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China's infrastructure finance in Africa

Impacts and lessons

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Abstract

China has provided substantial financing for African infrastructure development over the last two decades, but this is a role in flux. Chinese finance for African infrastructure was often directed towards 'megaprojects' in sectors such as hydropower, mining and rail. However, in the context of declining bilateral lending, and a shift to 'small and beautiful' in the Belt and Road Initiative, as well as greater policy focus on 'frontier' digital and green technologies, China's approach is evolving.

With the emergence of competing infrastructure initiatives from Europe, and growing investment interest in Africa from alternative partners, this paper takes a retrospective view of China's infrastructure finance and associated impacts, to draw policy lessons for infrastructure investors old and new.

We focus on four country-sector case studies – hydropower, railway, digital and renewable energy in Angola, Ethiopia, Guinea, Kenya and Zambia – to understand the contributions and challenges of Chinese infrastructure development in Africa.

The analysis highlights both the significant development impacts of Chinese-financed projects, as well as the considerable challenges posed by difficult macroeconomic, financial and governance contexts, with low capacity for project design and implementation. These opportunities and challenges are not unique to Chinese investments, but offer lessons for host governments as well as Chinese and other partners investing in high risk-return markets.

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Abbreviations and acronyms

BRI	(China's) Belt and Road Initiative
CCECC	China Civil Engineering Construction Corporation
CDB	China Development Bank
CFB	*Caminho de Ferro de Benguela* (the Benguela railway)
CLA	Chinese Loans to Africa (Boston University)
CRBC	China Road and Bridge Corporation
CREC	China Rail Engineering Corporation
CWE	China Water and Electric Corporation
DRC	Democratic Republic of the Congo
EAC	East African Community
EDG	*Electricité de Guinée*
EDR	Ethiopia–Djibouti Railway
EEP	Ethiopian Electric Power Corporation
EPC	Engineering, Procurement and Construction
ERC	Ethiopian Railway Corporation
ESIA	environmental and social impact assessment
ETC	Ethiopian Telecommunication Corporation
EU	European Union
EUR	euro
FDI	foreign direct investment
FOCAC	Forum on China–Africa Cooperation
GDI	Global Development Initiative
GDP	gross domestic product
GW	gigawatts
ICA	Infrastructure Consortium for Africa
ICBC	Industrial and Commercial Bank of China
ICT	information and communication technology
km	kilometres
kWh	kilowatt-hour
MW	megawatts

PPP	public–private partnership
SGR	standard gauge railway
SOE	state-owned enterprise
US	United States
USD	US dollar

Executive summary

China has been a significant source of finance for African infrastructure over the last two decades, but this is a role in flux. Until 2020, infrastructure finance from Chinese lenders constituted an average of 20% of Africa's total estimated infrastructure finance, largely via bilateral lending. However, China's overseas lending has been declining, and projects are becoming smaller.

Against this background, this paper looks back over the trends, characteristics and *impacts* of China's infrastructure finance during the boom years to draw policy lessons for future engagement, not only for Chinese actors and investors, but also for host governments and others stepping up infrastructure investment in Africa. It draws heavily from case study work in Angola, Ethiopia, Guinea, Kenya and Zambia. These countries have been significant recipients and beneficiaries of China's overseas finance and investment. Their experience also demonstrates the challenges – and changes – in China's approach to infrastructure investment in Africa.

Chinese infrastructure finance overseas has evolved in line with China's own economic transformation and sectors of strategic dominance. At the outset, engagement focused on sectors such as hydropower and rail, coinciding with major domestic expansion of these infrastructures and associated accumulation of capacity and expertise. While financing for these sectors has not disappeared, the shift in China's domestic industries towards high-technology sectors in digital and renewable energy has also been evident in overseas financing. These sectors are becoming priority areas of cooperation under China's 'Green Belt and Road', and under the Forum on China–Africa Cooperation.

Chinese infrastructure finance in Africa has primarily been channelled through loans from Chinese policy banks and, latterly, commercial banks, though Chinese companies and contractors also play a key role. High-level sovereign bilateral agreements under flexible lines of credit have been allocated to support national development plans, while in other cases projects have been driven by Chinese state-owned enterprises (SOEs). The latter have been actively engaged in project identification and financing, particularly in telecommunications infrastructure, as well as direct investments (FDI) in the mining and resource sectors. Across the board, Chinese contractors play a key role in design and construction, and sometimes in the management and operation of infrastructure projects.

China's infrastructure lending in Africa has been distinctive in its diversity, and in the use of risk-mitigation methods via contract design, financing projects that other bilateral donors and private investors may have avoided due to their risk profile. Natural resource export agreements (including oil, iron ore and cocoa) and cash-based escrow accounts have been used as risk-mitigation tools for debt repayment, while corporate investors have lowered risks

associated with logistics provision, integrating related transport and energy infrastructure into contracts. However, debt sustainability has been a persistent issue, in part driven by project selection, but also by factors such as contingent liabilities arising from lending to parastatals.

In terms of direct impact, Chinese infrastructure projects have been on a scale to materially increase the availability and quality of infrastructure within host countries. China's financing has contributed substantially to improving energy availability, accounting for over one-third of Africa's 25 gigawatts (GW) of increased capacity from 2009 to 2020. This has been primarily through hydropower generation, although smaller renewable energy projects have also played a role, as has investment in transmission networks. Rail projects have significantly enhanced networks in East Africa, Nigeria and Angola, adding or improving over 5,000 kilometres of line. Digital connectivity has improved substantially, particularly in Ethiopia, through large expansions of fibre optic networks.

There have been implementation challenges at the national level owing to limitations in infrastructure planning, operations and governance. The Chinese approach to project implementation has tended to avoid intervention in domestic policy. However, weak governance and underdeveloped policy frameworks in host countries, both at the macroeconomic and sectoral levels, have had negative impacts on project delivery and sometimes prevented the full realisation of expected benefits. These factors have influenced project identification, planning, financial negotiations and implementation, leading to poorly selected projects, inadequate enforcement of environmental and social regulations, and insufficient attention to the sustainability of operations and maintenance. In turn, these weaknesses have affected project and sector performance, with spillovers for revenue generation and external debt sustainability. Inadequate macroeconomic and fiscal oversight have further exacerbated these problems.

Chinese infrastructure projects are not unique in these challenges, but several distinct factors stand out. The incentive structures guiding Chinese contractors and borrowing governments or parastatal entities in project development can lead to project pipelines that are misaligned with national or sectoral development strategies. This has contributed to overoptimistic demand projections, repayment costs exceeding retail prices and a lack of coordination with complementary investments. Governance issues have been particularly prominent for projects that do not use competitive procurement. Such projects generate greater risks of lower-than-expected returns and reduced development impacts, while contributing to unsustainable sovereign debt risks.

Chinese experience with implementation of infrastructure projects in Africa offers lessons to other project financiers and developers. These lessons are timely given the growing interest in infrastructure development from partners in Europe, the United States (US) and the Gulf, all of which have ramped up their ambitions to support new infrastructure projects in sectors such as transport, energy and minerals. Key policy lessons include: the importance of aligning project

selection and approval with national development goals; underpinning project implementation with independent and realistic feasibility studies; and transparent international competitive bidding for project procurement. Attention should be paid to longer-term sustainability by building capacity to operate and maintain infrastructure networks, enforcing environmental and social standards, and ensuring that user revenues are adequate to meet maintenance requirements and service debts. Infrastructure development needs to be supported by a sound macroeconomic framework and careful oversight of fiscal risks.

1 Introduction

China has been a substantial contributor to infrastructure finance across the African continent, particularly in sub-Saharan Africa. Over the last two decades, Chinese capital, primarily channelled through official lending, has helped fill the infrastructure financing gap in a continent that – despite recent progress – continues to lag behind lower middle-income country (LMIC) peers.[1] China's infrastructure finance reflects the character of its own domestic growth and industrial capabilities, demonstrated in strong support for heavy transport and energy sector infrastructure, such as hydropower plants and railways.

Since the mid-2010s, lending to Africa has fallen steeply, influenced by domestic regulatory pressures and a new emphasis on risk management in China, alongside increased external debt pressures on African sovereigns (Parks et al., 2023; Chen and Liu, 2023; Chen and Emery, 2025). Post-Covid, official financing has become more risk averse, and there has been a growing pivot towards commercial investment in frontier sectors. At the same time, there is growing interest in infrastructure cooperation from other partners and strategic competitors to China. Since its launch in 2022, the European Union's (EU's) Global Gateway, framed as a counter-offer to China's Belt and Road Initiative (BRI), has focused strongly on the African continent, with planned investments mainly in green energy sectors, energy security (including critical raw materials) and digital infrastructure (Furness and Keijzer, 2022; Chimits et al., 2023). The US has ramped up its investment, along with the EU, in the Lobito corridor, and there has been strong growth in Gulf investment, particularly from Saudi Arabia and the United Arab Emirates (Afreximbank, 2024).

Against this rapidly changing context, this paper reflects on the impacts and lessons as Chinese and African partners recalibrate their engagement, and as (re-emerging) infrastructure investors seek to build partnerships. We review China's role in financing African infrastructure over the last two decades, addressing three key questions:

1. How is the role of China's infrastructure finance in Africa evolving?
2. What has been the *impact* of infrastructure investments on development outcomes?
3. What have been the main implementation *challenges* faced by infrastructure projects?

Drawing on qualitative and quantitative evidence over two decades, the paper focuses on four key sectors that reflect the changing nature of Chinese industrial dominance and cooperation priorities over time: hydropower; railways; digital technologies and telecommunications; and other renewable energy. Alongside financing trends, the paper documents associated impacts

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1 When measured on indicators such as generation capacity (megawatt (MW) per million population); access to electricity (percentage of population); 3G broadband coverage (percentage of population); and logistics performance.

and the challenges both host and home countries have faced, drawing evidence and country perspectives from five cases – Angola, Ethiopia, Guinea, Kenya and Zambia. These cases, outlined in further detail in the appendix to this paper, are selected due to their substantial uptake of Chinese-financed infrastructure projects, as well as the diversity of projects and financing modalities they represent.

The paper tells a nuanced story. Many projects have brought material enhancements to national infrastructure, often linked with national development plans and strategies. However, projects have frequently encountered significant challenges, underscoring that development impact depends on multiple aligning factors, the absence of which diminishes the potential gains from investments. These factors include the overall policy and planning framework, sectoral and macroeconomic governance, institutional capacity and wider market conditions. While these challenges are not unique to Chinese-financed infrastructure, some features of Chinese engagement may have exacerbated them. Many reflect limitations in the governance framework of host countries, with Chinese financiers tending to avoid intervention in domestic policy.

The report is structured as follows. Section 2 outlines the key trends in China's overseas lending in Africa, associated financing modalities and financial implications. Section 3 examines the impact of investments, highlighting development contributions made and challenges faced, drawing from examples in the selected countries. Section 4 concludes with policy lessons, considering how infrastructure projects – from China and from other partners – can be implemented in a manner that is both sustainable and supportive of longer-term development. Detailed country perspectives for all sectors are outlined in the appendix.

