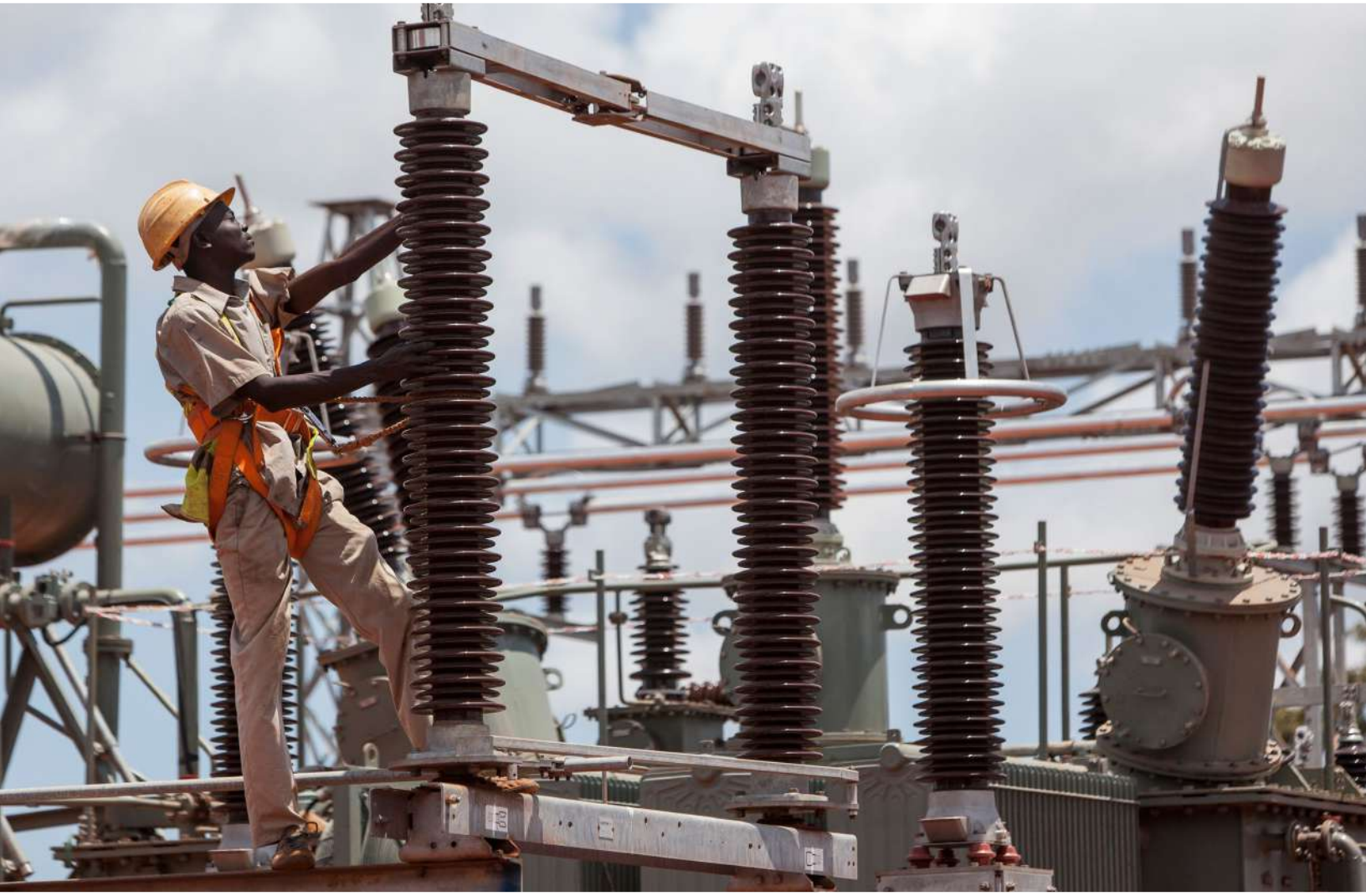
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POWER AFRICA TRANSMISSION ROADMAP TO 2030

A PRACTICAL APPROACH TO UNLOCKING ELECTRICITY TRADE

ACKNOWLEDGEMENT

Many individuals and organizations contributed to the development of this *Power Africa Transmission Roadmap*. This strategy blends ideas, input, and vision from a wide range of Power Africa's many partners, including those serving in the U.S. Government agencies and posts across sub-Saharan Africa, the private sector, international finance institutions, and African institutions.

In particular, we would like to extend a special thank you to the following people outside of the U.S. Government, who provided detailed input and insight: **Actis**, Lisa Pinsley; **African Development Bank**, Angela Nalikka, Ifeyinwa Miriam Emelife, Jacques Moulot and Omar Vajeth; **Agence Française de Développement**, Cyril Renault and Florent Germain; **Commonwealth Development Corporation**, Hanaan Marwah; **Deloitte**, Tunde Gbajumo; **East Africa Power Pool**; **European Union**, Georgios Grapsas; **Export-Import Bank of the United States**, Rick Angiuoni; **Globeleq**, Jonathan Hoffman, Christian Wright, Fiona Gonyea; **International Renewable Energy Agency**, Asami Miketa and Daniel Russo; **Japan International Cooperation Agency**, Kamiishi Hiroto and Wakamatsu Eiji; **Korea Eximbank**, Jae-Jeong Moon and Seonae Choi; **Kreditanstalt für Wiederaufbau**, Kevin Leask; **Millennium Challenge Corporation**, Robert Anderson and Thomas Haslett; **New Partnership for Africa's Development**, Mosad Elmissiry; **Nile Equatorial Lakes Subsidiary Action Program**, Grania Rosette Rubomboras; **Norwegian Agency for Development Cooperation**, Geir Yngve Hermansen and Ørnulf Strøm; **West Africa Power Pool**; **Southern African Power Pool,** Stephen Dihwa; **Swedish International Development Cooperation Agency,** Anders Arvidson, Elisabeth Ilskog, Monica Gullberg, Jörgen Eriksson and Stephen Mwakifwamba; **Tetra Tech**, Sarah Thessing, David Mwangi, Wangeci Wanyahoro, Jaap du Preez, Barney Speckman, Ajit Kulkarni, and Ryan Kilpatrick; **The Energy Practice of the Tony Blair Institute**, Gareth Walsh and Sergio Portatadino; and **World Bank**, Rahul Kitchlu and Sudeshna Banerjee.

Finally, a special acknowledgement to all of the staff across U.S. Government agencies and departments involved in developing this *Power Africa Transmission Roadmap*.

Cover: Substation in Tanzania. Photo: Jake Lyell for MCC

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FOREWORD BY POWER AFRICA COORDINATOR **ANDREW HERSCOWITZ**, AND AFRICAN DEVELOPMENT BANK GROUP VICE PRESIDENT, POWER, ENERGY, CLIMATE AND GREEN GROWTH, **AMADOU HOTT**



Andrew Herscowitz


Amadou Hott

The United States Government's Power Africa and the African Development Bank's "Light Up and Power Africa" and "Integrate Africa" initiatives share the goal of bringing a massive amount of new power generation online in Africa in the next few years. We are currently tracking more than 800 power generation projects that have the potential of being built by 2030. However, these potential new megawatts will never come online if there is no demand for that power, and if the transmission and distribution lines are not built to ensure efficient evacuation.

With 600 million people in Africa lacking access to power, how can we say that there is no demand for more power? We need to tap into that latent demand and unleash unprecedented economic growth on the African continent.

Development banks and agencies, the private sector, and governments have invested heavily in power generation. Some countries now have surplus supply. Others, however, still have critical power shortages. Over 40 percent of businesses cite the lack of a reliable power supply as the biggest constraint to their operations; and some have indeed closed or relocated.

To increase universal access to energy and ensure a cost-efficient, reliable power supply, we are working together to move power to where it is needed, especially by focusing on transmission. Strong, effective and efficient regional power pools are critical to promoting universal access, and ensuring that countries, people and industry are not spending more money on power than they need to spend. Does it make sense for one country to spend $0.35/kilowatt hour (kWh) on a potential geothermal project when it could potentially import power from a neighboring country for $.07/kWh, or less? Power Africa and the African Development Bank (which has been mandated by the African Union Commission and the New Partnership for Africa's Development to implement the Programme for Infrastructure Development in Africa, PIDA), are seizing the opportunity to improve coordination of all power pools and related parties and initiatives to support projects that enhance regional interconnections and encourage power trade.

We will continue to work hand-in-hand, with our partners, to create enabling environments that will accelerate deals, build institutional capacity, ensure the effective execution of projects, and create the conditions to make these projects operational and sustainable.

The *Power Africa Transmission Roadmap* promotes the Regional Transmission Agenda, which is part of the AfDB's Sustainable Utility Transformation Agenda, and outlines a proposed action plan to move projects in this Agenda forward. **By 2030, we aspire to mobilize at least $3 billion to install 7,500+ MW of transmission capacity, and bring at least 10 priority projects to financial close**.

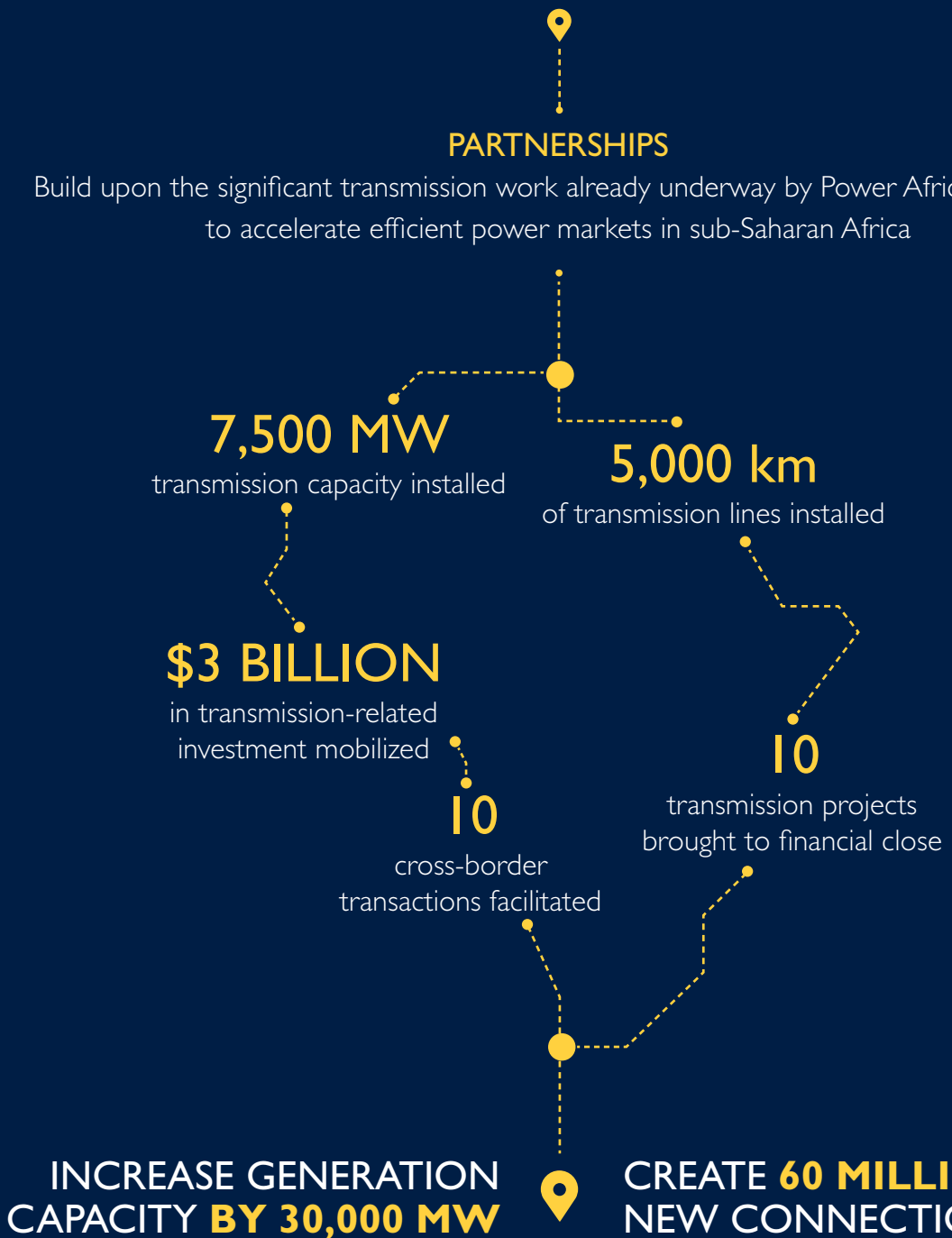
The proposed Transmission Roadmap reaffirms our commitment to universal access in Africa through cost-efficient project preparation and investment approaches, anchored on the right national and regional energy mix. Recognizing that Power Africa and the AfDB cannot do it alone, we have set the ball rolling, and we look forward to working with interested public and private stakeholders to contribute to, and support the implementation of this agenda.