2 Chinese infrastructure financing: trends and modalities

2.1 China's contribution to Africa's infrastructure

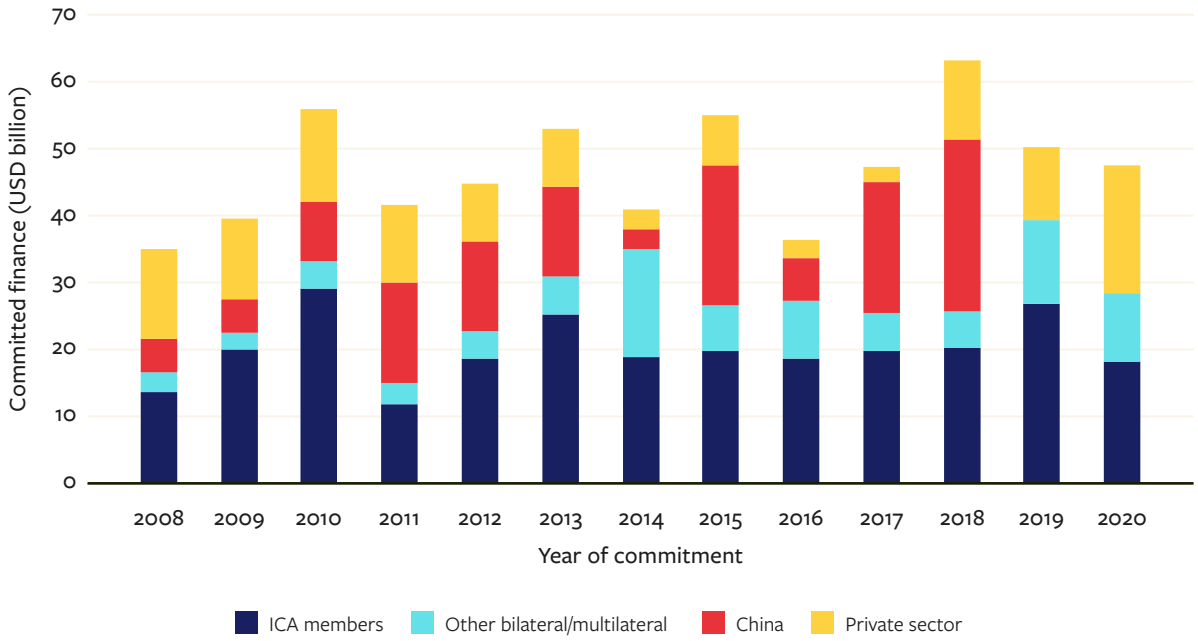
Africa faces an enduring infrastructure investment gap, lagging behind its peers on key measures including electrification, broadband coverage, logistics quality and transport infrastructure.

Estimates of the investment gap by the African Development Bank (AfDB) range between $130 billion and $170 billion annually, with a financing gap of $68–$108 billion.[2] Financing is not the only challenge: a lack of bankable projects, weak institutional capacity, inadequate funds for long-term maintenance and poor governance all impede the efficient selection and delivery of infrastructure projects. Against this backdrop, Chinese finance has made a significant contribution to narrowing Africa's infrastructure financing gap over the last two decades.

Based on data available up to 2020 from the Infrastructure Consortium for Africa (ICA), Chinese infrastructure finance relative to other sources is shown in Figure 1. While national governments remain the principal source of infrastructure finance, China has been the largest single-country provider of external infrastructure finance, amounting to an estimated $149 billion between 2012 and 2020, according to ICA, or 18% of total financing from all sources. In 2018, Chinese official finance accounted for 25% of African infrastructure finance, overtaking the combined share of all ICA members (see Figure 1).

2 See: www.afdb.org/en/news-and-events/public-private-partnerships-needed-bridge-africas-infrastructure-development-gap-65936#:~:text=He%20noted%20that%20the%20African,been%20primary%20investors%20in%20infrastructure

Figure 1 Trends in infrastructure financing commitments by source, 2012–2020



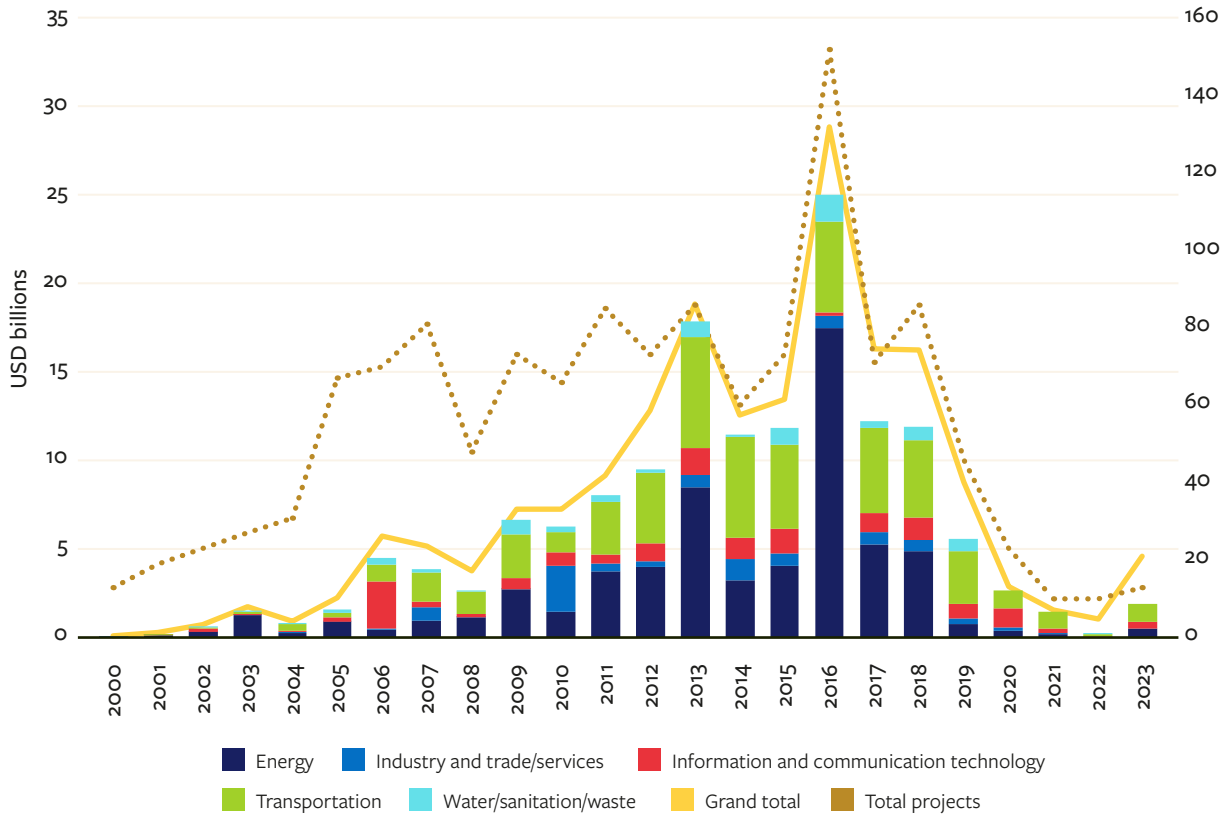
Legend: ICA Membership comprised G8 countries (plus governments of Spain and South Africa), African Regional Institutions and Multilateral Development Banks.
Note: ICA ceased to publish disaggregated data for China in 2019–2020, instead including China within the broader category of 'Other Bilateral/Multilateral'. However, ICA notes that China's financing fell significantly during those years, as is clear from comparing 'Other Bilateral/Multilateral' in 2019–2020 with the sum of 'China' and 'Other Bilateral/Multilateral' in the immediately prior years 2017–2018
Source: Authors' synthesis, Infrastructure Consortium for Africa (ICA) secretariat.

2.2 The waxing and waning of overseas lending

Overall lending from Chinese creditors to Africa has been substantial, at an estimated $183 billion in commitments over 2000–2023. Lending scaled up with deepening trade relationships and since 2000, has also been institutionalised through the triannual Forum on China–Africa Cooperation (FOCAC), which has set the tenor of cooperation priorities, and through the Belt and Road Initiative (BRI) (FOCAC, 2023a).

China's overseas lending trends have been strongly tied to its current-account surplus, which peaked at $420 billion (or 10% of gross domestic product (GDP)) by 2008. Following the global financial crisis, a new political consensus emerged domestically to invest these foreign exchange reserves more aggressively overseas, leading to the capitalisation of the national sovereign wealth fund and state-owned banks (Higgins, 2015; Liu, 2023). The boom in overseas lending supported an export-led growth strategy complemented by the international expansion of Chinese firms (Carmody et al., 2021).

Figure 2 Chinese loan commitments to infrastructure and other major sectors in Africa, 2000–2023



Source: Authors' elaboration. Boston University (BU) Chinese Loans to Africa (CLA) database (2024)[3]

Over this period, infrastructure finance dominated lending,[4] with, energy and transport (Figure 2) constituting around 65% of total infrastructure lending from 2000 to 2023. Railway projects (specifically standard gauge railway (SGR) projects in Kenya, Ethiopia and Nigeria) account for several of the largest loans, while energy sector finance has been dominated by a single borrower – Angola – largely for the oil parastatal, Sonangol, as well as a string of smaller hydropower investments.[5] Much of this finance has been provided in the form of export credit structures from China Eximbank and the major banks (see Table 1), though there has been growing participation of commercial and corporate financiers in the infrastructure sectors (Wu and Chen, 2024). Co-financing and syndicated loans (Chen and Emery, 2025) as well as public–private partnerships (PPPs) have increased (van Wieringen and Zajontz, 2023), reflecting a trend towards more risk-sharing and financial diversification, partly in response to growing issues around debt sustainability (see Box 1).

3 https://www.bu.edu/gdp/chinese-loans-to-africa-database/
4 Authors' calculations based on CLA data (2024).
5 According to CLA data (2024), the major peak in 2016 lending is largely down to a single loan to Angola, which was a refinancing loan for the recapitalisation of Sonangol.

Table 1 Key institutions and instruments in Chinese infrastructure finance

Institution	Financier	Instruments	Key terms
Ministries	China International Development Cooperation Agency (CIDCA) Ministry of Commerce (MOFCOM)	Zero Interest Loans (ZIL)	RMB denominated Zero-interest 20-year maturity
Policy banks/ financial institutions	Export-Import Bank of China (China Ex-imbank)	Concessional loans	RMB denominated 2–3% interest rate 15–20-year maturity 5-year grace period
		Preferential Export Buyers Credit (PEBC) Export Buyers Credit	USD denominated Varying loan terms 15-year maturity 3–5-year grace period
	China Development Bank (CDB)	Commercial loans (Master Facility Agreements) Medium to long-term project loans	USD/EUR denominated Libor floating rate Varying maturity (2–9 years) Varying grace period (3–5 years)
	China Export & Credit Insurance Corporation (Sinosure)	Medium to Long-term export credit insurance (MLT) Overseas investment insurance	Covers up to 90–95% of project value against political/ commercial risks Up to 15-year coverage
Commercial banks	Industrial and Commercial Bank of China (ICBC) Bank of China (BOC) China Construction Bank (CCB)	Medium to long-term project loans Export buyers credits	USD/EUR denominated Libor floating rate Varying maturity and grace periods
Corporates	Various SOEs (e.g. Sinohydro, ZTE) Private companies (e.g. Huawei, Jinko Solar)	Seller's credits	USD denominated Varying rate Varying maturity and grace periods
		Equity investment/PPP	

Source: Authors' compilation, based on Rudyak and Chen (2021); Custer et al. (2023); Wu and Chen (2024)

Two factors led to the retrenchment of China's overseas lending since 2015. The internal, factor was the change in domestic financial sector regulations following the loss of foreign exchange reserves during China's 2015 financial crisis (Rudyak and Chen, 2021).[6] The external factor, was the end of a commodity super cycle from 2014, which increased macroeconomic and fiscal

6 See: Measures for the Supervision and Administration of the Export-Import Bank of China (https://lawinfochina.com/display.aspx?id=27038&lib=law&EncodingName=big5).

pressures for African borrowers (Brautigam, 2020). The Covid-19 shock put a further halt on lending, implementation and pipeline development, and triggered debt repayment problems in several borrowing countries (Box 1). While lending recovered slightly in 2023 (see Figure 2) (Engel et al., 2024), overall volumes and numbers of projects remain below pre-Covid levels, with lower financing commitments in the 2021 and 2024 FOCAC forums (Calabrese and Chen, 2024). The BRI itself has also seen a narrative shift since 2021, with a renewed focus on risk management and 'small and beautiful' projects, a 'Green BRI', and 'high-quality development', with green and digital sectors also emphasised in the Global Development Initiative (GDI) launched in 2021.