ANDREW HERSCOWITZ
Power Africa

AMADOU HOTT
African Development Bank Group



POWER AFRICA
TRANSMISSION TARGETS FOR 2030



These targets are ambitious yet realistic; they are based on the priority projects defined in Section 4 of this Roadmap, which have a high potential to unlock regional trade. These targets assume completion rates ranging between 70% and 100% depending on the projects' level of prioritization (high intervention, light support, or watchlist, as outlined in Section 4 – with a higher probability of completion for projects requiring light support). These numbers do not account for generation or transmission projects that will be commissioned after 2025, due to the lack of reliable information on generation projects to be commissioned over this period.

EXECUTIVE SUMMARY

RATIONALE FOR AND OBJECTIVES OF THE TRANSMISSION ROADMAP

Over the last decade, many governments and major bilateral donors have focused their support of sub-Saharan Africa's energy sector on advancing country-based approaches to power generation and transmission. As a result, some countries now have national supply surpluses and stranded power assets, while others face critical supply shortages. However, the ability for electricity trade to flow from areas of surplus to areas of demand is severely constrained, within and across borders. This trend highlights the urgent imperative to move power from its generation sources to where it is needed, thus providing cost-efficient supply and enhancing energy security. In line with this imperative, Power Africa's 2.0 Strategy commits to increase access to electricity in sub-Saharan Africa by increasing focus on transmission.

As an important step toward addressing this imbalance, the *Power Africa Transmission Roadmap* was developed to help unlock electricity trade in the region. While Power Africa's efforts are focused on both national and regional transmission, the primary purpose of this Transmission Roadmap is to highlight cross-boundary trade opportunities that can be exploited for broader regional electricity access and economic benefit. The Transmission Roadmap therefore has two main objectives. First, it aims to enhance cooperation between major stakeholders by identifying transmission projects that are critical to cross-border electricity trade and highlighting bottlenecks/risks of delay (this focus would also include domestic projects with the potential to support regional trade, e.g., by connecting new generation capacity to cross-border lines). Second, it aims to support priority projects by highlighting the contributions development partners can make to their completion, to complement government-led initiatives.

This Transmission Roadmap proposes an action plan to facilitate ongoing dialogue and action in the development partner community focused on the priority projects. This dialogue will build on existing efforts at the sub-region level (e.g., East, West, and Southern Africa) and help provide an integrated perspective on the cross-border transmission agenda across sub-Saharan Africa. This integrated perspective will enable public and private stakeholders to identify potential gaps in the support provided to priority projects and facilitate cross-regional dialogue to address these gaps.

OPPORTUNITIES FOR TRADE AND PRIORITY PROJECTS

The *Power Africa Transmission Roadmap* identifies 10 major immediate opportunities for regional power trade in East, West, and Southern Africa. These opportunities reflect

current or projected imbalances in power supply/demand, and have an economic rationale, i.e., importing power would be cheaper for a given country than generating it domestically or resorting to emergency power generation. Specifically:

- TWO OPPORTUNITIES IN EAST AFRICA: Exports to Tanzania (EKTZ line) and Southern Africa, and sub-regional trade in the Nile Basin (NELSAP power interconnections).
- FOUR OPPORTUNITIES IN SOUTHERN AFRICA: Central corridor from South Africa to the Democratic Republic of Congo; integrating Malawi into the power pool; western corridor delivering power to Namibia; and bringing new power capacity to the region (e.g., Mozambique).
- FOUR OPPORTUNITIES IN WEST AFRICA: Interconnection of the Senegal-Guinea axis (OMVG line); addressing power deficits in landlocked countries (e.g., Burkina Faso); enabling Côte d'Ivoire to export to the West (CLSG line); and addressing regional imbalances in the eastern Gulf of Guinea.

To realize these opportunities, we identified 18 priority transmission projects (**Exhibit 2**). We prioritized these projects based on their potential to unlock regional trade, their scheduled completion time, and the feasibility of resolving the bottlenecks they face. Four of these priority projects are in East Africa, nine are in Southern Africa, and five are in West Africa. **Together, these projects represent the potential for a combined installed capacity of 11,000+ MW and 7,200+ km of lines**.

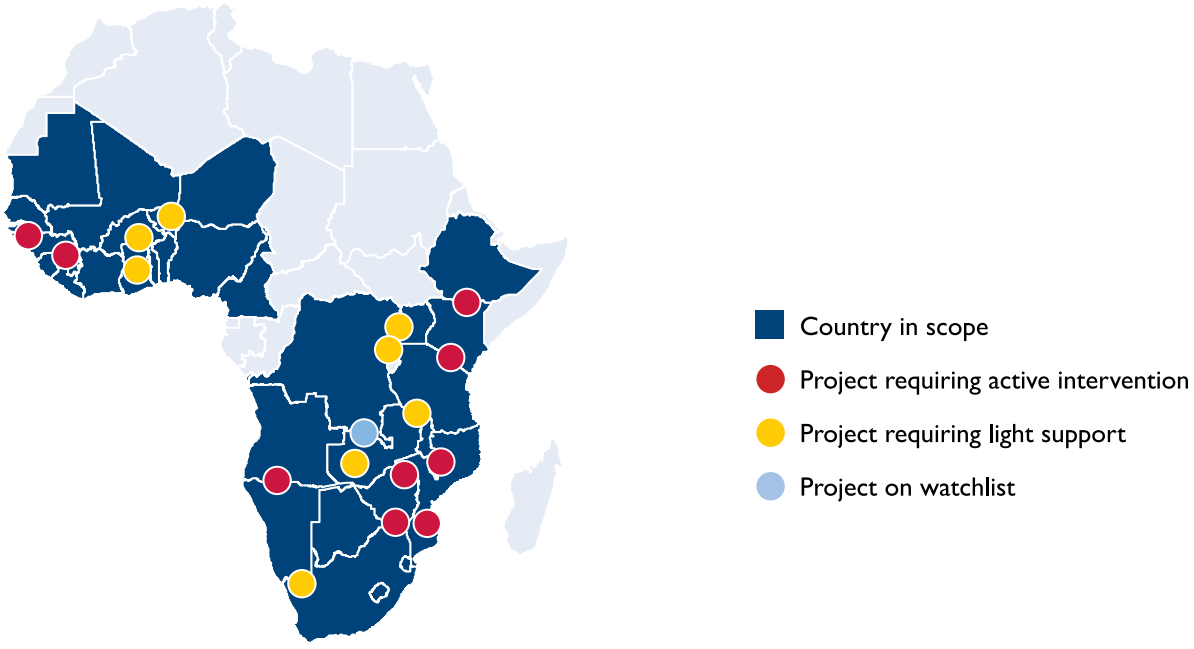
ACTION PLAN AND COORDINATION

Many of the priority projects face bottlenecks/risks of delay. We identified three types of bottlenecks and recommended actions for each:

- **Enabling environment**, including permits and political involvement at the national or regional level that can facilitate project coordination and help negotiations;
- **Funding**, or the ability to secure concessionary financing sources for early stage development, feasibility studies and/or financial close; and
- **Project implementation** issues that can jeopardize project timelines, construction quality and/or budgets.

EXHIBIT 2

COUNTRIES IN SCOPE AND PRIORITY TRANSMISSION PROJECTS IDENTIFIED



Stakeholder coordination is critical to the success of these projects. Given the number of stakeholders active in transmission in sub-Saharan Africa – governments, regional power pools and bilateral and multilateral organizations – the coordination around the action plan must leverage the existing mechanisms in each power pool, the support of development partners, and ongoing Africa-wide initiatives (e.g., Program Infrastructure Development for Africa (PIDA) under the African Union). More focused effort around specific project gaps could accelerate execution and mobilize investment.

Attracting more private investment into these regional transmission projects that are typically financed by the public sector is also important. Power Africa and our partners have the opportunity to bring the private sector to the discussion by developing alternate financing models to advance this approach and working hand-in-hand with governments to increase the visibility on prerequisites to implementation (e.g., permits and land access).

Working together on the priorities identified in this Transmission Roadmap, Power Africa and our partners can help move power to where it is needed to provide a more cost-efficient supply and enhance energy security across the continent.





Mtoni Service Station Zanzibar. Photo: Jake Lyell for MCC

2 CONTEXT OF THIS WORK

INTRODUCTION TO POWER AFRICA

In June 2013, the United States (U.S.) Government launched Power Africa in partnership with African governments, bilateral and multilateral development partners, and the private sector to double access to electricity in sub-Saharan Africa and accelerate power transactions. The partnership comprises more than 160 public and private sector entities. Now in our fifth year, Power Africa has built the financial and human resources, recruited the partners, and identified the specific deal flow to create a clear path to success.

Power Africa aims to increase installed generation capacity by 30,000 megawatts (MW), while adding 60 million new household and business connections by 2030. In February 2016, the U.S. Congress passed the *Electrify Africa Act of 2015*, which charges Power Africa with increasing installed generation capacity by 20,000 MW and providing first-time energy access for 50 million beneficiaries by 2020 — an effort that directly supports Power Africa's original goal.

In March 2018, Power Africa released the Power Africa 2.0 Strategy, which builds on the original generation and access objectives to increase focus on improving distribution and transmission. Strategic Pillar I supports generation projects to reach the 30,000 MW target by 2030. Strategic Pillar II focuses on achieving 60 million connections, and includes support for transmission and distribution lines, regional integration and trading. Strategic Pillar III aims to unlock the potential of the energy sector through the enabling environment.

As of October 2018, Power Africa had helped bring 9,635 MW of generation projects to financial close and helped 12.5 million new households obtain access to electricity. Our partners have invested over $18 billion in 119 electrification projects to date. These achievements put Power Africa on track to attain our 2020 and 2030 goals.

RATIONALE FOR DEVELOPING A TRANSMISSION ROADMAP FOR SUB-SAHARAN AFRICA

Over the last five to ten years, assistance from many major bilateral and multilateral development partners in the energy sector in sub-Saharan Africa has focused on advancing country-based approaches to generation and transmission. Some countries now have national supply surpluses and stranded power assets, while their neighbors face critical supply shortages. However, the ability for electricity to flow from areas of surplus to areas of demand is severely constrained, within and across borders. This trend highlights the urgent need to move power from its sources of generation to where it is needed – including across borders – to provide cost-efficient supply and enhance energy security.

The imperative to shift power across borders is in line with Power Africa's commitment to increasing access to electricity in the region, and with the focus on transmission under the Power Africa 2.0 Strategy. This Transmission Roadmap also aligns with key U.S. policy goals outlined in the Department of State and USAID Joint Strategic Plan (JSP) and the United States National Security Strategy.

These goals include, among others, removing barriers to energy trade and promoting U.S. exports, working to attain universal energy access, and ensuring energy security for U.S. allies and partners.

OBJECTIVES AND SCOPE OF THE TRANSMISSION ROADMAP

The Transmission Roadmap has two main objectives. First, to enhance cooperation between major stakeholders by identifying transmission projects critical to cross-border electricity trade and highlighting bottlenecks/risk of delay. Second, to motivate action to address the bottlenecks these projects face by highlighting potential contributions from development partners and contributing to facilitate existing coordination mechanisms. This Transmission Roadmap thus builds on existing efforts at the sub-region level (e.g., East, West and Southern Africa) while providing an integrated perspective on the cross-border transmission agenda for sub-Saharan Africa.

This Transmission Roadmap highlights the transmission and distribution work that Power Africa's partners are engaged in across the region to illustrate the collective effort required to implement and sustain our goals. The Transmission Roadmap does not attempt to provide a comprehensive breakdown of all Power Africa activities in every country, nor a view of every partner's activities.

This Transmission Roadmap offers a tangible plan to realize a common vision of an economically vibrant sub-Saharan Africa by developing its transmission network to unlock regional power trade in a rapid and transparent manner. It evaluates the roles currently played by different development partners and identifies gaps where intervention may be required. It also prioritizes the specific interventions on which Power Africa could focus, complementing the work of other development partners.

The geographic scope of the Transmission Roadmap covers 32 countries that were included in the work previously done for Power Africa at the sub-region level: Angola, Benin, Botswana, Burkina Faso, Cameroon, Côte d'Ivoire, Democratic Republic of Congo (DRC), Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, eSwatini, Tanzania, Togo, Uganda, Zambia, and Zimbabwe. In terms of transmission, the Roadmap focuses on inter-country lines but also includes certain domestic lines that are critical to enabling cross-border trade by evacuating power from stranded assets (these domestic lines can also address local deficits domestically during peak periods).

HOW THIS ROADMAP BUILDS ON AND DIFFERS FROM PREVIOUS WORK

This Transmission Roadmap builds on previous work conducted by Power Africa, our partners, and the regional power pools to prioritize and analyze transmission and coordinate local development partner efforts. Most of these previous transmission analyses were done at the level of the regional power pools. We leveraged three major sources of insight in the development of this Roadmap:

- Africa-wide and sub-region initiatives developed by bilateral or multilateral institutions, e.g., Africa Power Vision by the New Partnership for Africa's Development (NEPAD)[1];
- Power Africa work conducted in 2017 and 2018 at the sub-region level in West Africa, East Africa, and Southern Africa;
- Where relevant, interviews with additional experts to understand major updates to the project portfolio/context since the publication of the aforementioned reports.

This Transmission Roadmap therefore offers a consolidated and updated perspective on work done previously while seeking to define priorities and the most critical bottlenecks across the sub-regional power pools. It does not intend to go to the same level of detail as other reports, but rather to provide actionable insights on transmission projects that could unlock trade in sub-Saharan Africa. The list of projects and priorities is based on the latest information available to date and should therefore be updated once more visibility is provided on long term transmission projects (or generation projects that could unlock regional trade).

1 Africa Power Vision Concept Note and Implementation Plan (January 2015), NEPAD

3 SUPPLY/DEMAND FORECASTS AND OPPORTUNITIES FOR TRADE

The following supply/demand forecasts are split into two timeframes: 2018-2025 and 2025-2030.

2025 SUPPLY/DEMAND FORECASTS

Analyzing demand and supply dynamics is critical to understanding the volumes available for trade and to identifying priority interconnector lines that need to be built to move surplus power to countries with a power deficit. Based on anticipated domestic consumption and expected timelines for commissioning of generation plants, the 32 countries examined have varying levels of excess power supply or deficit.

To determine the regional anticipated peak demand and supply up to 2025, we:

- Estimated peak annual demand in MW for each country and scaled it up by 15 percent to account for reserve margins and system losses.
- Derived peak available capacity from installed capacity adjusted by peak capacity factors, estimated from prior work; when capacity factors were unavailable, we used assumptions depending on the source of energy.[2]
- Used planned commissioning of generation plants to track generation projects expected to come online between 2018 and 2025 (as well as planned decommissioning). These new generation projects contribute to the estimated peak surplus/deficit per country over the period.

2 In East and Southern Africa, the peak hour capacity factors used were 0% for solar, 30% for wind, 90% for hydropower dams, and 95% for other technologies; in West Africa, country- and source-specific factors were used

The main sources to estimate peak demand and supply include country-specific integrated resource plans, prior regional studies conducted by and for Power Africa, the latest updates from expert interviews, as well as publicly available sources such as Enerdata and UDI World Electric Power Plants Database.

EAST AFRICA

East Africa's peak supply of around 7,800 MW (2018) is expected to grow to ~17,800 MW by 2025, with peak demand of ~7,000 MW growing to ~14,400 MW. Ethiopia, Kenya, and Uganda will have power surpluses, while Tanzania and Rwanda will have deficits through 2022 and 2020, respectively. Opportunities therefore exist for cross-border trade (**Exhibit 3**).

- Ethiopia, Uganda and Kenya exhibit surpluses of power
  - Ethiopia's large surplus of ~1,200 MW is expected to grow to ~1,900 MW by 2025 as new generation capacity comes online (e.g., Baro, GibeIV, Karadobi, and Renaissance hydroplants). These assumptions on supply will need to be revised once more visibility is provided on these generation plans. The predominance of low-cost hydropower – which will account for 95 percent of available generation capacity by 2025 – gives Ethiopia a strong competitive advantage in terms of exports (however, seasonal fluctuations in hydropower capacity may impact the surplus available on a monthly level). Ethiopia

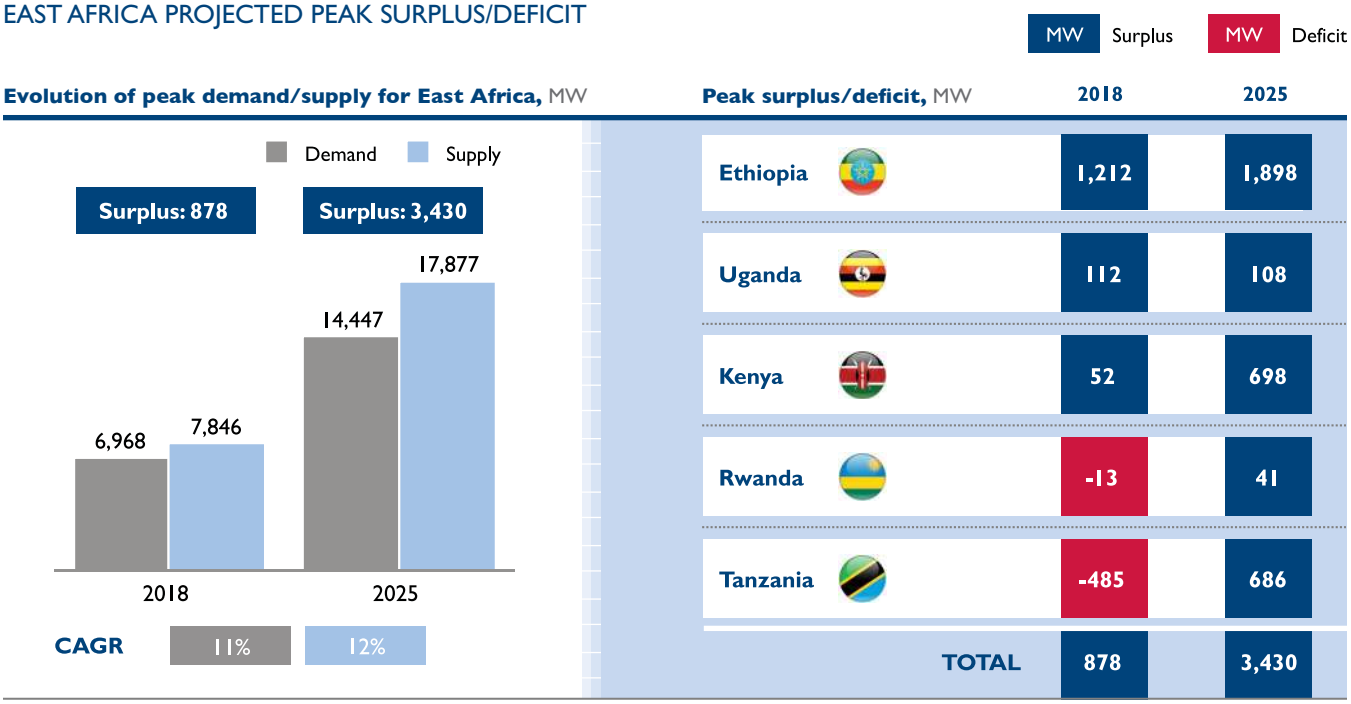
currently exports 200 MW to Djibouti and Yemen, and additional exports to Sudan will push this total to1,200 MW by 2022. Draftagreements with Egypt also suggest further export potential to North Africa.

- Uganda and Kenya's peak surplus is less significant, at 112 and 52 MW in 2018, respectively. Uganda's generation mix is primarily based on hydropower, while Kenya's is dominated by geothermal. Uganda's surplus should remain around 100 MW by 2025, while Kenya's surplus should grow to nearly 700 MW by then.

- In 2018, Rwanda and Tanzania have deficits (of 13 and 485 MW, respectively) but the commissioning of new generation projects will likely create a surpluses in 2020 (Rwanda) and 2022 (Tanzania). Not all of these projects are confirmed, so extended domestic deficits may persist in the medium term (excluding imports).

EXHIBIT 3

EAST AFRICA PROJECTED PEAK SURPLUS/DEFICIT



NOTE: totals may not sum up due to rounded numbers

WEST AFRICA

West Africa's peak supply of ~13,500 MW in 2018 is forecast to grow to ~30,400 MW in 2025, with peak demand of ~17,700 MW growing to ~30,600 MW. Ghana, Côte d'Ivoire, Cameroon, Guinea, Liberia, Senegal and Togo should maintain energy surpluses between 2018 and 2025, while Burkina Faso, Gambia, Guinea Bissau, Niger and Nigeria should have deficits over the period (with Niger transitioning to surplus in 2025). Benin, Mauritania and Sierra Leone are expected to transition from light deficit to light surplus over the period, while Mali should follow the opposite trajectory. Again, this situation suggests opportunities for inter-country trade (**Exhibit 4**).

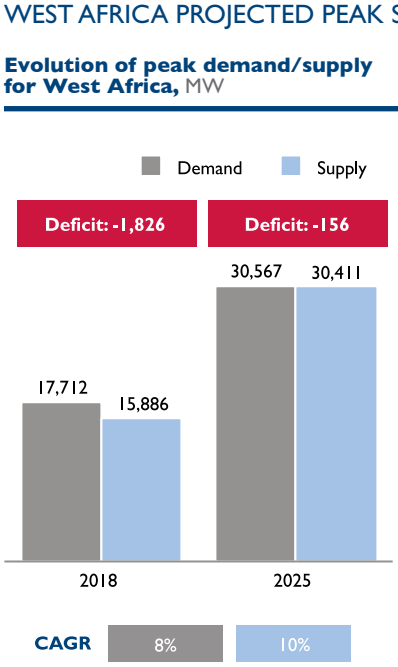
- Ghana is expected to maintain significant surplus over 2018-2025 (between ~500 MW and ~1,300 MW). Historically dominated by hydropower, there is an increase of gas in the generation mix. Similarly, Côte d'Ivoire is also expected to grow its surplus from around 300 MW to over 1,500 MW over 2018-2025 through additional generation from hydropower and gas plants.

- Cameroon, Guinea, Liberia, Senegal and Togo are expected to have generation surpluses, but smaller than Ghana and Côte d'Ivoire.

- Burkina Faso, Gambia and Guinea Bissau are expected to maintain a generation deficit (-101, -82, -15 MW, respectively in 2018, staying at similar levels up to 2025, except for Burkina Faso where the surplus will grow to -435 MW); Niger should remain in deficit in the short to medium term, transitioning to surplus in 2025.
- Nigeria highlights the most significant deficit in the region at ~3,400 MW in 2018. This is the result of significant challenges in the power sector, including a lack of maintenance and repair of existing generation capacity and a critical deficit in domestic transmission capacity. While these challenges are currently being addressed at the domestic level with the support from development partners present in the country, we do not expect generation to recover fast enough to allow for peak surpluses by 2025. The electricity sector is mainly based on natural gas thermal power plants (~85 percent of the grid-connected power plants are gas, while the remaining 15 percent are hydropower plants).
- Benin, Mauritania and Sierra Leone are expected to transition from moderate/low peak deficit (between -14 and -126 MW) in 2018 to peak surpluses (~100-130 MW) by 2025; conversely, Mali should follow the opposite trajectory, suggesting future import needs.

EXHIBIT 4

WEST AFRICA PROJECTED PEAK SURPLUS/DEFICIT



MW Surplus MW Deficit

Peak surplus/deficit, MW	2018	2025		2018	2025
Ghana	1,286	514	Gambia	-82	-77
Cote d'Ivoire	331	1,547	Guinea Bissau	-15	-41
Cameroon	48	139	Niger	-42	50
Guinea	27	717	Nigeria	-3,407	-3,545
Liberia	29	4	Benin	-126	110
Senegal	55	373	Mauritania	-14	100
Togo	53	58	Sierra Leone	-43	127
Burkina Faso	-101	-435	Mali	79	-74
			TOTAL	-1,826	-156

NOTE: totals may not sum up due to rounded numbers

SOUTHERN AFRICA

Southern Africa's peak supply of ~63,700 MW (2018) will rise to ~76,800 MW in 2025, with peak demand of ~54,300 MW growing to ~66,200 MW. The aggregate surplus of ~9,400 MW (2018) is driven by countries with surpluses (Angola and South Africa), while some countries (e.g., Malawi, Namibia) will have power deficits. Countries like Mozambique and Zambia are expected to transition from deficit to surplus over the period. Southern Africa also offers opportunities to trade power between countries (**Exhibit 5**), in some cases facilitated by existing infrastructure.

- South Africa and Angola exhibit significant surplus and opportunity for exports to neighboring countries:
  - South Africa's current surplus of ~8,800 MW is expected to remain by 2025, with a power generation mix dominated by coal;

- Angola's surplus of ~2,500 MW should grow to ~3,000 MW in 2025, driven by hydropower and oil.