Box 1 Debt sustainability

The use of debt-based infrastructure finance, often at non-commercial terms and driven by government demands and SOE interests, has contributed to external debt sustainability issues in several cases, particularly due to sovereign guaranteed borrowing (explicitly or implicitly) from parastatals.

For example, in Zambia, borrowing by Zambian SOEs (including the power utility ZESCO) accounted for $3.5 billion of the $16.7 billion external debt in 2021. There were two reasons behind this. The first reason was the sheer proliferation of different types of Chinese creditors, which included policy banks and state-owned commercial banks, as well as contractors and private enterprises. The second reason was the lack of public debt oversight in host government agencies, resulting in a permissive borrowing environment that allowed Zambian SOEs to take advantage of these various financing offers. The combination of these two effects, contributed to a 'tragedy of the commons' in Zambia's external borrowing, where individually rational borrowing decisions became collectively unmanageable., As a result, 30% of Zambia's total external debt being owed to Chinese entities (Brautigam, 2022).

Similarly, in Ethiopia, non-Paris Club bilateral debt from China accounted for nearly 27% of overall debt by 2020, with high levels of borrowing from parastatals including Ethiopian Electric Power (EEP) and the Ethiopian Railway Corporation (ERC). The government has since initiated reforms, including a Public Enterprise Proclamation, to rein in SOE borrowing and improve financial sustainability and debt management. It also negotiated a reprofiling of its external SGR loan from China Eximbank in 2019 and extended the maturity of the debt from 20 to 30 years (Chen, 2024).

The Covid-19 pandemic in 2020, subsequently compounded by rising global interest rates after 2022, turned pre-existing debt issues into a broader crisis, requiring a systemic approach. This took the form of the G20 Debt Service Suspension Initiative (DSSI) in 2020, followed by the G20 Common Framework, which for the first time integrated China into a multilateral platform for debt restructuring and reprofiling. Four African countries (Chad, Zambia, Ethiopia and Ghana) have applied, and three have undergone successful, if prolonged, restructurings with official and bondholder creditors (Chen and Hart, 2025; Grigorian and Bhayana, n.d.).[7]

The broader challenges facing borrowers, compounded by diminished risk appetite from Chinese creditors, signal a more cautious approach to debt and infrastructure finance in the post-Covid era. FOCAC pledges at the 2024 forum were more modest, with a stronger emphasis on mobilising investment from companies than on further lines of credit. Future phases of infrastructure investment are likely to involve greater use of equity finance and PPP-led models, rather than sovereign lending.

7 Ethiopia's restructuring is still under way, delayed by the civil war in Tigray between November 2020 and November 2022. While the Government of Ethiopia reached agreement with its official creditors in early 2025, at the time of writing it had yet to conclude negotiations with its commercial bondholders.

3 Development impact of Chinese finance for African infrastructure

Energy (oil and gas, and hydropower) and transportation (particularly rail) have traditionally been the dominant sectors of focus for Chinese infrastructure financing. There has also been growing interest in fostering new renewable energy (solar and wind) as well as digital technologies (Xinhua, 2024). This section discusses Chinese-financed infrastructure across all these sectors in five countries – Angola, Ethiopia, Guinea, Kenya and Zambia. A more detailed description of experiences in each country and sector can be found in the appendix.

3.1 Classic sectors of Chinese infrastructure investment: hydropower and rail

Prior to the Covid-19 pandemic, Chinese infrastructure finance in Africa made a substantial contribution to the development of energy and transport infrastructure, particularly through hydropower and railway projects. There are three broad reasons for this. First, these sectors reflected China's domestic experience and industrial capacity at the time. Second, African governments were particularly interested in strengthening such infrastructure as part of their national economic development strategies. Third, traditional donors had become reluctant to finance these types of infrastructure, whether due to environmental sustainability concerns in the case of hydropower (World Commission on Dams, 2000), or financial sustainability concerns in the case of railways (Foster and Briceno-Garmendia, 2010).

The African continent has vast untapped hydropower resources (IHA, 2021) – with potential estimated at 1,750 terawatt-hours, or approximately twice current electricity consumption – and the lowest rail network density in the world. In contrast, China boasts the world's second-largest rail network, reaching 141,000 kilometres (km) in 2020, with a quarter on high-speed routes, the highest percentage of any country in the world (Reuters, 2020). As for hydropower, in 2022 alone China installed 24 gigawatts of hydropower capacity domestically, three-quarters of the total capacity expansion globally for that year (IEA, 2023).

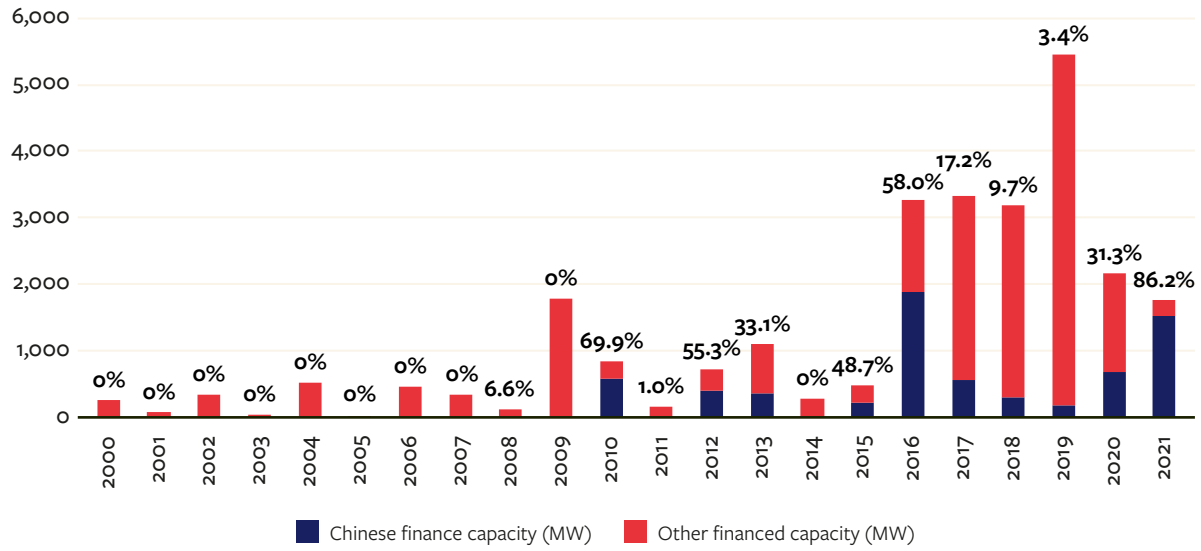
3.1.1 Hydropower

Overall financing patterns

The recent history of hydropower finance in Africa can be divided into three broad periods (Figure 3). From 2000 to 2008, hydropower financing came entirely from Western sources and was relatively modest, enabling construction of 250 megawatts (MW) per year on average. From 2009 to 2015, there was a notable ramp-up to 775MW per year on average, with Chinese sources contributing the majority of this financing. These dams represented about one-third of total hydropower expansion on the African continent over this period. From 2016–2020, there was a

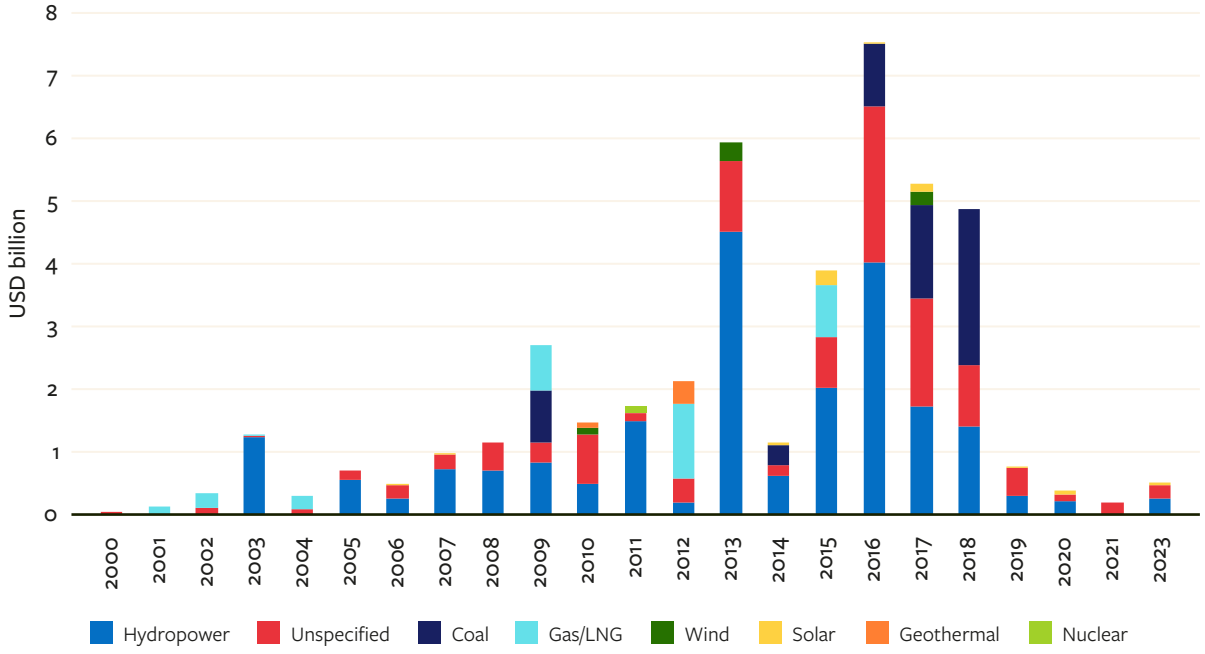
noticeable further step-up in financing commitments from all sources, to 3,500MW per year on average, albeit with non-Chinese sources contributing the majority in most years (ICA, 2014; ICA, 2018). Between 2009 and 2020, China committed to finance and construct a cumulative total of 9GW of hydropower in Africa.

Figure 3 Financing commitments to construction of hydropower generation in Africa disaggregated by nationality of financier, and proportion of Chinese-financed projects, 2000–2021 (MW)



Source: Authors elaboration based on analysis of installed hydropower capacity from Platt's database and Chinese finance from AidData GCDF v2.0

Figure 4 Chinese energy infrastructure financing, by energy source (exc. oil), 2001–2023



Source: Boston University China Global Energy Finance database (2023)

To support the construction of hydropower projects in Africa, Chinese financial institutions committed a cumulative total of some $24 billion over the 2000s. Hydropower constitutes nearly half (48%) of China's non-oil energy finance to Africa.[8] Projects span a wide size range, with more than a dozen small projects (under 100MW each) alongside a handful of megaprojects (in excess of 1,000MW each). Some of the largest Chinese hydropower projects include the Gilgel Gibe III Hydropower Project (2010) in Ethiopia, which has been operational since 2015 (Power Technology, 2024), and the Caculo Cabaça Dam and Transmission Line Project (2016) in Angola, which is still under construction (FOCAC, 2023b). Chinese financing has also supported several mid-sized projects, including the Souapiti (Guinea), Zungeru (Nigeria), Karuma Falls (Uganda) and Kafue Gorge Lower (Zambia) dams. On average, Chinese projects provided $2.6 million in finance per megawatt of installed capacity. For projects up to 1GW, construction periods have typically averaged 4–6 years, extending to 10 years for some megaprojects.