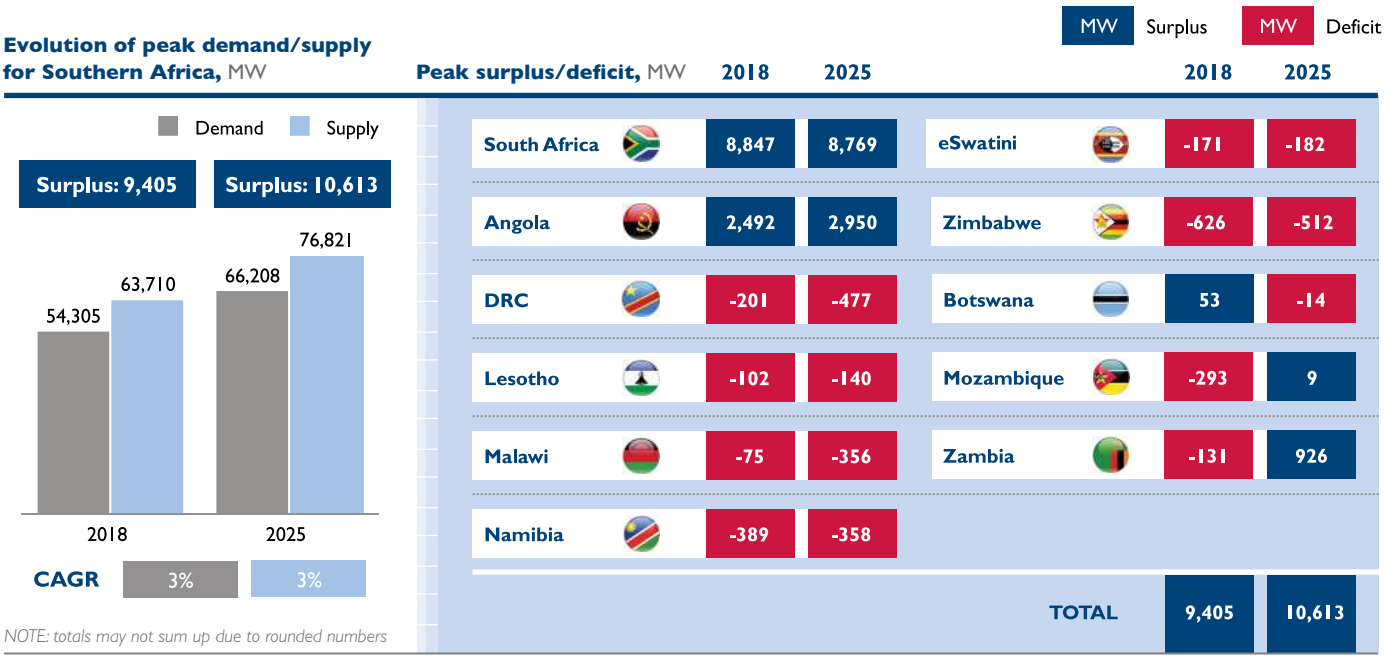
- DRC (-201 MW in 2018), Lesotho (-102 MW), Malawi (-75 MW), Namibia (-389 MW), eSwatini (-171 MW), and Zimbabwe[3] (-626 MW) should remain in deficit over 2018-2025 due to insufficient generation and transmission constraints that prevent them from integrating power domestically. These countries are expected to import power when they hit peak demand, requiring the accelerated construction of transmission lines.

- Botswana is expected to transition from a small surplus (53 MW) in 2018 to a slight deficit by 2025, also suggesting the need to import power at peak demand.

- Mozambique and Zambia should transition from peak deficit to surplus between 2018-2025. In particular, Zambia is expected to transition to a surplus in 2023 (434 MW) that grows to 925 MW in 2025, mostly thanks to the commissioning of the Kafue Gorge Lower hydropower project. Strengthening interconnections between Zambia and the rest of the region can help evacuate this surplus, but also mitigate risks from drought-related lower hydropower capacity for countries that are largely dependent on this source of energy.

EXHIBIT 5

SOUTHERN AFRICA PROJECTED PEAK SURPLUS/DEFICIT



2030 SUPPLY/DEMAND FORECASTS

The above supply projections for the three power pools run until 2025 and are based on analyses of generation projects expected to come online. Many of these projects have gone through the development phase and have reached (or are near) financial close, making these projections reliable. We therefore expect all of these generation projects to come online based on their latest expected commissioning date.

The 2025-2030 generation pipeline is more difficult to predict because projects are more uncertain for this timeframe. Consequently, the number of transmission projects required to address both domestic and cross-border needs is also difficult to predict. Our supply estimates, which are based on expected commissioning

3 All work concerning Zimbabwe is subject to United States Government rules and regulations concerning Zimbabwe.

dates for generation plants, are therefore likely to underestimate the actual supply for 2025-2030, as they would exclude generation plants not yet in the pipeline. However, our analyses suggest that countries with a large power surplus before 2025 (e.g., Côte d'Ivoire, Ethiopia, South Africa) will maintain this surplus through the advent of additional gas, hydropower, geothermal and solar generation capacity. Pre-feasibility and feasibility studies will be required to understand which generation plants are likely to be developed in each country and what new transmission lines will be needed to take power to countries in deficit. Such an update to the pipeline of transmission projects could take place in 2020, once the pipeline of generation projects for 2025-2030 is more certain.

COST DIFFERENTIALS

Regional power is traded when a country with a generation surplus becomes connected to a country with a generation deficit and when an economic rationale exists for the trade. For a country in deficit, it makes sense to import power if it costs less than emergency power capacity or power from more costly, inefficient domestic sources.

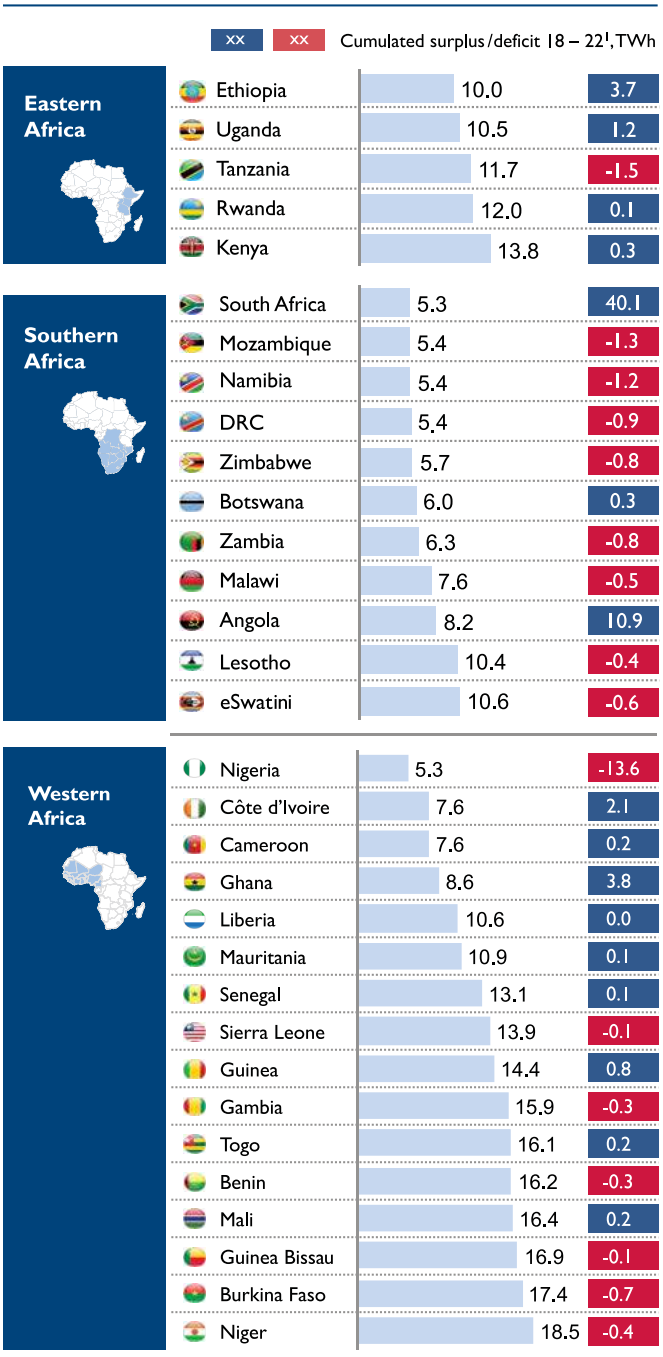
We looked at the generation cost of power across the 32 countries and mapped it to each country's expected surplus or deficit over the next five years (**Exhibit 6**). Generation cost is the average cost of producing one kWh of power, i.e., the weighted average cost across the various sources of energy used by a country (e.g., coal, gas, hydro, solar). It differs from the cost of power charged to the end-consumer, which is not analyzed here. While generation costs do not include transmission costs (both domestic and cross-border), they can be considered as an indicative measure of where trade may be more cost efficient (versus emergency power capacity).

The analysis indicates that in each sub-region, countries with an energy deficit will be able to find opportunities to import from countries with an available surplus and competitive cost (e.g., Tanzania could import from Ethiopia in East Africa; Sierra Leone could import from Côte d'Ivoire in West Africa). Moreover, the cost of power from the countries with major surpluses is significantly lower than the cost of using an emergency power supply (which is typically around 40 to 50 cents per kWh). While this analysis does not reflect actual prices charged for power in peak or off-peak cycles, it clearly suggests the potential for cross-border trade in sub-Saharan Africa.

EXHIBIT 6

COST-EFFICIENT TRADE OPPORTUNITIES EXIST FOR DEFICIT COUNTRIES IN EACH POWER POOL

Energy generation cost (median over 2018 – 2022, cts/kWh)



1 Energy consumption calculated on the basis of a 2 hours peak demand/supply per day, 365 days per year

OPPORTUNITIES FOR TRADE

We identified 10 major opportunities for regional electricity trade in East, West and Southern Africa (Exhibit 7). They reflect current or projected regional imbalances in power supply/demand, as well as the economic rationale outlined in the previous section. These trade opportunities focus on areas where local surplus of power could be used to address a country's deficit. Trade opportunities between two countries in deficit (e.g., between Niger and Nigeria) were not included in this approach; we also excluded trade opportunities between countries in surplus.

Section 4 of this Transmission Roadmap identifies priority projects that could unlock these opportunities, and Section 5 outlines the main bottlenecks and action required to ensure their timely completion.

EAST AFRICA

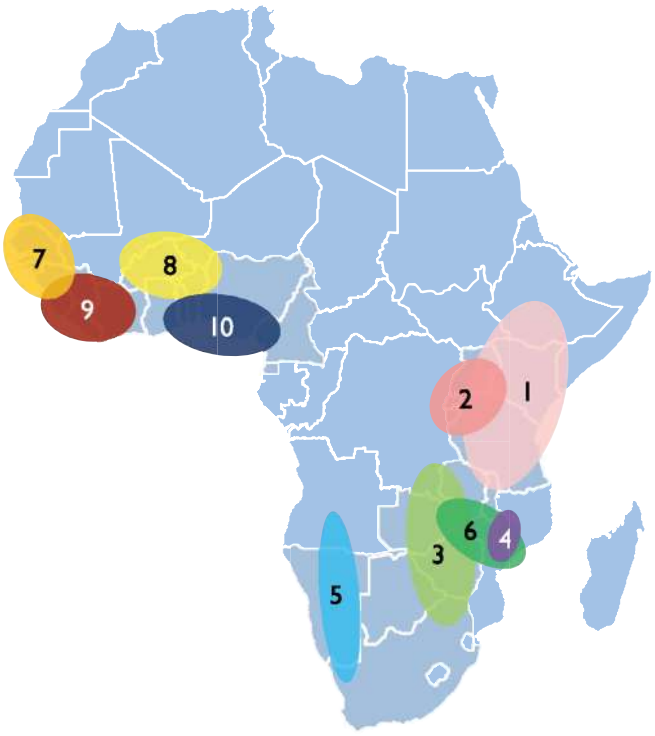
1. **Exports to Tanzania** (EKTZ line); Tanzania will experience a supply deficit in the medium term, ranging between -500 and -800 MW. Sources of power could come from Ethiopia (expected to have generation surpluses of ~1,200-1,900 MW from low cost hydropower), Uganda given its expected surplus growth, or Kenya to a lesser extent. SAPP could also be an alternative, through the interconnection with Zambia.
2. **Nile Basin sub-regional trade** (NELSAP power interconnections) could move power to Rwanda, which is expected to remain in deficit in the short term. Power could come from Kenya or Ethiopia, through a reinforced interconnection around Lake Victoria (covering Kenya, Uganda, Rwanda, Burundi, and Tanzania, with connections to DRC, as well).

SOUTHERN AFRICA

3. **Central corridor opportunity** between South Africa, Zimbabwe, Zambia, Mozambique and the DRC to export power to Zambia and industrial offtakers, such as the Copperbelt in southern DRC and north-western Zambia (accumulated deficit could reach

EXHIBIT 7

OVERVIEW OF THE MAIN TRADE OPPORTUNITIES



East Africa

- 1 Exports to Tanzania (EKTZ line)
- 2 Nile Basin sub-regional trade (NELSAP power interconnections)

Southern Africa

- 3 Central corridor opportunity
- 4 Connecting Malawi to the power pool
- 5 Western Corridor opportunity / delivering power to Namibia
- 6 Bringing new power capacity to the region

West Africa

- 7 Interconnection of the Senegal-Guinea axis (OMVG line)
- 8 Addressing power deficit in landlocked countries
- 9 Enabling Côte d'Ivoire exports to the west (CLSG)
- 10 Addressing regional imbalances in the eastern Gulf of Guinea

~2,000 MW). Power sources would include South Africa in the short term and Mozambique in the medium term.

4. **Connecting Malawi to the power pool** (expected deficit of up to -400 MW in 2025) through a connection to Mozambique and the rest of the Southern Africa Power Pool.
5. **Western Corridor opportunity / delivering power to Namibia** (expected deficit of -400 MW before 2025), most likely from neighbors with a surplus supply, e.g., South Africa or Angola.
6. **Bringing new power capacity to the regional market**, especially in Mozambique (gas), South Africa (various sources) and Zambia (mostly hydro, e.g., Kafue Gorge Lower), which would allow additional generation surpluses to be traded across the region.

WEST AFRICA

7. **Interconnection of the Senegal-Guinea axis**, particularly through the Gambia River Basin Organization (Organisation pour la Mise en Valeur du fleuve Gambie, or OMVG), which covers Senegal, Guinea, Guinea-Bissau and Gambia, to supply countries in deficit (e.g., Guinea-Bissau) and dispatch potential future surpluses from Senegal (e.g., the Sambangalou hydropower project).
8. **Addressing power deficit in landlocked countries (e.g., Burkina Faso, Niger) through a northern connection in Ghana**, which has surpluses (over 1,000 MW in the short run and over 500 MW in 2025).
9. **Enabling Côte d'Ivoire to export its surplus to the West**, especially to Sierra Leone and Guinea, which will experience deficits before 2025, via the CLSG line.
10. **Addressing regional imbalances in the eastern Gulf of Guinea**, with opportunities including exports from Togo (surplus ranging between 20-50 MW between 2018 and 2025) to Benin (deficit between 50 and 130 MW over the period), and Cameroon to Nigeria, which should experience significant deficit through 2025 and beyond.

The above estimates represent a theoretical, maximum trade volume, and do not consider financing, technical or commercial factors (e.g., commissioning of transmission lines, or signature of Power Purchase Agreements (PPAs) that would enable this trade).



Power lines in rural Tanzania. Photo: Jake Lyell for MCC

MAIN CHALLENGES TO UNLOCKING REGIONAL POWER TRADE

Three main challenges impede the development of transmission lines that could unlock regional power trade: enabling environment, funding, and project implementation.

- **Enabling environment** includes, for instance, required permits (e.g., rights of way) and political traction, which can facilitate project coordination as well as inter-country negotiations.
  - Failure to plan or foresee risks in securing rights of way to build transmission infrastructure can cause significant delays, create additional funding needs, and potentially require political or third-party intervention to facilitate dialogue. Environmental concerns can also inhibit transmission development.
  - Political traction is essential to facilitate inter-country negotiations, for instance complex bilateral negotiations on power purchase agreements orwheeling charges. Political drive is also critical when prioritizing regional projects and must be taken into account at both the regional and national level. Finally, it can facilitate project coordination, for example, by pulling in the right stakeholders (e.g., regulators, utilities) at national or regional meetings. In the case of regional transmission projects, a key challenge is to align the political will of different jurisdictions.
  - Also included in the enabling environment is logistics, which can cause delays in imports of equipment if import procedures or infrastructure are not adequate.

Example of the importance of securing rights of way: the Mombasa – Nairobi transmission line

The transmission line from Mombasa to Nairobi (481 km, 220/400kV) was commissioned in August 2017, to connect the capital of Kenya to coastal generation capacity. The project experienced delays of more than three years, partly due to right of way issues.

This line faced multiple disputes related to land access along its route, including compensation levels, affected acreage, identifying the rightful landowner, and damage due to construction works. These issues required KETRACO, the local transmission company, to undertake various mitigation actions such as re-evaluating compensation packages, engaging with local authorities, and re-routing sections of the line.

This project highlights the importance of securing rights of way early on in the project lifecycle, as it can cause significant delays and cost overruns from compensation and running expenses. Rights of way can thus impact a project's financial stability and deter investors. Community engagement[4] at the early stages of project development is critical to ensure accuracy and transparency in the land acquisition component of a project, to ensure fairness in compensation and/or other benefits shared with affected communities, and to understand and manage community grievances.

4 Power Africa's *Guide to Community Engagement for Power Projects in Kenya*, (January 2018), is designed to help power generation and transmission project developers plan and implement more effective, comprehensive, and transparent community engagement strategies, with an emphasis on creating positive outcomes for companies and communities alike.

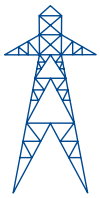
- **Funding** refers to the ability to secure financing sources for various stages of the project, such as early-stage development, feasibility studies, and project construction. Securing funding is a critical enabler, and a recurring challenge for regional transmission projects. Several reasons can explain funding difficulties, including:
  - **Challenges in proving bankability:** As with any infrastructure project, the bankability of transmission projects partly relies on the reliability of future revenue streams, in this case traditionally demonstrated through long term contracts with creditworthy offtakers. In the transmission space, the offtakers are typically utilities with often low levels of creditworthiness. Before investment decisions can be made, there needs to be a critical feasibility assessment of probable trading volumes, as well as of offtake prices (which are not always cost-reflective, based on the regulations in place). For regional transmission projects, revenues would come from the utility in a different country, which can increase the difficulty of recovering arrears.
  - **Limited private investments:** Historically, private investments in energy in Africa have focused on generation, rather than transmission projects. World Bank analyses of private participation in this space identify only a limited number of examples. Three whole-of-grid concessions were analyzed as a part of this study (Cameroon, Mali, Senegal), and it was found that very little investment had been made to expand the transmission network.[5]
- **Project implementation** can threaten adherence to project schedules, quality, and cost expectations. An example of an obstacle related to project implementation is the failure of a contractor to meet its contractual obligations, which can cause significant delays. For instance, some Northern Corridor projects in the Nile basin sub-region are being stalled by poor performance and/or bankruptcy of contractors. If the initial contract does not fully account for these situations, terminating it can cause additional delays and costs. Even after construction, issues may arise in terms of operationalization and O&M. Some of these issues can also be related to the limited availability of skilled workers.

Why choosing the right contractor matters: Lake Turkana transmission project

The Lake Turkana transmission project connects the 310 MW Lake Turkana wind farm in northern Kenya to the country's main interchange in Narok, 428 km to the south.

The initial contractor hired for this project faced bankruptcy after completing ~70% of the work. Despite early warning signs related to its financial situation, the contractor remained in place even after construction was put on hold for more than a year. Faced with growing pressure from the country's utility company and investors in the idle wind farm, the government signed a performance-based contract with a new consortium. In early 2018, construction resumed and was completed six months later.

5 *Linking Up: Public-Private Partnerships in Power Transmission in Africa* (2017), World Bank Group



4 TRANSMISSION PROJECTS THAT COULD HELP UNLOCK TRADE POTENTIAL

INITIAL LIST OF PROJECTS

We selected the initial list of projects based on two types of transmission lines that can enable power trade in sub-Saharan African countries:

- **Cross-border transmission lines** (e.g., Kenya to Tanzania line from Isinya to Singida);
- **Domestic lines** that bring in new generation capacity or connect different parts of national grids to ensure the power supply reaches interconnected substations, which can address local domestic deficits and enable cross-border trade in off-peak period (e.g., Mozambique domestic line from Vilanculos to Maputo, which brings 400 MW from the Temane gas plant to the grid). ***For purposes of this analysis, we did not include transmission lines needed strictly for domestic use. Such analysis at a more granular country level will be done as a next step***.

We also excluded interconnections to countries not in scope (e.g., South Sudan, Somalia).

We used three major sources of information to develop the initial list of projects:

- Previous Power Africa work at the sub-region level (East, West, and Southern Africa);
- The latest available preparatory work for the regional masterplans;
- Development partner and Africa transmission expert interviews and materials.

We selected 47 transmission projects: 40 inter-country and seven domestic lines (see full list in the Appendix).

These projects are key to capturing the trade opportunities identified in Section 3. We identified nine projects in East Africa, 19 in Southern Africa, and 19 in West Africa.

We developed an understanding of these projects on four dimensions to form a comprehensive and up-to-date picture of each situation:

- KEY PROJECT DETAILS: Description of the transmission line, its route and technical specifications (Expected COD[6], capacity (MW), voltage (kV), length (km) and total CAPEX)
- STATUS: latest stage achieved by the project in its life-cycle (development, feasibility, wayleaves, construction or operation)
- CURRENT OBSTACLES: main bottlenecks hindering the project's implementation across three dimensions (enabling environment, funding, project implementation)
- DEVELOPMENT PARTNER CONTRIBUTION: Identification of development partners involved in each project and the nature of their support (funding, technical assistance)

The projects have then been mapped against the countries' current power surpluses and deficits to identify and prioritize the ones that would help capture trade opportunities.

6 Our best understanding of the latest expected Commercial Operation Date of the project, identified through official sources, expert interviews and/or press research

PRIORITIZATION METHODOLOGY

Our prioritization of transmission projects identifies those that will unlock large trade potential and where Power Africa and our partners can address bottlenecks or potential risks to ensure that they are commissioned on schedule (**Exhibit 8**).

We used three main criteria to prioritize the projects: impact, timing and feasibility.

STEP 1 - IMPACT: DOES THE PROJECT HAVE REAL POTENTIAL TO UNLOCK TRADE?

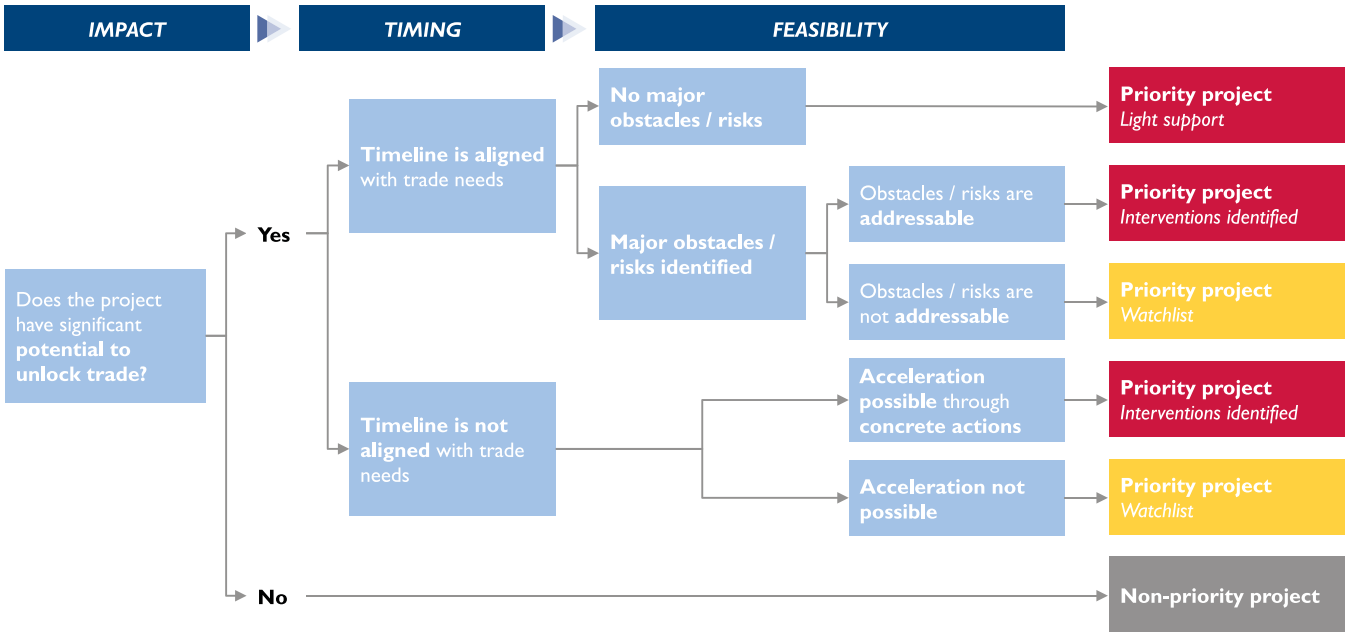
The impact of a project is estimated in terms of the supply deficit it can address. For each project, we measured the supply deficit of the connected country/countries by multiplying the average annual size of the deficit by its duration in years. Deficits were not time discounted to reflect the importance of deficits spanning several years, even if they happen further into the future. Projects addressing a total deficit equivalent to 100 MW or more are deemed to have large potential to unlock trade; projects addressing a lower number of MW are not considered to be a priority.

STEP 2 - TIMING: DOES THE SCHEDULED COMMISSIONING DATE ALIGN WITH THE TRADE NEEDS OF THE CONNECTED COUNTRIES?

The timing of a project refers to the difference in years between the expected date of commissioning and the earliest occurrence of a deficit/surplus in the countries that the project connects. If the difference is less than one year, the project is deemed to align with trade needs; if the difference is more than one year, the project needs to be accelerated. For projects that need to be accelerated, the potential for acceleration is theoretical, and provided on a best practice basis. Actual feasibility for acceleration will need to be determined on a project-by-project basis.

EXHIBIT 8

PROPOSED PRIORITIZATION METHODOLOGY FOR TRANSMISSION PROJECTS



STEP 3 - FEASIBILITY: HOW CAN POWER AFRICA AND OUR PARTNERS ENSURE THAT THE PROJECT IS COMMISSIONED WHEN NEEDED?

We categorized bottlenecks/potential risks to completion into the three categories described in the section on challenges: enabling environment, funding, and project implementation.

For each project, we then provided a qualitative assessment of the magnitude of the bottleneck(s) or risk(s) based on expert interviews and the latest data available. Projects with redundancies were not kept as priorities.

The three steps described above are analyzed sequentially to determine the prioritization of each project. We defined three levels:

- **PRIORITY PROJECTS REQUIRING ACTIVE INTERVENTION:** projects in this category are considered to deliver sufficient impact, enjoy the right timing vs. trade needs, but face significant obstacles/risk of delay to completion, and/or have a need to be accelerated through concrete, identifiable actions.
- **PRIORITY PROJECTS REQUIRING LIGHT SUPPORT:** projects in this category are considered to deliver sufficient impact, enjoy the right timing vs. trade needs, and face only minor obstacles/risk of delay to completion.
- **PRIORITY PROJECTS ON THE WATCHLIST:** projects in this category are considered to deliver sufficient impact, and (1) enjoy the right timing vs. trade needs but face significant obstacles/risk of delay that cannot be addressed under current conditions or (2) need to be accelerated but cannot be under current conditions.