China's domestic hydropower development started to expand rapidly in 1999, and by 2004, its installed hydropower capacity was the largest in the world. By 2008, it had the highest number of registered patents in hydropower technology and innovation, even as Organisation for Economic Co-operation and Development (OECD) countries slowed down dam-building following the recommendations of the World Commission on Dams (Gagnon et al., 2002). Chinese know-how and construction capacity placed national companies in a strong position to seek new global hydropower business opportunities (Zhou et al., 2020). At the same time, relatively easy access to export credits from China Eximbank gave hydropower companies the financial backing they needed to take on major hydropower projects in Africa. Financing for hydropower has been concentrated in countries with substantial hydropower resources, with the largest projects in Angola, Ethiopia, Ghana, Guinea, Nigeria, Sudan, Uganda and Zambia. For many countries, Chinese-financed hydropower represents a sizable share of total installed generation capacity (as much as 40–80%).

Construction work for Chinese-financed hydropower projects in Africa may be competitively procured, albeit with the competition limited to Chinese firms, or firms may be chosen through direct negotiation. By far the most prevalent contractor is Sinohydro, which has been involved in about half of all projects, constructing over 10GW of installed capacity. The only other company with significant participation across multiple projects is the China Gezhouba Group (CGGC), responsible for over 5GW of installed capacity and with participation in one-fifth of all projects.[9] A handful of other players[10] have each been responsible for about 1GW of capacity, while all other players are very small.

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8 Authors' calculations based on BU China Global Energy Finance Dataset 2023.

9 For this calculation, the contribution of each contractor was presumed to be equal and the total generation capacity of the hydropower project was apportioned by the number of major contractors involved.

10 These include China Energy Engineering Corporation (CEEC), China Water and Electric Corporation (CWE) and Harbin Electric (HPEC).

The case of the 1,250MW Merowe dam in Sudan, the first of China's major commitments to finance and construct African hydropower infrastructure, is illustrative of engagement in the sector. The full project consisted not only of the dam for power generation, but also 1,500 kilometres of transmission lines to take the electricity to the capital and major port cities. The project, which began in 2009, involved a particularly complex construction consortium comprising Sinohydro, China Western Power Engineering & Construction (CWEC), Harbin Power Equipment Co. (HPEC), and Western players Alstom and Lahmeyer. The commissioning of the dam led to an 18% growth in the country's electricity generation, as well as irrigation and flood defence benefits.

Country perspectives

The experience of the recipients of some of the largest Chinese financed hydropower projects – Ethiopia, Ghana, Guinea and Zambia – highlights both the benefits and the challenges involved in these kinds of projects. Further details on each country are in the appendix.

Benefits

Chinese-financed hydropower projects made major contributions to domestic generation capacity in host countries, often leading to a notable surge in power generation capacity and associated energy supply.

Perhaps the most dramatic example is Guinea. Despite having vast hydropower resources, the country had long struggled to develop its electricity sector due to the scale of the investments involved. A partnership with China's Water and Electric Corporation (CWE) in 2011 resulted in the commissioning of the 234MW Kaleta hydropower plant in 2015. This led to an immediate 40% expansion in the country's electricity generation that year, providing immediate relief from power shortages, stabilising power supply and allowing the phaseout of emergency rental plants. Power outages reported by industrial customers declined steeply, from 214 hours per month in 2006 to 14 hours per month in 2016 (World Bank Enterprise Surveys, 2016). A second, larger hydropower project, Souapiti (515MW) – dubbed the 'Three Gorges' of Guinea – was commissioned in 2021. This doubled Guinea's hydroelectric production capacity overnight, creating a potential energy surplus for export to the West Africa Power Pool.

Similar patterns are evident in other countries. Chinese engagement in Ghana's hydropower sector enabled completion of the long-delayed Bui dam in 2013 and boosted the country's installed capacity by 404MW (Bui Power Authority, 2024). In Ethiopia, Chinese-financed hydropower projects – most notably the Gilgel Gibe III (1,870MW) megaproject[11] – account for 20% of overall installed generation capacity. In the two years following the commissioning of Gilgel Gibe III in 2016, electricity generation in Ethiopia surged by 30%. In Zambia, Chinese

11 The Gibe cascade is a series of dams including the existing Gibe I dam (184MW), Gibe II power station (420MW), and Gibe III (1,870MW) dam, and the planned Gibe IV (1,472MW) and Gibe V (560MW) dams.

engagement led to the development of two major hydropower generation projects – Lake Kariba North (360MW) and Kafue Gorge Lower (750MW) – which together represent about 30% of Zambia's national installed generation capacity.

Challenges

A series of challenges have also arisen consistently across Chinese-financed hydropower plants in the countries studied.

First, planning deficiencies meant that insufficient attention was given to hydrological risks under changing climate conditions, specifically the increasing prevalence of drought. In Zambia, the onset of drought conditions has critically impacted the generation capacity of Chinese-financed dams, leading to blackouts across the country and the declaration of a state of emergency in March 2024 (Euronews, 2024). In Ghana, the commissioning of the Bui dam in 2013 coincided with a period of drought, preventing any immediate impact on the volume of electricity generation, and in Guinea drought conditions affected power generation from Souapiti.

Second, management and planning failures led to poor coordination of generation and transmission investments, sometimes leaving generation assets stranded and preventing (or at least delaying) the flow of electricity to the economy. In Ethiopia, poor management by the national power utility EEP led to delays in the completion of the transmission projects needed to evacuate power from Gilgel Gibe III. Generation and transmission were contracted to separate construction firms, and so neither had responsibility for ensuring compatibility with the grid, resulting in voltage regulation challenges along the new transmission line. In Guinea, delays in the expansion of transmission lines from Souapiti and Kaleta to the capital, Conakry, left large amounts of new generation power stranded.

Third, the environmental and social aspects of projects have been a cause of controversy and implementation delays. In Ethiopia, delays to the official Environmental and Social Impact Assessment were in part responsible for time and cost over-runs in the construction phase of the Gilgel Gibe III project. In Guinea, the construction of the Souapiti scheme entailed the largest resettlement of people in Guinea's post-independence history. Management of the social and environmental impacts of the project created controversy and delays.

Fourth, post-construction, a common difficulty has been the tendency to price hydropower purchase agreements above the retail electricity price, with resulting impacts on financial viability and debt sustainability. In Zambia, electricity generated by the Kafue Lower Gorge dam was contracted to be supplied to the state utility at $0.13–0.16 per kilowatt-hour under the Power Purchase Agreement, with the proviso that the price would drop to $0.08–0.10 per kilowatt-hour once the loan to China was repaid. Given that electricity retail tariffs in Zambia were then only around $0.05–0.06 per kilowatt-hour, this electricity was to be sold at a loss.

In Guinea, the price agreed in the Power Purchase Agreements for the Kaleta and Souapiti hydropower plants with the national utility, Electricité de Guinée (EDG), averages prices across the two projects at $0.1075, well above the retail price of electricity, necessitating substantial subsidies from the Ministry of Finance. In Ethiopia, the price negotiated under the Power Purchase Agreements for Gilgel Gibe III significantly exceeded the retail price such that every kilowatt-hour of electricity supplied led to a financial loss for the national power utility EEP.

3.1.2 Rail

Africa's rail lines were developed primarily during the colonial period, often to facilitate extraction of mineral resources by connecting landlocked cities and countries to ports. This led to a profusion of single line networks, with a relatively minor role for passenger or other freight transport. Many of these lines have subsequently seen dwindling traffic. Only about half a dozen African railways have traffic density above the estimated minimum viability threshold of 2–3 million units annually, with the majority carrying under 1 million units (Raina et al., 2022).[12] To achieve full financial sustainability that accounts for not just operations and maintenance, but also development and renewal of infrastructure, the threshold is closer to 10 million traffic units (Ibid.).[13]

China has been a global leader in rail development. The Tenth Five Year Plan (2001–2005) and the Mid to Long-Range Network Plan (MLRNP) (2003) both emphasised construction of high-capacity trunk rail lines as the backbone of China's transport system (World Bank, 2009). However, by the end of the 2010s, the sector had become increasingly saturated, leading to excess capacity. Rail technology, including high-speed rail, was designated as a key strategic sector for export, with a view to redirecting domestic excess capacity to overseas projects (Ker, 2017, Lin et al., 2021). Goods and services – locomotives and equipment, along with engineering, managerial and other services – were provided as part of a loan package to recipient governments, including in Africa (Chen, 2020).

Overall financing trends

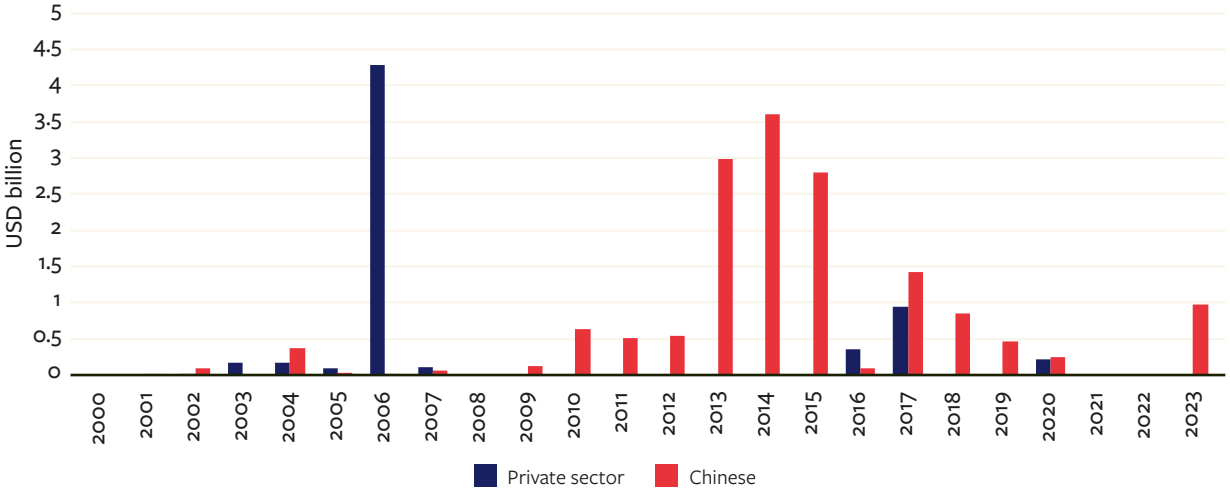
China's earliest foray into railway construction in Africa was the TAZARA railway, connecting Tanzania and Zambia, undertaken as a goodwill project in the 1970s. Subsequently, Chinese engagement remained modest until two sizable commitments: one, in 2006 for Angola, to

12 Indeed, railways in all of the following are estimated to have traffic units under the one million annual threshold: Angola (CFL, CFB); Benin; Botswana; Cameroon; DRC; Republic of Congo; Côte d'Ivoire; Eritrea; Ethiopia–Djibouti; Ghana; Guinea; Kenya; Liberia; Madagascar; Malawi (CEAR); Mali–Senegal; Namibia; Sierra Leone; Sudan; Tanzania (TRC); Tanzania–Zambia; Togo; Uganda; Zambia; Zimbabwe.

13 Except South Africa, this level of traffic density is only seen in Mauritania, which has 728km of single-track standard gauge line (1,435mm) connecting the port city Nouadhibou with Tazadit, the iron mining region. It carries approximately 13 million tonnes of iron ore annually

rehabilitate the Benguela Railway ($0.7 billion) and another, in 2007 for Sudan, to finance a rail connection from Port Sudan to Khartoum ($1.7 billion). From 2011 to 2014, China scaled up financing substantially to an annual average commitment of $3.0 billion (Figure 4). Three countries account for around 71% of the total: Kenya, Ethiopia and Nigeria. These countries received significant loan financing between 2011 and 2015.

Figure 5 Financial flows to African railways ($ b)



Notes: 1. The Chinese financing amount includes only external financing, not the recipient government's own capital contributions; 2. 'Other Public' refers to recent government contracts by Tanzania and Ethiopia for greenfield rail projects only for design and construction. The projects are: Morogoro to Makutupora Inter-City Electrical Railway, Dar es Salaam and Morogoro Standard Gauge Railway Line and the Awash-Kombolcha-Hara Gebeya Railway. The bids were won mainly by the Turkish firm Yapi Merkezi Insaat VE Sanayi As. For non-Chinese financed projects, any project without details on the sponsors partnership, the estimated investment was divided equally among the known sponsors. For projects with partial details, the remaining percentage of the investment amount was assigned as 'Others'.

Source: Authors' elaboration based on a combination of Chinese finance from BU/SAIS-CARI Chinese loans to Africa Database and Western finance from World Bank PPI Database

China's cumulative funding for African rail projects between 2000 and 2023 stands at just under $16 billion, for the construction or improvement of over 5,500km of line. Engagement by other financiers and private sector actors over this period was intensive in the mid-2000s, but fell dramatically after 2007, amounting to around $6.3 billion over a 20-year period. This makes China by far the largest foreign supporter of African rail (Figure 4).[14] China's rail finance has slowed

14 Non-Chinese financing for African rail has come primarily from the private sector; details drawn from the World Bank Private Participation in Infrastructure (PPI) database. The starting point is the total investment amount reported for each project in the database. Since debt-equity ratios are not reported in the database, a typical debt-equity ratio for project financing structures of 70:30 is assumed. On this basis, private investment can be estimated by combining: a) the private portion of the equity based on the reported percentage of private equity in the project; and b) the private portion of debt that is assumed to be the debt remaining after subtracting any multilateral and bilateral debt.

significantly since 2015 in line with broader trends, but more recent years have seen continued lending for ongoing projects – notably in 2023 with the financing of an extension of the Lagos–Kano SGR line to Kaduna, Nigeria.

Almost all the projects undertaken without Chinese support have been structured to capture private sector participation and investment, mainly in the form of brownfield concessions. Private capital has come almost exclusively from French ($650 million), Canadian ($38 million) and South African ($36 million) investors. Involvement of development finance institutions in these transactions (including the International Finance Corporation (IFC), International Development Association (IDA) and the European Investment Bank (EIB) and Proparco, a subsidiary of Agence Française de Développement (AFD)) has been modest, amounting to $459 million. Over the last two decades the World Bank has provided approximately $700 million for various rail projects, including in the Democratic Republic of the Congo (DRC), Mozambique, Cameroon and Tanzania. In 2023, the US Development Finance Corporation (DFC) announced financing of over $500 million to upgrade the Lobito railway in Angola, as part of a regional rail initiative under the Partnership for Global Infrastructure Investment (PGII) (US Department of State, 2024).

China has also been actively engaged in the rehabilitation of existing rail lines in Angola and Nigeria and continues to provide grant support for the TAZARA railway, but the bulk of financing has been for construction of new SGRs. On average, China has provided about $1.9 million of finance per kilometre of railway in the case of brownfield rehabilitation, and $5.2 million per kilometre of railway in the case of greenfield construction of freight railways. The duration of construction for Chinese-financed rail projects has been around 3–4 years for greenfield projects and around 7–8 years for brownfield projects. Some of the latter have been particularly challenging, as in the case of the Benguela railway in Angola, which necessitated the removal of landmines remaining after the civil war.

Some half-dozen Chinese contractors have been responsible for building Chinese-financed rail projects in Africa. Of these, two account for almost 50% of projects by value: China Civil Engineering Construction Corporation (CCECC) and China Rail Engineering Corporation (CREC). China Road and Bridge Corporation (CRBC) and its parent company, China Communications Construction Corporation (CCCC), have also been involved in major rail construction. The main private contractors and concessionaires involved in rail projects financed by countries other than China include Bollore, Canac, Comazar, Eramet and Getma.

Country perspectives

This section examines China's engagement in rail development in specific African countries – notably Angola, Ethiopia and Kenya – highlighting both the development benefits and implementation challenges that arose in each case. Further details on each country are available in the appendix.

Benefits

These three cases clearly illustrate substantial expansion or upgrading of rail infrastructure from Chinese engagement, which was focused on the connection of capital cities and major production areas to seaports.

Angola's rail infrastructure was largely destroyed during the country's protracted civil conflict between 1975 and 2002 (China Lusophone Brief, 2018). The most strategic rail line, which had been highly profitable before the war, was the *Caminho de Ferro de Benguela* (CFB), known as the Benguela railway. The line links the Atlantic port of Lobito to the land border with the DRC, providing the shortest route to the sea for the rich copper mining belt in DRC and Zambia. After the war, a Chinese loan financed the rehabilitation of the full 1,344km CFB line, including 67 stations, a process that was completed in 7 years. The line was also upgraded to allow for faster trains (90km/hr) and accommodate higher traffic volumes.

The Ethiopian Railway Corporation (ERC) was created in 2007 to oversee the construction of a new and fully electrified national rail network spanning 5,000km. The network was intended to support an industrialisation and export-oriented growth strategy by connecting major planned industrial zones across the country (including many developed with Chinese involvement) to the seaport in Djibouti (also financed and constructed by Chinese financial institutions and SOEs). The first major link of the project, the 756km Addis Ababa–Djibouti Railway, costing $4.3 billion, was supported by an export credit from China Eximbank (Chen, 2021).

The construction of Kenya's SGR was originally intended to be the first stage of a larger regional infrastructure programme (CPCS, 2009). Kenya's Vision 2030 anticipated a large investment in the Port of Mombasa and associated rail freight capacity. Accordingly, Kenya became a core partner in the BRI, with its involvement centred around the SGR linking Mombasa to Nairobi. The China Road and Bridge Corporation (CRBC), a large state-owned engineering company, proposed an Engineering, Procurement, and Construction (EPC) arrangement to the government, and was subsequently engaged to construct the Mombasa–Nairobi portion, with $1.6 billion of financing from China Eximbank. The 472km line was completed after 32 months in 2017, well under the 60 months allowed by the contract. Subsequently, China also funded the 120km Nairobi–Naivasha line, at an estimated cost of $1.5 billion (IRJ, 2024).

Challenges

While all three countries saw the completion of the contracted projects, a range of serious issues delayed or prevented the full development benefits from being realised. In some cases, corrective measures were or will be needed.

First, planning deficiencies and poor design limited capacity in some cases. With the Benguela railway in Angola, a post-construction assessment of the CFB project concluded that there had been no proper feasibility study and that the line did not meet the technical standards to be used for the main route for the export of ore from the Copper Belt in the Southern African hinterland (China Lusophone Brief, 2018). Redressing these issues, to make the line fit for purpose, would have required substantial investments estimated at $250 million for infrastructure upgrades and $150 million for the acquisition of rolling stock, as well as improvements to maintenance and traffic management systems (MINTRANS, 2019). As a result, the anticipated mineral rail traffic from Central Africa to the port of Lobito, which had been estimated at 300,000–1 million tonnes a year, failed to materialise.

Second, there were coordination failures between rail and complementary infrastructure. In Ethiopia, an electric railroad was constructed in a country with an energy system that was not ready to support it. Despite the timely completion of the rail line in 2016, delays in the construction of the associated electricity transmission network held up commissioning until 2018. Even then, poor energy sector planning, shortages of generation capacity, and a lack of necessary transmission and distribution infrastructure led to power outages and voltage surges, leading to frequent suspension of services during early operation. Another shortcoming was the failure to coordinate the line route with the location of emerging industrial zones to create direct rail links that could capture more freight traffic.

Third, projects have been plagued by governance challenges, ranging from environmental and social concerns to allegations of corruption. The most extreme example is Kenya, where to accelerate construction and implementation of the SGR, China and Kenya utilised a government-to-government procurement model, which exempted the project from the country's Public Procurement and Disposal Act. The project was not subject to competitive bidding or the reporting requirements for government tenders but underwent single-source procurement. In the absence of competition, construction costs were well above earlier estimates, at around $5 million per kilometre on average (Carrai, 2021). There were repeated allegations of corruption in connection with the project, along with public concern over inflated costs (Transport, Public Works and Housing, 2020). Investigations were launched by the Public Prosecutor in 2018 and the Ethics and Anti-Corruption Commission in 2019.

Fourth, underlying demand projections for rail freight proved overly optimistic. In Angola, given lower than anticipated cross-border mineral freight, CFB operates at a fraction of its design capacity, carrying mainly passengers paying nominal fares. Copper and manganese, the main

anticipated traffic on the line, currently account for less than 20% of total volumes (Raina et al., 2022). As a result, rail revenues barely meet staff salaries, and CFB depends on a state subsidy to cover 50% of revenues (Ibid.). Service of the debt associated with the CFB line falls to the government, which is already highly indebted.

Similarly, in Kenya, revenues earned by the new Mombasa–Nairobi line fell short of the operating costs of $170 million; the difference was partially covered by a government subsidy of $49 million in 2018 (Business Daily, 2020). Operating costs of the rail line included the management fee of around $1 million a month to Afristar, a subsidiary company of CRBC, which took on contractual responsibility for operating the line until 2024. Although the debt for construction was transferred to the books of the state-owned Kenya Railways Corporation (KRC) there is no possibility of servicing the associated Chinese loans from rail revenues (Ibid.).

Fifth, operation and management of the new rail infrastructure has faced institutional capacity limitations. In Kenya, a management contract was put in place to undertake operation and maintenance of the new lines, but had to be cancelled in 2021 due to default on the payment of the annual management fee. Operations reverted to the national rail company (IRJ, 2021). A similar arrangement was put in place for the Addis–Djibouti line, with a management contract awarded to CREC and CCECC, the Chinese companies responsible for construction, for the six years up to 2024, when operations were to be handed back to local operators (myNEWS, 2024). Under the agreement, Chinese contractors also undertook to send ERC employees to technical universities in China (Rucai, 2017). Despite arrears in payment, the management contractors in this case continued to fulfil their operational functions.

3.2 Frontier sectors of China's infrastructure investment

While investments in digital infrastructure in Africa have been longstanding, particularly in telecoms, digital cooperation has become increasingly prominent in policy discourse. China launched the Digital Silk Road concept in 2015, raising digital connectivity as a priority in BRI cooperation. Plans for improved digital connectivity have been emphasised in subsequent BRI fora, and digital cooperation has been a central theme in China's cooperation with Africa (China Daily, 2023). The Global Development Initiative (GDI) also centres on the digital economy and connectivity. Green infrastructure and clean technologies also stand out as new sectors of infrastructure cooperation. The pledge of 'no new coal overseas', announced by President Xi Jinping in 2021, has largely halted investments in Africa's coal sector, and the 2023 Belt and Road Forum emphasised a shift to high-quality 'green' projects. These emergent sectors of cooperation reflect a similar prioritisation of energy generation and connectivity infrastructure as previously, alongside the transfer of China's domestic industrial capacity.