LIST OF PRIORITY PROJECTS

Based on the prioritization methodology described above, we identified 18 projects that could unlock power trade in sub-Saharan Africa: four in East Africa, five in West Africa, and nine in Southern Africa (**Exhibits 9-11**). Together, these projects represent a combined installed capacity of 11,000+ MW and 7,200+ km of lines. These projects can be mapped to eight of the 10 trade opportunities identified in Section 3. Some projects linked to two of the trade opportunities (enabling Côte d'Ivoire exports to the West and addressing regional imbalances in the eastern Gulf of Guinea) have not been prioritized because their potential impact on regional trade in the medium term was below the threshold of 100 MW. Of the 18 projects prioritized, nine require active intervention, eight require light support and one is on the watchlist. Details on obstacles and recommended actions for each project are provided in Section 5.



Transmission substation at the 450 MW Azura-Edo power station in Nigeria. Photo: Harith General Partners

To prioritize transmission projects in this Transmission Roadmap, countries with a consistent surplus of 100MW+ (to allow for trade opportunities) in the period within scope were prioritized. We recognize, however, that there will be opportunities to support other cross-border projects that are important to countries' economies, development and energy sector sustainability. For example, the Mbarara-Shango line (Uganda to Rwanda), is a key project that could save Rwanda $1.3 million to $2 million per month in diesel in 2019-2020. This savings represents roughly 15% of the Rwandan utility's monthly spend on energy – a huge amount considering the utility is heavily subsidized by the state (roughly 1.4% of GDP). The infrastructure is nearing full completion and Uganda and Rwanda are prioritizing the project. The framework and the agreements, structures and technical preparations needed for the project will also be instrumental for future cross-border lines for Rwanda and in the region, so its importance goes beyond the 40 MW or so that Rwanda would use it to import in the short term.

EXHIBIT 9

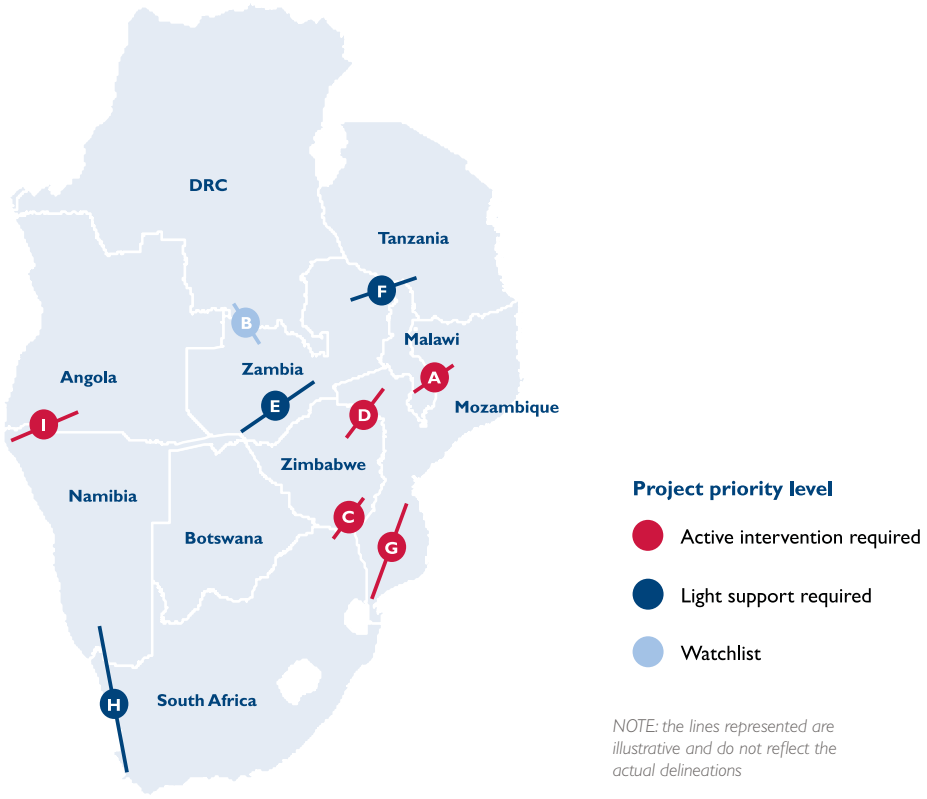
EAST AFRICA PRIORITY TRANSMISSION PROJECTS



Trade opportunity		Connected substations	Length Km	Status	COD
Exports to Tanzania (EKTZ line)	A	Wolayta-Sodo, Suswa	1,010	Construction	2019
	B	Isinya, Singida	463	Construction	2021
Nile Basin sub-regional trade	C	Masaka, Mwanza		Feasibility	2022
	D	Kasese, Bunia	582	Feasibility	2019

EXHIBIT 11

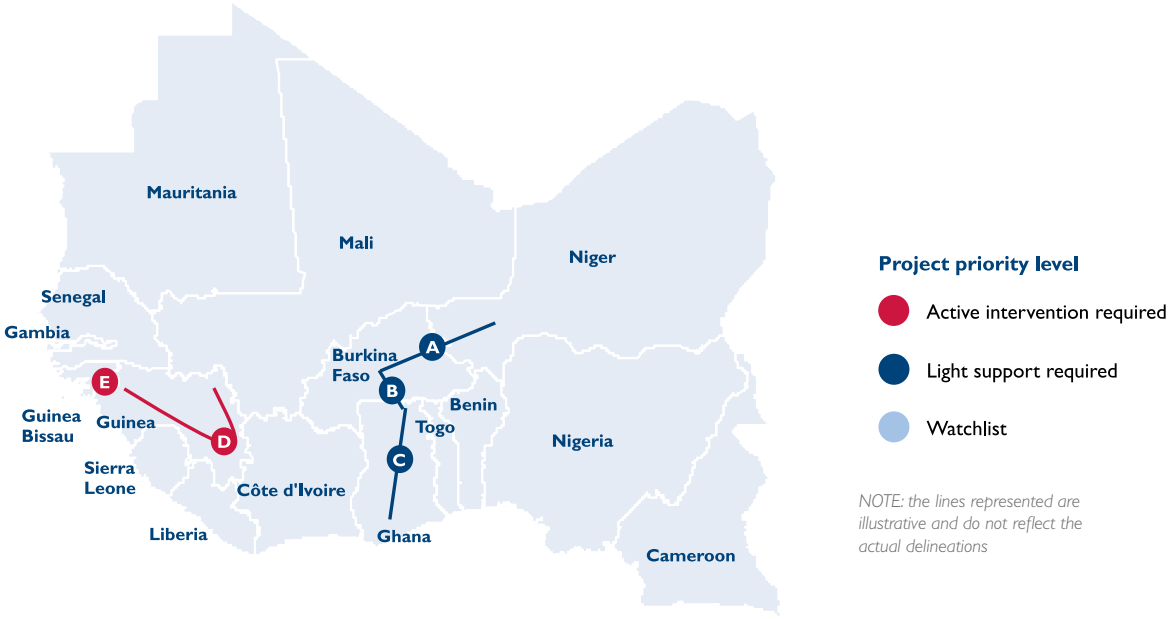
SOUTHERN AFRICA PRIORITY TRANSMISSION PROJECTS



Trade opportunity		Connected substations (line name)	Length Km	Status	COD
Connecting Malawi to the power pool	A	Phombeya-Matambo	210	Feasibility	2020
Central corridor opportunity	B	Solwezi-Kolwezi	79	Feasibility	-
	C	Triangle-Nzhelele *(MoZiSa)*	275	Feasibility	-
	D	Bindura-Songo *(MoZiSa)*	400	Feasibility	-
Bringing new power capacity to the regional market	E	Kafue – Town-Victoria Falls	350	Feasibility	2023
	F	Kasama-Mbeya *(ZTK)*	343	Development	2020
	G	Vilanculos-Maputo *(STE)*	584	Feasibility	2023
Western corridor opportunity / delivering power to Namibia	H	Harib-Kenhardt	270	Development	-
	I	Baynes hydropower plant-Ondjiva *(ANNA)*	500	Feasibility	-

EXHIBIT 10

WEST AFRICA PRIORITY TRANSMISSION PROJECTS



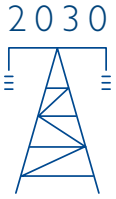
Trade opportunity		Connected substations (line name)	Length Km	Status	COD
Addressing power deficit in landlocked countries	A	Ouagadougou-Niyamey (Northcore – S2)	500	Construction	2022
	B	Bolgatanga-Ouagadougou	198	Operation	2019
	C	Kumasi-Bolgatanga	550	Construction	2019
Interconnection of the Senegal-Guinea axis	D	Mali-Boké *(OMVG - S1)*	350	Construction	2021
	E	Boké-Saltinho *(OMVG – S2)*	130	Construction	2020

ESTIMATED BENEFITS FOR CONNECTED COUNTRIES

Cross-border connections offer significant financial and non-financial benefits. Financial benefits include power trade revenues for the exporters, savings for the importers, and wheeling revenues for countries that provide their transmission networks as conduits. For example, the Ethiopia-Kenya-Tanzania transmission lines give Ethiopia the potential to earn over $200 million in exports to Tanzania over the next four years. Tanzania would save up to $500 million by substituting cheap imported power for its own expensive emergency power. And if Kenya wheels power through its network and does not export its surplus, it could earn over $15 million. By the same token, West Africa stands to reap annual benefits from regional trade of up to $1.2 billion by 2025. Non-financial benefits derive from converting the amount of power traded into residential connections. The power traded across the Ethiopia-Kenya-Tanzania transmission lines translates into several million connections, with a significant potential to improve livelihoods, and help businesses grow in a sustainable way.



Olkaria Geothermal Transmission Lines, Kenya. Photo: Carole Douglis, USAID



5 ROADMAP TO ACHIEVE 2030 OBJECTIVES

DEVELOPMENT PARTNER ENGAGEMENT AND MAIN ACTIVITIES

To ensure completion of the priority projects, Power Africa and our partners need to address the bottlenecks through actions specific to each project. Stakeholder coordination is a prerequisite to the execution of this Transmission Roadmap. While development partners have made continuous efforts to coordinate their support, better alignment around specific priority project gaps could help accelerate execution and mobilize investment.

Various stakeholders are active in the transmission space in sub-Saharan Africa, including national governments, regional power pools (SAPP, WAPP, EAPP) and bilateral and multilateral development partners (e.g., AFD, AfDB, AU, European Investment Bank, KFW, the World Bank, and the Governments of Norway and Sweden). This Transmission Roadmap aims to build off existing mechanisms in each power pool, the support of development partners, and ongoing Africa-wide initiatives such as NEPAD's continental transmission masterplan (currently under development). Private sector support in cross-border transmission is still nascent and is therefore not covered in this section.[7]

We mapped the major development partners involved in transmission (Table 1), breaking down the nature of their support into financial and technical assistance/ capability building, and examining the project lifecycle areas they support. This mapping is based on nearly 20 interviews conducted with development partners, and is not exhaustive by any means. It can rather be considered as representative of the most significant financing and capacity building activities in this space.

The key areas of support (through technical assistance and financing) are covered; there is also strong interest from some development partners to enter or scale up their support to regional transmission projects (e.g., Commonwealth Development Corporation). On the other hand, our analysis of obstacles for priority projects points to potential gaps in the areas or the nature of the support provided. These gaps include, for instance, technical assistance to ensure project commercial viability (e.g., capability building in negotiations or review of the technical agreements), and institutional strengthening to help governments acknowledge the benefits of cross-border trade, when relevant.

7 PPPs in transmission are gaining traction, especially in blended finance, and could be considered to attract private investment, especially in cases where commercial viability is guaranteed

TABLE 1 MAIN ACTIVITIES SUPPORTED BY DEVELOPMENT PARTNERS IN TRANSMISSION IN SUB-SAHARAN AFRICA



DEVELOPMENT PARTNER	SECTOR REFORMS	PROJECT DEVELOPMENT DESIGN	COMMERCIAL READINESS & FINANCIAL CLOSE	CONSTRUCTION	OPERATIONS & MAINTENANCE
Development partners Active in Transmission work in sub-Saharan Africa					
AFD					
AfDB					
ATI					
China Exim Bank					
DANIDA					
DBSA					
DFID					
EIB					
EU					
GIZ					
Canada					
ICBC					
IDC					
IFC					
IRENA					
JICA					
KfW					
KOICA					
Korea EximBank					
MCC					
MIGA					
NEPAD					
Norway					
OPIC					
SIDA					
US Exim Bank					
USTDA					
World Bank					
Development partners with potential to scale up presence in transmission space					
USAID/Power Africa					
CDC Group					
Coface					
EDC					
Islamic Development Bank					
Nexi					

ACTION PLAN TO ACHIEVE OBJECTIVES

The action plan focuses on projects requiring light support, projects needing active intervention, and projects on the watchlist. Actions were categorized into three thematic support areas that respond to the categories of obstacles identified earlier. For each support area, we identified examples of active development partners with the expertise, resources and/or experience to address the bottlenecks identified (the examples provided below do not constitute an exhaustive list).