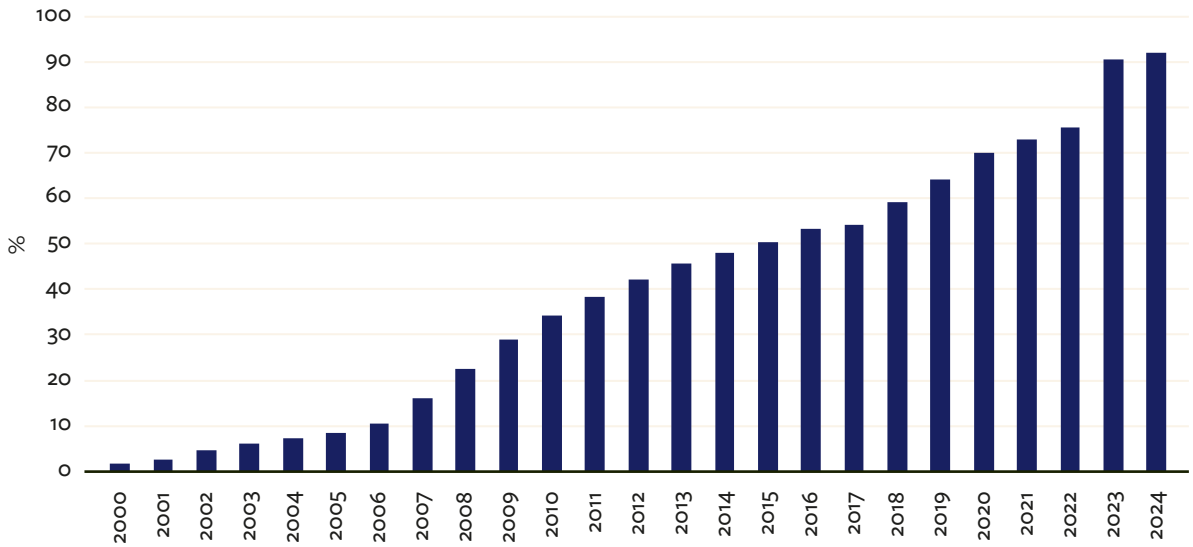
Compared to hydropower or rail megaprojects, these frontier sectors are distinctive in that they can sustain smaller-scale, private sector-led financing. They are also sectors where China faces competition from other investors, such as the US and EU – digital and green cooperation have been designated as priority areas under the EU Global Gateway, for example.

3.2.1 ICT and digital technologies

China's information and communication technology (ICT) sector has seen phenomenal growth. Rapid industrialisation and modernisation efforts beginning in the 1970s laid the groundwork for the digital revolution. By the early 2000s, China was experiencing a digital transformation unparalleled in speed and scale (Fernandez et al., 2018). This was supported at the policy level by initiatives such as the 'Made in China 2025' roadmap and 'Internet Plus', both launched in 2015 to drive domestic industrial and digital innovation.

Digital connectivity has expanded dramatically. China's fibre optic cable lines reached almost 60 million kilometres in 2022, compared to 44 million in 2018 (+37%) (China Internet Network Information Center, 2023). The number of internet users has grown from virtually zero in 2000 to almost 80% of the population in 2023 (Figure 5), with 94% of the population reached by 5G networks.[15] China is a global leader in 5G communications and the only country ahead of the International Telecommunication Union (ITU)'s '2020 5G development schedule'. China is also contributing to setting standards in the development of this technology (Shi-Kupfer and Ohlberg, 2019). Chinese companies are leaders in various digital sectors, including e-commerce, mobile payments and financial technology.

Figure 6 Share of people in China using the internet, 2000–2024



Source: International Telecommunation Union (ITU) DataHub

15 See: https://datahub.itu.int/data/?e=CHN

With this dominant position, Chinese companies have expanded into the Global South, including in Africa, exploring overseas markets as part of the 'Going Out' strategy. The National Informatization Strategy (2016–2020) and the launch of the Digital Silk Road offered further encouragement for the overseas expansion of China's digital and tech giants. These policies have yielded concrete results, for both private and state-owned firms. ZTE, a state-owned company, and the private firm Huawei (which entered the African market as early as 1998) contributed to building or revamping Africa's telecom infrastructure, while state-owned companies China Telecom, China Unicom and China Mobile have all been active in expanding international telecommunications links, including land-based and undersea cables (Heeks et al., 2024).

Overall financing trends

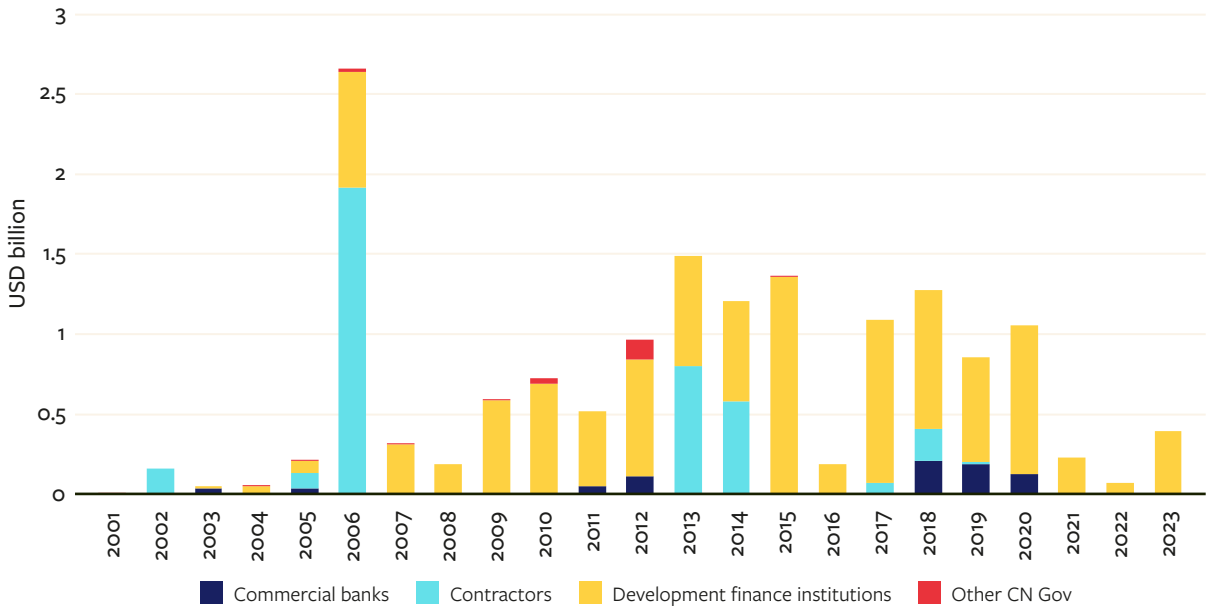
The ICT sector has long been prominent in Chinese infrastructure finance in Africa. From 2000 to 2023, ICT received the third-highest volume of loan commitments (after energy and transport), with nearly $14 billion committed. Figure 6 shows that trends in Chinese loans to the ICT sector in Africa roughly follow the same pattern as overall loans to Africa, growing until around 2018, then declining until 2022. A couple of years (2006 and 2013) saw exceptionally high commitments, all attributable to large loans agreed for Ethiopia, including a $1.9 billion loan from ZTE in 2006 to finance the three phases of the Millennium Plan Telecom Project, and from Huawei in 2013 for $800 million to fund the expansion of the telecom network. Financing of African digital infrastructure grew in parallel with the accelerated expansion of broadband infrastructure and internet usage in China, with a marked acceleration in broadband subscriptions in China from 2003.

In terms of sources of finance, 69% of funding for digital investments came from Chinese policy banks, mainly China Eximbank. Chinese contractors, primarily ZTE and Huawei,[16] provided another 25%, with the remaining 5% financed by Chinese commercial state-owned banks (Bank of China, CITIC, ICBC), and Chinese government agencies (such as CIDCA).

Private sector financing from companies and contractors such as Huawei distinguishes digital sector investments from 'traditional' sectors (see Figure 6). However, this financing is generally supported by lending from policy banks. For instance, with respect to the $1.9 billion loan to Ethiopia agreed in 2007, ZTE provided a $1.5 billion supplier credit to the Ethiopian Telecom Company to purchase equipment from ZTE. This credit was, in turn, supported by a $1.5 billion export seller's credit from China Development Bank to ZTE. In 2013, both Huawei and ZTE signed an $800 million supplier credit agreement with Ethio Telecom (formerly Ethiopiapian Telecom Company) to expand the telecom network. The two companies reportedly secured $1.6 billion in export seller's credit from China Eximbank and then used the proceeds to on-lend to Ethio Telecom (Custer et al., 2023).

16 Since 2019, Huawei has claimed a status as a private company, but this has been contested. At its founding in 1987, the company was registered as a 'collective-owned enterprise', an intermediary status between SOE and private ownership (Marquis and Qiao, 2022: 213). The company has referred to itself as collectively owned by its employees, and later as a private company.

Figure 7 Chinese loan commitments to the ICT sector by financier, 2000–2023



Source: Boston University Chinese Loans to Africa Database

Huawei has been one of the main financiers and contractors for Chinese ICT projects in Africa, lending a total of $1.1 billion towards seven ICT projects in 2000–2021. Huawei has a unique status as a non-SOE involved in both funding and delivering ICT projects for Chinese-financed infrastructure (Tugendhat and Voo, 2021). In the period 2000–2018, it was involved either as a lender or contractor in 49 projects, more than any other private or state-owned Chinese company (Tugendhat and Voo, 2021).

Policy and commercial banks and contractors have lent around $80 million to building or upgrading national telecom or digital infrastructure and networks. Policy banks also lent to African governments for e-government and digitalisation projects. The Chinese government directly financed smaller projects ($15 million on average) to procure equipment, develop information technology (IT) systems or provide training programmes related to ICT. Ethiopia has received by far the most finance from China for ICT projects, receiving over $3 billion from 2000 to 2023, or 20% of the total loaned by China in this sector. Nigeria is second ($1.4 billion), followed by Angola ($1.3 billion) and Cameroon ($1.2 billion). The early stages of China's financing for ICT infrastructure covered the expansion of the broadband network in African countries. Later stages focused on e-government projects and data centres: the Konza Smart City Project in Kenya is one recent example.

Country perspectives

This section examines China's engagement in ICT and digital technologies in specific African countries. The experiences of Ethiopia and Kenya highlight both the development benefits and implementation challenges that arose. Further details on each country case are in the appendix.

Benefits

Both Ethiopia and Kenya saw a substantial expansion in digital connectivity as a result of Chinese engagement. Chinese telecoms and ICT investments in Ethiopia have led to qualitative improvements in network coverage and access. In 2006, ETC signed what was at the time the largest agreement in the history of African telecommunications. The 'Millennium Plan' project provided a loan of $1.5 billion (to which ZTE added $400 million for engineering services) to overhaul and expand Ethiopia's telecommunications system.

The project was divided into three phases covering different parts of the country's network. The first phase connected the ICT network of Ethiopia's 13 largest cities, while the second and third phases expanded coverage initially along key road networks and subsequently to rural areas (Gagliardone, 2016). The project achieved notable results. The number of internet and data subscribers grew from 71,059 in 2009 to around 221,000 by the end of 2012 (Custer et al., 2023). The number of mobile subscribers grew from less than 1.2 million in September 2007 to around 17.5 million in 2012, and internet users increased from 1% to 20% of the population from 2001 to 2022.