- **Enabling environment**, through embedded advisors and technical assistance (e.g., tariff setting, Public Private Partnerships (PPP) framework, procurement processes, operational readiness, facilitation of cross-country discussions). Development partners active in this space include AFD, the Department for International Development (DfID), EIB, International Finance Corporation (IFC), Millennium Challenge Corporation (MCC), NEPAD, and the World Bank. Examples include:
  - NEPAD facilitates and coordinates the development and implementation of the project using its effective outreach to both the national and regional energy stakeholders and development partners, as well as giving the political support needed for accelerating project implementation. It also helps projects reach bankability through the NEPAD IPP Facility with, for instance, the OMVG hydropower and transmission line. NEPAD is seconded in its mandate by AfDB, its implementing agency;
  - Power Africa supported the drafting of the Ethiopia-Kenya-Tanzania transmission line wheeling agreement and related tariffs;
  - World Bank is funding a feasibility study for a 350 km, 400 kV transmission line between Nkhoma Substation in Lilongwe and Mzuzu in Northern Malawi.
- **Funding and transaction support** to help reach financial close. Development partners active in this space include AFD, AfDB, EU, KFW, IFC, and JICA. Examples include:
  - Power Africa provides project transaction support to bring late-stage power generation, transmission, and distribution projects to financial close. As of October 2018, Power Africa had facilitated the financial close of more than 9,600 MW of generation projects through a toolbox approach that can also be utilized for transmission projects;
  - AfDB (contributing $338 million) and AFD (contributing $114 million) are co-financing the construction of the Ethiopia – Kenya interconnector;
  - To finance the OMVG project, AFD, AfDB and KFW provided over $200 million collectively for the Guinea – Senegal interconnector.
- **Project implementation support** through Project Management Units and technical assistance. Examples of Development partners active in this space include AfDB, IFC and Norway. For instance, Norway provided technical assistance to the implementation of the Mputa-Hoima evacuation project in Uganda.

The timelines provided in the action plan refer to the proposed deadlines for the execution of the actions, are based on benchmarks from NEPAD's Africa Power Vision, and represent a conservative estimate of the timing required.[8]

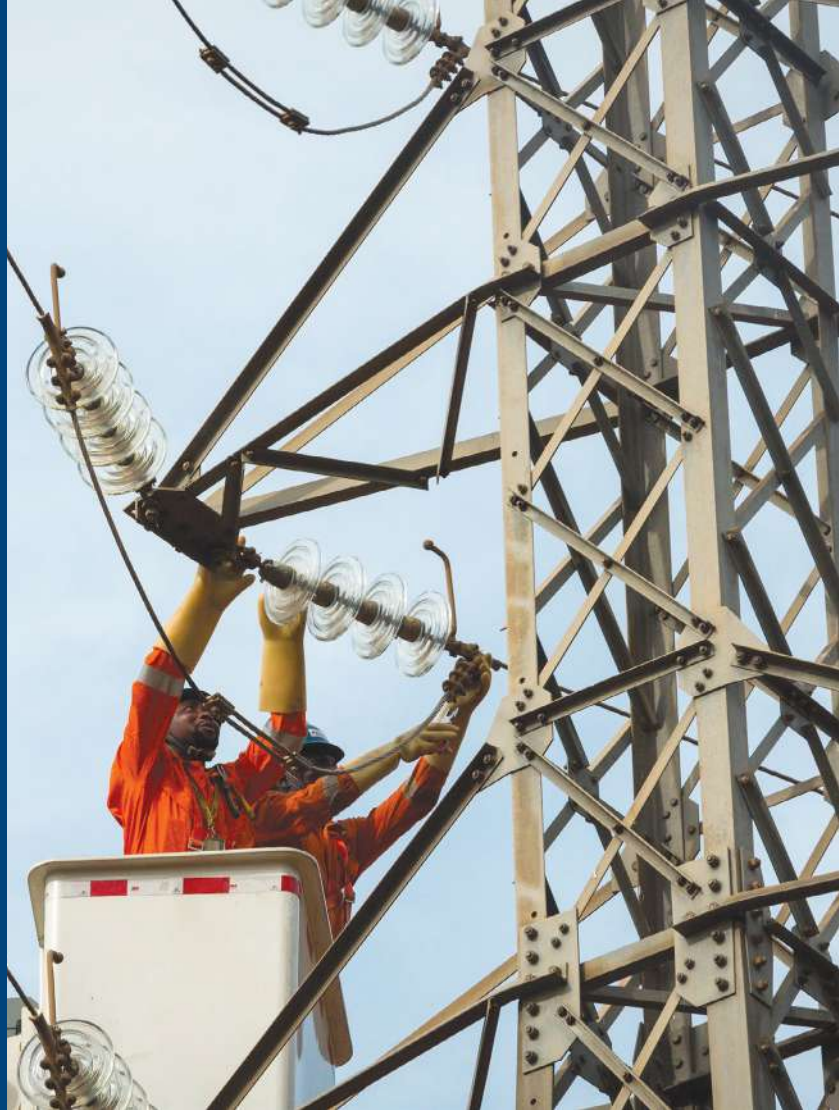
Beyond the project-specific actions highlighted above, Power Africa and our main development partners have an opportunity to strengthen the existing coordination mechanisms at the regional and national level. For instance, we can facilitate best practice sharing at the continental and regional levels through dedicated transmission workshops. We can also help facilitate the dialogue between regional and national meetings to ensure that the regional transmission agenda takes into account domestic projects and constraints, and vice-versa. Promoting the integration of regional power trade in national transmission plans will also facilitate the adoption of interconnection compliance codes and ease the operationalization of the cross-border lines.

8 Africa Power Vision Concept Note and Implementation Plan (January 2015), NEPAD

Existing decision-making and coordination mechanisms

Transmission projects in Africa are currently being prioritized at the continental level, through the African Union Commission (AUC). More specifically, the AUC bodies involve member countries at the highest level to identify and define priorities, which are then being coordinated by NEPAD, acting as the AUC's implementing body. The priorities are grouped under the Program Infrastructure Development for Africa (PIDA), a joint initiative from the AUC, AfDB, and the New Partnership for Africa's Development Planning and Coordination Agency (NPCA). Coordination around project execution is replicated at the regional and national levels.

Through this Transmission Roadmap, Power Africa aims to support the existing coordination mechanisms by providing specific assistance to project bottlenecks and facilitate the dialogue at the sub-Saharan, regional, and national levels.



Line maintenance in Abuja, Nigeria. Photo: Ryan Kilpatrick for Power Africa

Finally, Power Africa and our partners can help accelerate regional transmission projects by attracting more private investment in the space. This acceleration can be achieved through the design of alternate financing and by facilitating the dialogue with the private sector through specific forums and roundtables. These approaches should not be "cookie-cutter" but rather tailored to specific projects through a joint development by relevant stakeholders. Development partners such as the World Bank, which have extensive experience in designing such models, would be well-positioned to co-lead this effort.

TABLE 2 **ACTIVE INTERVENTIONS** ON PRIORITY PROJECTS

Enabling environment **Funding and transaction support** **Project implementation support** **H1 First half** **H2 Second half**

REGION	CONNECTED COUNTRIES	CONNECTED SUBSTATIONS	PROJECT STATUS AND MAIN OBSTACLES	RECOMMENDED ACTIONS	TIMELINE
EAST AFRICA	Ethiopia-Kenya*	Wolayta-Sodo-Suswa	*Construction* Substations constructions is a challenge and taking longer than expected Tanzania would need to sign a 800 MW PPA to cover its deficit (especially around 2020) but only signed a 400 MW agreement with Ethiopia Wheeling agreement with Kenya to be finalized	Support updates in the PPA discussion between Ethiopia and Tanzania Support Wheeling agreement discussions with Kenya Support substations construction in Sodo-Suswa	• H1 2019 • H1 2019 • H1 2020
	Kenya-Tanzania*	Isinia – Singida	*Construction* Tanzania would need to sign a 800 MW PPA to cover its deficit (especially around 2020) but only signed a 400 MW agreement with Ethiopia Wheeling agreement with Kenya to be finalized	Support PPA discussion between Ethiopia and Tanzania Support Wheeling agreement discussions with Kenya	• H1 2019 • H1 2019
SOUTHERN AFRICA	Mozambique	Vilanculos-Maputo	*Feasibility* Financing gap of USD 220 Mn Right of way issues (over 300 households potentially impacted by the line)	Support Mozambique in funding renegotiations with WB Look at creative ways to assist with the credit enhancement of EDM for its gas and power off take obligations Mozambique to solve right of way issues	• H2 2019 • H1 2019
	Zimbabwe-South Africa*	Triangle-Nzhelele	*Feasibility* Funding not secured Project currently under financial restructuring	Support project funding/ provide necessary funds Support project financial restructuring Support closing the feasibility study Explore levers to accelerate the project in partnership with Zimbabwe's government and its selected contractors	• H2 2019 • H1 2019 • H2 2019 • Ongoing support

* Projects that need acceleration because their COD arrives one or more years after the first deficit expected in the connected countries

TABLE 2 ACTIVE INTERVENTIONS ON PRIORITY PROJECTS *(CONTINUED)*

Enabling environment **Funding and transaction support** **Project implementation support** **H1 First half** **H2 Second half**

REGION	CONNECTED COUNTRIES	CONNECTED SUBSTATIONS	PROJECT STATUS AND MAIN OBSTACLES	RECOMMENDED ACTIONS	TIMELINE
SOUTHERN AFRICA	Zimbabwe-Mozambique*	Bindura-Songo	*Feasibility* Funding not secured Project currently under financial restructuring	Support project financial restructuring Support project funding/ provide necessary funds Appoint embedded coordinator at EDM	• H1 2019 • H2 2019
	Malawi-Mozambique	Phombeya-Matambo	*Feasibility* Mozambique faces right of way issues Escom needs technical support to operate and maintain the 400kV grid, as well as the interconnections	Support Mozambique solve right of way issues Provide technical support to Escom to enable it to operate and maintain the 400kV line and the interconnections	• H1 2019 • Until 6 months after COD
	Namibia-Angola*	Baynes hydropower plant-Ondjiva	*Feasibility* Potential right of way issues in Namibia, discussions with local stakeholders to start on Q4 2018 after finalization of social and environmental impact study	Offer transaction advisory and technical support to RTN to prepare personnel to operate in interconnected SAPP system Follow-up on right of way issues in Namibia and support resolution if necessary	• H1 2019
WEST AFRICA	Guinea*	Mali-Boké (OMVG – S1)	*Construction* Right of way issues in Guinea PPA not yet signed between Guinea and Senegal and Guinea-Bissau	Support solving right of way issues in Guinea Support PPA discussions between OMVG countries	• H1 2019 • H1 2019
	Guinea-Guinea Bissau	Boké-Saltinho (OMVG – S2)	*Construction* Right of way issues in Guinea PPA not yet signed between Guinea and Senegal and Guinea-Bissau	Support solving right of way issues in Guinea Support PPA discussions between OMVG countries	• H1 2019 • H1 2019

* Projects that need acceleration because their COD arrives one or more years after the first deficit expected in the connected countries

TABLE 3 LIGHT SUPPORT ON PRIORITY PROJECTS

Enabling environment **Funding and transaction support** **Project implementation support** **H1 First half** **H2 Second half**

REGION	CONNECTED COUNTRIES	CONNECTED SUBSTATIONS	PROJECT STATUS AND MAIN OBSTACLES	RECOMMENDED ACTIONS	TIMELINE
EAST AFRICA	Uganda-DRC	Kasese-Bunia	*Feasibility* • No known obstacles	Support project execution to ensure it respects the expected COD	• Ongoing support
	Uganda-Tanzania*	Masaka-Mwanza	*Feasibility* Funding not secured; currently in discussions with the East African Community countries	Support funding discussions with EAC to reach financial close Accelerate project	• H1 2019 • Ongoing support
SOUTHERN AFRICA	Namibia-South Africa	Harib-Kenhardt	*Development* • Limited information available, no known obstacles	Support project implementation to ensure on time commercializatio	• Ongoing support
	Zambia*	Kafue Town -Livingstone	*Feasibility* Financial close not happened yet. JICA interested but needs to confirm	Follow-up funding discussions with JICA to reach financial close	• H1 2019
	Zambia-Tanzania	Kasama-Mbeya	*Construction* Uncertainty towards choice of substations in Zambia due to changes in the past	Follow-up project implementation to ensure Zambia keeps its committed substation destination	• Ongoing support
WEST AFRICA	Ghana	Kumasi-Bolgatanga	*Construction* • No known obstacles	Support project execution to ensure it respects the expected COD	• Ongoing support
	Ghana-Burkina Faso	Bolgatanga-Ouagadougou	*Operation* The line is operational but only used at 50% capacity due to the unfinished Kumasi – Bolgatanga line	Ensure capacity ramp-up happens in time to use the line at full capacity	• H1 2019
	Burkina Faso-Niger*	Ouagadougou-Niyamey	*Construction* • No known obstacle	Support ongoing contracting process	• H1 2019

TABLE 4 PRIORITY PROJECTS ON THE WATCHLIST

SOUTHERN AFRICA	Zambia-DRC	Solwezi-Kolwezi	*Feasibility* Funding needs to be secured, despite traction coming from the copper-belt mining basin DRC's political instability delays the project	• DRC political issues make the obstacles difficult to address	• N/A

* Projects that need acceleration because their COD arrives one or more years after the first deficit expected in the connected countries

6 CONCLUSION

This Transmission Roadmap identifies over 11,000 MW and 7,200 km of transmission lines that could help unlock regional trade in East, Southern, and West Africa. It is critical that the right transmission projects are developed, financed, built and commissioned to unlock the continent's growing trade opportunities and deliver power to areas of need.

Many of the 18 priority projects identified will require action from utilities, regional power pools and development partners to address bottlenecks with the enabling environment, funding, or implementation. Power Africa is uniquely positioned to support the coordination efforts underway. Our extensive network of partnerships with public and private sector players and a supplementary toolbox from more than 160 partners have helped accelerate deal flow and project execution, leverage capital, and improve the enabling environment.

Stakeholder coordination and increasing levels of private investment are key to the success of these projects. Coordination efforts should complement existing mechanisms at the sub-regional and regional levels. For example, the regional power pools have their own coordination systems with direct support from some development partners. Power Africa and our partners will consult with the power pools to ensure an efficient coordination approach.

Attracting more private investment to fund regional transmission projects (typically financed by the public sector) is also key. Power Africa and our partners have the opportunity to develop alternate financing models in addition to helping countries develop PPP frameworks for transmission infrastructure.

Additional analysis into wholly domestic transmission lines that are ancillary to regional trading networks, but which are critical for domestic movement of power, will be identified in follow-up actions to this Transmission Roadmap.

Power Africa and our partners are well positioned to help move power to where it is needed, thus providing a more cost-efficient supply and enhancing energy security across sub-Saharan Africa.

7 APPENDICES

APPENDIX A: FULL PROJECT LIST

EAST AFRICA

COUNTRIES	SUB-STATIONS	UPDATED COD	CAPACITY (MW)	VOLTAGE (KV)	LENGTH (KM)	COST (USD MILLION)
ETHIOPIA-KENYA	WOLAYTA-SODO-SUSWA	2019	2,000	500	1,010	1,260
KENYA-TANZANIA	ISINYA-SINGIDA (EKT)	2021	2,000	400	463	310
KENYA-UGANDA	LESSOS-BUJGALI/TORORO	2019	440	220KV UGANDA, 400KV ON KENYAN SIDE	151	380
UGANDA-RWANDA	MBARARA-MIRAMA	2018	440	220	200	58
RWANDA-TANZANIA	RUSUMO-NYAKANZI	2019	400	220	120	33
KENYA-TANZANIA	KISUMU-MWANZA (NILE BASIN INTERCON)	-	400	220	496	120
DRC-BURUNDI	RUZIZI II HYDROELECTRIC DAM - BUJUMBURA	-	-	-	78	37
UGANDA-TANZANIA	MASAKA-MWANZA	2022	200	220	582	-
UGANDA-SOUTH SUDAN	KARUMA-JUBA	2021	-	400	190	47
UGANDA-DRC	KASESE-BUNIA	2019	-	220	352	150

SOUTHERN AFRICA

COUNTRIES	SUB-STATIONS	UPDATED COD	CAPACITY (MW)	VOLTAGE (KV)	LENGTH (KM)	COST (USD MILLION)
MALAWI-MOZAMBIQUE	PHOMBEYA-MATAMBO	2020	2,400	400	210	125
MALAWI-MALAWI	MCHINJI-CHIPATA WEST	2019	200	400	60	-
MALAWI-TANZANIA	NEW BWENGU-SONGWE	2022	180	400	206	829
ZAMBIA-TANZANIA	KASAMA-MBEYA	2020	400	- 330 KV IN ZAMBIA - 400 KV IN TANZANIA	343	173
ZAMBIA-NAMIBIA	NEW LIVINGSTONE-ZAMBEZI	2021	300	400	408	223
ZAMBIA-DRC	SOLWEZI-KOLWEZI	-	500	330	79	-
ZAMBIA-MALAWI	CHIPATA -NKHOMA IN LILONGWE	-	-	330	60	42
ZAMBIA-MOZAMBIQUE	CHIPATA -CATAXA	-	900	400	160	50
NAMIBIA-ANGOLA	BAYNES HYDROPOWER PLANT-ONDJIVA	-	400	400	500	1,200
NAMIBIA-SOUTH AFRICA	•HARIB •KOKERBOOM/ KEETMANSHOOP- •AGGNEIS •ARIES/KENHARDT	-	750	220/400	270	-
ZIMBABWE-SOUTH AFRICA	TRIANGLE-NZHELELE	-	650	400	275	-
ZIMBABWE-MOZAMBIQUE	BINDURA-SONGO	-	500	330	400	-
BOTSWANA-SOUTH AFRICA	ISANG-WATERSHED B	2022	800	400, 132, 132	210	-
MOZAMBIQUE	VILANCULOS-MAPUTO	2023	900	400	584	540
ZAMBIA	KAFUE TOWN - LIVINGSTONE	2023	1,000	330	350	110
ZIMBABWE	HARARE-BULAWAYO	-	-	-	430	-
NAMIBIA	AUS-GERUS	2019	600	400	280	-
NAMIBIA	AUS-KOKERBOOM	-	500	400	735	-
ZIMBABWE	SOUTH AFRICAN BORDER-PLUM TREE	2022	1,500	0	50	-

WEST AFRICA

COUNTRIES	SUB-STATIONS	UPDATED COD	CAPACITY (MW)	VOLTAGE (KV)	LENGTH (KM)	COST (USD MILLION)
GUINEA-GUINEA BISSAU AND SENEGAL	BOKÉ-SALTINHO (OMVG – S2)	2020	250	225	<500	711 (full OMVG)
CÔTE D'IVOIRE-SIERRA LEONE	MAN-KAMAKWIE	2020	110	225	1,411	500
NIGERIA-NIGER	BIRNIN KEBBI-ZABORI	2022	330	400	880 (full Northcore interconnector)	730
BURKINA FASO-NIGER (THROUGH NIGER AND NIGERIA)	OUAGADOUGOU-NIYAMEY	2022	330	400	880 (full Northcore interconnector)	730
BENIN-NIGER	MALANVILLE-ZABORI	2022	330	400	880 (full Northcore interconnector)	730
GHANA-BURKINA FASO	BOLGATANGA-OUAGADOUGOU	2019	327	225	198	93
GHANA-MALI	BOLGATANGA-BAMAKO	2021/2022	100	225	742	230
GUINEA-MALI	FOMI-BAMAKO	2021	200	225	<500	711 (full OMVG)
NIGERIA-CAMEROON	NGAOUNDÉRÉ-YOKA	2021	-	-	-	-
GUINEA	MALI-BOKÉ (OMVG – S1)	2021	250	225	<500	711 (full OMVG)
GHANA-TOGO	VOLTA-DAVIÉ(LOMÉ)	2018	776	330	150	<200
CÔTE D'IVOIRE-GHANA	BINGERVILLE-DUNKWA	2020	1,000	330	245	178
MALI-SIERRA LEONE	KAYES-TAMBACOUNDA	2020	327	225	275	103
MALI-MAURITANIA	KAYES-KIFFA	2021	250	225	437	306
SENEGAL-MAURITANIA	TOBENE-NOUAKCHOTT	2021	250	225	414	207
TOGO-BENIN	DAVIÉ-SAKETE	2018	977	330	173	<100
TOGO-BENIN	PORGA-DAPAONG	2022	178	161	82	<100
TOGO-GHANA	DAPAONG-BAWKU	2022	178	161	65	<100
GHANA	KUMASI-BOLGATANGA	2019	-	330	550	161

APPENDIX B: ACRONYMS

$ (USD)	United States Dollar
AFD	French Development Agency (Agence Française de Développement)
AfDB	Africa Development Bank
ATI	African Trade Insurance Agency
AUC	African Union Commission
CDC	Commonwealth Development Corporation
CLSG	The Côte d'Ivoire, Liberia, Sierra Leone and Guinea line
CNPC	China National Petroleum Corporation
COD	Commercial Operation Date
DANIDA	Danish International Development Agency
DBSA	The Development Bank of Southern Africa
DFID	Department for International Development
DP	Development Partner
DRC	Democratic Republic of Congo
EAC	East African Community
EAPP	East African Power Pool
EDCF	Economic Development Cooperation Fund (Korea)
EIB	European Investment Bank
EKT	Ethiopia - Kenya - Tanzania line
EU	European Union
GIZ	German Development Agency (Deutsche Gesellschaft für Internationale Zusammenarbeit)
ICBC	Industrial and Commercial Bank of China
IDC	Industrial Development Corporation
IEA	International Energy Agency
IFC	International Finance Corporation
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
IsDB	Islamic Development Bank
JICA	Japan International Cooperation Agency
KFW	German Development Bank (Kreditanstalt für Wiederaufbau)
km	Kilometer

KOICA	Korea International Cooperation Agency
kV	Kilovolt
KW	Kilowatt
KWh	Kilowatt-hour
MCC	Millennium Challenge Corporation
MIGA	Multilateral Investment Guarantee Agency
MW	Megawatt
MWh	Megawatt hour
NELSAP	Nile Equatorial Lakes Subsidiary Action Plan
NEPAD	New Partnership for Africa's Development
NPCA	New Partnership for Africa's Development Planning and Coordination Agency
OMVG	The Gambia River Basin Development Organization (Organisation pour la Mise en Valeur du fleuve Gambie)
OPIC	Overseas Private Investment Corporation
PATRP	Power Africa Transaction and Reforms Program / Tetra Tech
PIDA	Programme for Infrastructure Development in Africa
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
O&M	Operations and Maintenance
SAEP	Southern Africa Energy Program / Deloitte
SAPP	Southern African Power Pool
SIDA	Swedish International Development Cooperation Agency
U.S.	United States
USADF	U.S. African Development Foundation
USAID	United States Agency for International Development
USDA	U.S. Department of Agriculture
USTDA	United States Trade and Development Agency
WAPP	West African Power Pool
WB	World Bank
ZTK	Zambia - Tanzania - Kenya line

APPENDIX C: SUPPLY AND DEMAND ASSUMPTIONS

SUPPLY ASSUMPTIONS

DATA SOURCES	Main sources that we used to estimate peak supply include: a. Local sources – country-specific integrated resource plans, utilities annual reports and power pool reports among others. These local sources detailed out the expected power supply based on a list of potential generation projects with their target commissioning dates For countries where projects were expected to be commissioned, e.g., South Africa, we used the decommissioning schedule to adjust accordingly b. Industry sources – UDI World Electric Power Plants Database c. Power Africa prior work – studies done for Power Africa (especially in East and West Africa) corroborated with latest updates from expert interviews We utilized multiple data sources to sense check accuracy of numbers within an acceptable range (e.g., +/- 3% points for CAGRs)
CAPACITY FACTOR ADJUSTMENTS	Power surplus/deficits and trade volumes are based on peak available capacity (as opposed to nameplate/ installed capacity) Peak available capacity is derived from installed capacity adjusted by capacity factors Where peak hour capacity factors were available (e.g., for Hydro ROR projects), capacity factors were used to derive the available capacity at peak Where peak hour capacity factors were not available, the following assumptions were used: a. East and Southern Africa • 0% for Solar • 30% for Wind • 90% for Hydro Dams, and • 95% for all other technologies • 70% for Hydro ROR (run-of-the-river) b. West Africa varied by country, but common capacity factors were: • 30% for wind • 50-60% for hydropower • 20% for solar • 40% for bagasse • 90% for HFO
TIMING	We used latest publicly available COD for generation projects

DEMAND ASSUMPTIONS

DATA SOURCES	To estimate peak demand, we similarly leveraged multiple sources to ensure data accuracy. The data sources include: a. Local sources – country-specific integrated resource plans, utilities annual reports, power pool reports b. Industry sources – Enerdata c. Power Africa prior work – studies done for Power Africa (especially in East and West Africa) corroborated with latest updates from expert interviews We forecasted demand based on historical growth and applied the same CAGR in the projection period. For countries like Ethiopia that already exported power, this demand was considered in scope. We also removed captive power supply (e.g., mines in Mali). Like supply assumptions, multiple sources were used for demand to also validate accuracy of numbers
ADJUSTMENT FACTORS	Power surplus/deficits and trade volumes are based on peak demand Base load demand = 24 hours, Midday demand = 12 hours, Peak demand = 2 hours Peak demand for each country is scaled up by 15% to account for reserve margins and system losses



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Power Africa is a U.S. Government-led initiative comprised of 12 U.S.Government Departments and Agencies, over 130 private sector companies, and 16 bilateral and multilateral development partners. Launched in 2013, Power Africa's goals are to increase electricity access in sub-Saharan Africa by adding more than 30,000 megawatts of electricity generation capacity and 60 million new home and business connections. The Power Africa Coordinator's Office uses a USAID-led model to integrate the 12 U.S. Government Departments and Agencies into a one-stop-shop to remove barriers that impede energy development in sub-Saharan Africa and to unlock the substantial natural gas, wind, solar, hydropower, biomass, and geothermal resources on the continent. To date, Power Africa has leveraged over $50 billion in commitments from the public and private sectors, including more than $40 billion in commitments from the private sector.

For additional information, please visit the Power Africa website (www.usaid.gov/powerafrica).

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