In Kenya, Chinese institutions – primarily China Eximbank – have financed a combination of network expansion and e-government projects. In 2007, China Eximbank and the government signed a $37 million loan agreement for Phase 1 of the National Optic Fibre Backbone Infrastructure (NOFBI), to lay 4,300km of fibre optic cable to connect eight provincial headquarters and 53 towns. A concessional loan agreement for $72.5 million was signed in 2012 for Phase 2, and for an e-government expansion project. Another agreement followed in 2016, worth $98.7 million, for the same project. The funding allocated through these loans was to be used to contract Huawei to construct 2,100km of national optic fibre backbone infrastructure, passing through 8 major towns and 36 districts. Construction began in 2014, but as of February 2021, the project was still not complete (Custer et al., 2023). There has been a significant increase in internet users in Kenya, from 1% to 40% of the population between 2000 and 2022. Chinese financing for ICT infrastructure in Kenya, including funding for 2,100km of national fibre-optic backbone infrastructure, played an enabling role.

Challenges

Chinese engagement in digital sectors in Ethiopia and Kenya has substantially expanded infrastructure and facilitated rapid gains in access to the internet. However, lack of competition and transparency in the implementation of projects has raised concerns about corruption and value for money, while some projects have faced considerable delays.

In Ethiopia, Chinese lending to the digital sector was channelled entirely via the state monopoly, ETC, supported by ZTE. At the FOCAC summit in 2006, ZTE and ETC agreed a sole supplier deal worth $1.9 billion giving ZTE the right to supply and install all telecommunications equipment

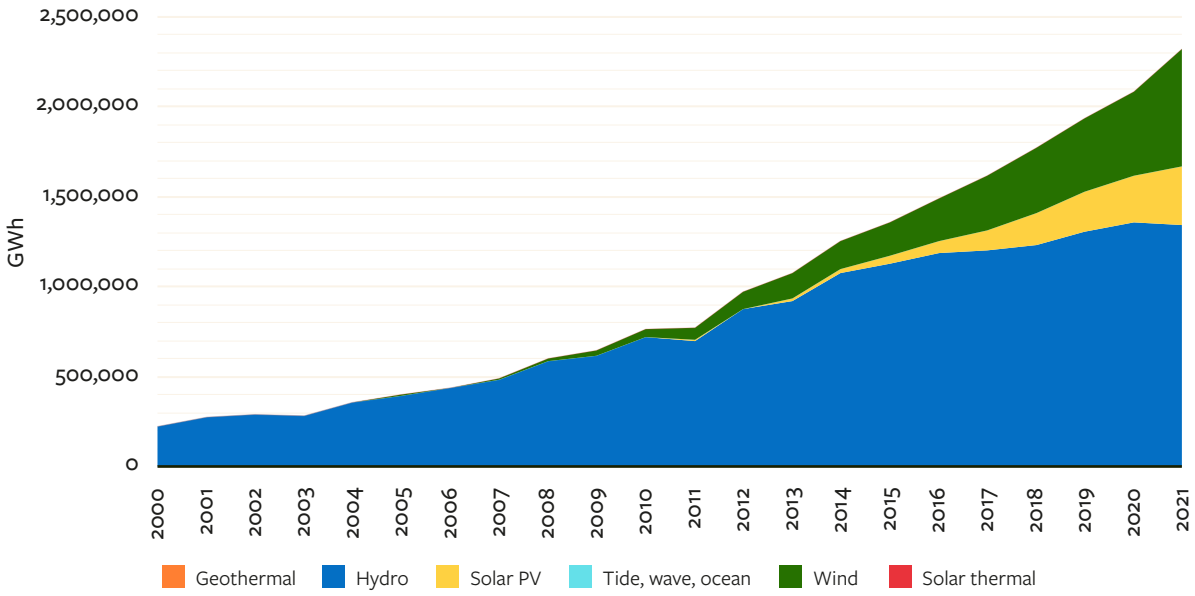
in Ethiopia over a three-year period. In the absence of competition, there was little incentive to keep costs and prices low and quality/access high (Gagliardone, 2016). The award of such a large contract to one supplier, without a competitive process, was questioned by many observers (Custer et al., 2023).

In both Kenya and Ethiopia, allegations of corruption around Chinese-finance digital projects emerged. In 2022, Kenya's Auditor General identified equipment that was faulty, idle or disconnected from electricity and therefore unusable. He further noted that total funding for the project could not be ascertained, and that the concessional loan agreement and contract with ZTE had not been provided for audit (Custer et al., 2023). In Ethiopia, irregularities in purchases from international suppliers were raised by the Ethiopian authorities in relation to the Millennium Project, including procurement of low-quality equipment and bribes (Ibid.).

3.2.2 Renewable energy

Over the last decade, China has become a world leader in the production of newer renewable energy technologies, notably in solar photovoltaics (PV) panels and equipment, wind turbines and battery and energy storage technologies. Domestically, it has scaled up its share of these renewable energy technologies, constituting over 40% of its non-hydro renewable energy generation (Figure 8). Expansion of renewables capacity has been exponential since 2023, with installed wind and solar energy capacities on track to surpass China's installed coal capacity (GEM, 2024).[17]

Figure 8 China's renewable energy generation by source, 2000–2021



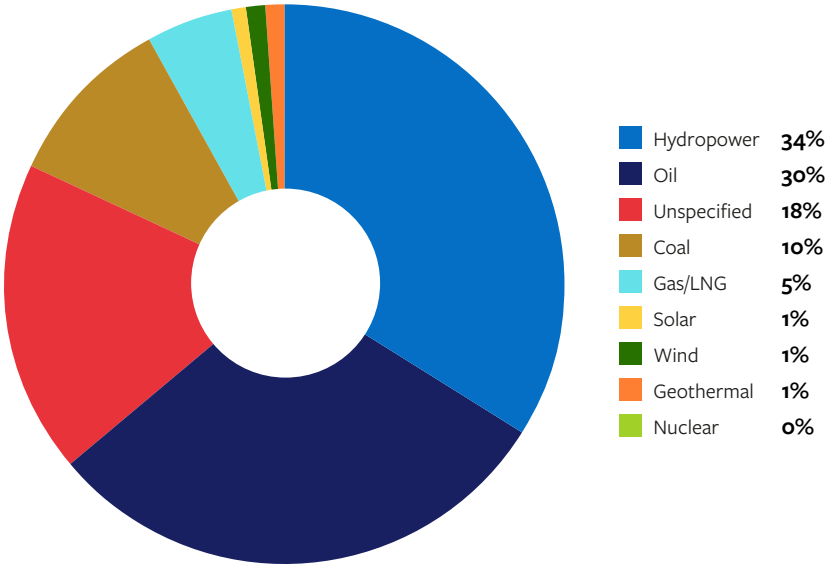
Source: IEA Renewables Information: www.iea.org/data-and-statistics/data-product/renewables-information

17 This was reported to have taken place in April 2025: China's Solar and Wind Capacity Surpasses That of Mostly Coal-Based Thermal Energy for the First Time - EcoWatch

Overall financing trends

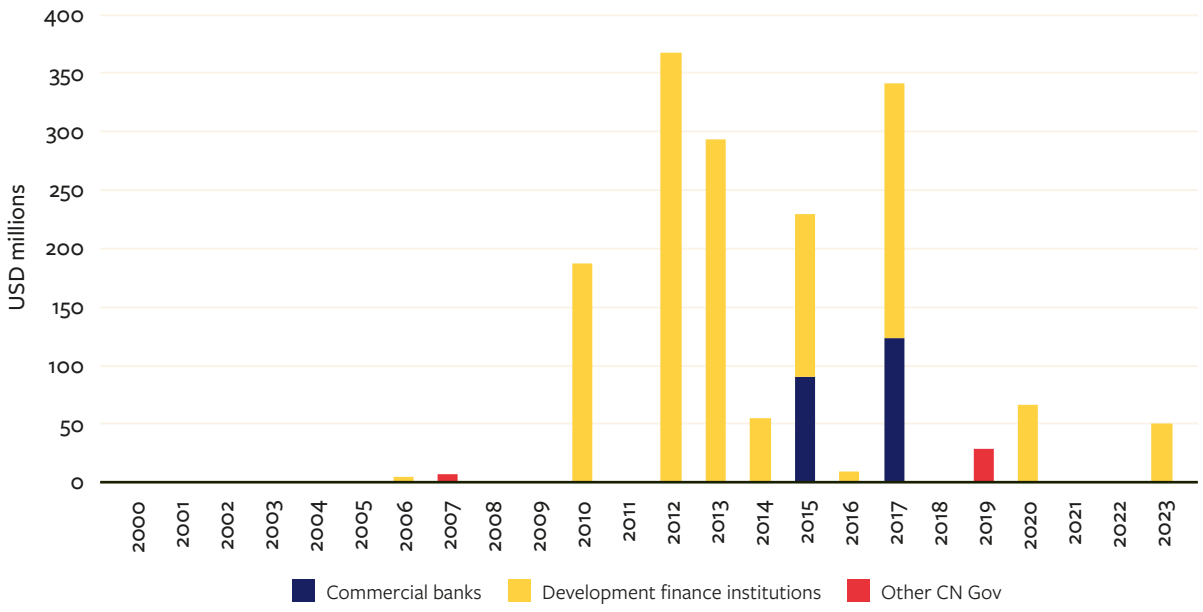
Despite this rapid expansion at home, China's official financing for energy infrastructure over the two decades up to 2020 was dominated by fossil fuel and hydropower projects, while wind, geothermal and solar energy only received 3% of total lending for energy projects, amounting to $1.5 billion (Figure 8).

Figure 9 Chinese energy sector financing, by energy source, 2001– 2020



Source: Boston University China Global Energy Finance database (2023)

Figure 10 Chinese loan commitments to non-hydro renewable energy sectors by financier, 2000–2023



Source: Boston University China Global Energy Finance database (2023)

China's official financing for renewable energy in Africa has been concentrated in a small number of countries, with Kenya and Ethiopia the largest recipients, each receiving around $610 million over 2001–2020 for projects in geothermal, solar power and wind generation. All projects were financed by Eximbank, with concessional loans or preferential export credits. Another important aspect of Chinese renewable energy sector financing has been the construction of transmission lines connecting generation projects (including renewables and projects of other investors) to national grids.

Despite limited volumes of official financing to the sector, there are indications that renewable energy and clean technologies will attract greater investment in coming years. The 2024 FOCAC forum pledged 30 new green cooperation projects, cementing green energy cooperation with Africa as a key future priority.[18] With a smaller ticket size and lower capital investment, the sector has a much more diverse set of private sector actors compared to the largely SOE-dominated sectors of rail and hydropower, with Chinese counterparts facing more commercial competition from international suppliers and contractors.

While official financing for renewables has been relatively low, Africa has been a significant market for Chinese EPC contractors and cleantech suppliers (Shen and Power, 2017); since the 2021 FOCAC, Chinese-constructed projects have delivered an estimated 27GW in installed renewable energy.[19] Chinese private investors are also active in the renewable energy sector. Recent data shows significant growth in Chinese FDI in renewable and clean technology manufacturing in North Africa, financed via equity rather than official lending (Xue and Larsen, 2025).

Country perspectives

This section examines China's engagement in renewable energy in specific African countries. The experiences of Ethiopia and Kenya highlight both the development benefits and implementation challenges that arose in each case. Further details on each country case are available in the appendix.

Benefits

Chinese renewables investments, while relatively small scale, have enhanced energy access and provided capacity-building in countries like Kenya and Ethiopia. China supported ambitious national green development strategies, contributing to energy generation capacity, and provided training and skills transfer to African counterparties.

China has played a significant role in the development of Kenya's geothermal resources, as well as large-scale grid-connected solar. The Olkaria Geothermal field project, which comprises

18 This includes a $50 million loan for a solar power plant in Burkina Faso. See: https://www.mfa.gov.cn/eng/xw/zyxw/202409/t20240905_11485719.html

19 See: https://developmentreimagined.com/expert-view-china-africa-climate-action-tracker-may-2024/

six planned geothermal power stations, has been financed through an array of bilateral and multilateral donors, including China Eximbank, which helped finance the $122 million drilling and exploration project in Olkaria IV, beginning in 2011,[20] and the SOE SinoPec, which was contracted for the pipe system installation of the 280MW power stations.[21] In the subsequent Menenga project, Chinese private power company Sosian has been involved in a 35MW geothermal plant as an independent power producer (IPP). The plant began generating power for the grid in 2023 (Hakeenah, 2023). Chinese actors were also closely involved with the development of Kenya's largest solar plant, the Garissa Solar Power Project, generating 54MW of capacity by 2019. In conjunction with the Rural Electrification Authority (REA), the project was constructed by Chinese contractors Jiangxi Corporation for International Economic and Technical Cooperation (CJIC) using Chinese solar panels from JinkoSolar. It was financed by a $155 million concessional loan from China Eximbank.

In Ethiopia, Chinese firms and financing have played a major role in developing wind projects. The 51MW Adama wind farms, southeast of Addis Ababa, were developed by the parastatal Ethiopia Electric Power (EEP) in partnership with HydroChina and China Geo-Engineering Overseas Construction Group (CGCOC). This was supported as an Engineering, Procurement, Construction and Finance (EPC+F) contract, with a preferential export credit from China Eximbank. Phase I of the project was inaugurated ahead of schedule in 2012 and Phase II came online in 2015. EEP negotiated some knowledge/technology transfer through capacity-building of local engineers and university academics (Chen, 2018). China Eximbank also financed the Aysha I and II wind power projects to the tune of $252 million in 2017. These were partially active as of 2023. Dongfang Electric Corporation is to install two 120MW-capacity plants under an EPC structure similar to the Adama wind farms project. The farm is intended to power the Addis–Djibouti economic corridor and generate foreign exchange through energy exports.

Notwithstanding these important advances in renewable energy development, projects also encountered challenges in the form of social conflict, concerns regarding value for money and implementation delays.

Like the hydropower and rail sectors, Chinese-financed renewables projects in Ethiopia and Kenya have faced challenges around land compensation and resettlement issues, and implementation delays. In Kenya's Garissa project, tensions arose over the limited employment opportunities provided by the project (Bhamidipati and Hansen, 2021). In Olkaria, issues revolved around inadequate communications regarding the project's impact and progress and unsatisfactory resettlement policies and logistics (Kong'ani et al., 2021).

Fiscal constraints and external debt, as well as ongoing debt restructuring negotiations in the case of Ethiopia, have also contributed to project delays and the shelving of further wind power

20 See: https://china.aiddata.org/projects/31023/
21 See: www.thinkgeoenergy.com/kengen-signs-140m-pipeline-and-technology-deal-with-chinese-sinopec/

developments. While there are strong prospects for the sector both in terms of resource endowments and political ambitions on the part of African governments, ensuring a sound macroeconomic environment and transparent project implementation will be key in unlocking investments in these sectors, and capturing potential opportunities in renewables manufacturing supply chains.

The Olkaria project in Kenya has been scrutinised over value for money on the well-drilling investment. A report from the Kenyan Auditor General in 2021 notes that some of the wells drilled between 2011 and 2015 'have never been connected to any plant for generation of power … while no corresponding revenue has been realised to date' despite the utility continuing to repay the loan.[22]

In Ethiopia, the Aysha project faced significant difficulties related to the country's macroeconomic downturn and fiscal constraints, including foreign exchange shortages. Technical and land compensation issues, as well as the Covid-19 pandemic and the civil war, all contributed to substantial delays in project completion. Disbursements on the Chinese loan were halted as of 2021 following Ethiopia's default and the start of its sovereign debt restructuring through the G20 Common Framework. Future phases of the project were shelved in 2023.

22 See: www.oagkenya.go.ke/wp-content/uploads/2022/11/KenGen-2020-2021.pdf

4 Conclusions and policy lessons

Since 2011, China has provided an estimated cumulative total of $117 billion of finance, representing almost 20% of total infrastructure financing for Africa (ICA, 2018; ICA 2014). Chinese official financing, tied to Chinese production and provision of services, facilitated substantial exports of goods, services and technologies from China in areas where significant capacity had been established. African markets have been hugely important for Chinese contractors, suppliers and a plethora of Chinese state-owned enterprises and banks, Chinese government departments, and private entrepreneurs. Sectors such as construction, rail locomotives, renewable energy, technology and services such as engineering, managerial and technical services have benefitted from Chinese outward investment and infrastructure finance. At the same time, these capital outflows enabled the diversification of China's portfolio, while investments associated with key natural resource sectors allowed access to critical commodities.

Chinese external financing largely reflected its domestic growth and concomitant savings accumulation. China was able to deploy its large savings in search of high returns in Africa by devising contractual structures that reduced financial risk. Procuring Chinese contractors during design, construction and operation also meant Chinese know-how was involved and Chinese actors received payments from the loan, serving both national industrial promotion strategies and reducing risk by ensuring trusted suppliers and contractors. In some cases, loans were backed by trade in commodities (such as oil or minerals), with proceeds from commodity sales deposited in escrow accounts from which Chinese lenders and contractors were paid. Financing to parastatals was guaranteed implicitly or explicitly by governments. More recently, Chinese lenders have turned to co-financed projects with other foreign lenders, part of a drive towards risk-sharing and risk-mitigation (Parks et al., 2023; Chen and Emery, 2025).

4.1 Successes and benefits

Beyond their financial significance, Chinese infrastructure projects have made an important contribution to the physical expansion of infrastructure stocks in Africa. Chinese-financed hydropower capacity since 2000 amounts to a total of some 9GW, representing around 24% of the total installed hydropower capacity for sub-Saharan Africa. Chinese-financed projects have added or significantly upgraded around 5,600 kilometres of rail line, almost 9% of the total 65,000km sub-Saharan African rail network. Chinese contractors have delivered large and complex infrastructure projects at speed, when others opted not to enter these markets.

At the country level, this impact has been significant. China has developed the entirety of the key capital city to port rail routes in both Ethiopia and Kenya and has rehabilitated a third of Angola's rail system. In Zambia and Guinea, currently operational Chinese-financed hydropower plants represent some 40–50% of installed power generation capacity. In Guinea, the commissioning of the first major Chinese-financed hydropower project, Kaleta, led to a 40% jump in domestic

power generation, ending years of power shortages that had been crippling economic activity. Similar, though proportionally smaller, surges can be observed in Ethiopia and Sudan. In Ethiopia and Kenya, Chinese financing and construction of the ICT network has increased access to telecom and digital networks across the country.

4.2 Challenges for Chinese-financed infrastructure

A range of policy and institutional issues consistently arise across the cases reviewed in this paper. These can be broadly clustered in three areas: investment planning, financial and operational sustainability, and sector governance – including links with the overall macroeconomic framework.

Investment planning

Poor coordination of complementary investments. Investments in one area of infrastructure often need to be synchronised with complementary investments in others. Generation plants require transmission lines to evacuate power, while railways require parallel electricity supplies to power trains. This can entail a challenging level of cross-sectoral coordination to ensure that related sector plans align, and that project delivery advances in tandem.

In Ethiopia, delays in the completion of the government-funded transmission line meant that electricity from the Gilgel Gibe III hydropower project could not immediately be transmitted to centres of demand. Similarly, the productivity of the Addis–Djibouti rail line was significantly restricted due to capacity and technical issues in the line's electrification, to which the delay in the Aysha wind farm projects partially contributed. The lack of spurs to connect the new railway to industrial production sites reduced traffic flows, resulting in lower revenue generation.

Mischaracterisation of service demand. Service demand has commonly been overestimated, leading to unduly optimistic economic and financial appraisal of projects. As a consequence, project revenues often fall short of what is required to support debt service together with operating and maintenance costs. At the same time, inadequate engagement with stakeholders may lead to infrastructure design that fails to meet the needs of the target market or users, further constraining demand. Mischaracterisation of demand often arises from a lack of technical capacity on the part of project financiers and developers, as well as national planners, but may also reflect political pressures to develop infrastructure without due regard for such considerations.

Chinese-financed rail projects in Africa have been particularly susceptible to these issues. Kenya's SGR project, despite serving the vibrant Nairobi-to-Mombasa corridor, has not realised projected traffic volumes and faces financial sustainability challenges, while the Ethiopia–Djibouti rail line has similarly struggled to grow revenues. Perhaps the most extreme case is the Benguela railway in Angola, which, due to design misspecification, has not succeeded in capturing any significant volume of mineral exports from the Copper Belt, which it was originally intended to serve, and has consequently struggled to generate adequate traffic.

Failure to consider climate risk. Climate change poses significant risks that can undermine the performance of infrastructure assets. The most salient example is hydropower, whose output is critically dependent on rainfall patterns and particularly vulnerable to drought. Hence the importance of subjecting infrastructure project selection to rigorous stress-testing for potential climate change and severe weather effects, and robust decision-making at the appraisal stage to allow for potential modifications to project design.

Some Chinese projects in African countries are already seeing the impact of changes in weather patterns. In Zambia, major Chinese-financed hydropower projects have not generated the anticipated volumes of electricity due to drought, contributing to a national power supply emergency in 2024. Drought conditions soon after completion have significantly affected production from other Chinese-financed hydropower projects, notably Bui in Ghana and Souapiti in Guinea.

Financial and operational sustainability; regulatory framework

Lack of financial viability of infrastructure sectors. The overall financial health of a sector affects how individual projects within that sector perform. For example, power generators need to sell the energy they produce to creditworthy off-takers, typically distribution utilities. In many African countries, retail prices charged for infrastructure services are not cost-reflective and may not even cover the wholesale costs of power purchase. Financial viability is further prejudiced when utilities' management do not have incentives to control costs in service provision or investment decisions.

A recurring problem in the hydropower sector is that host governments have signed power purchase agreements with off-takers at prices that exceed the retail tariff of electricity in the country. In Zambia, the national utility purchased electricity from Chinese-financed hydropower projects at two to three times the retail price to consumers. This means that power generated by these schemes is essentially being sold at a loss. Similarly, energy produced by the Kaleta and Souapiti dams in Guinea is bought at prices necessitating significant government subsidy. Lack of sector reform, including an appropriate regulatory framework and transparency in costing, have affected financial and operational sustainability.

Inadequate provision for operations and maintenance. Infrastructure maintenance has been a longstanding challenge in Africa, particularly with transport infrastructure. Adequate provision for maintenance entails having sufficient cashflow for this purpose and ensuring the technical and institutional capacity to deliver on maintenance activities.

A salient example is the Ethiopian railway sector, which was built from scratch with Chinese support in the absence of any prior rail sector know-how in the country. Management contracts with Chinese contractors have provided a way forward for maintaining infrastructure where

capacity constraints exist, although it has proved challenging to generate the cashflow to pay the associated fees. In Kenya, the management contract put in place with the Chinese operator for the Mombasa to Nairobi line was cancelled in 2021, due in part to challenges paying management fees.

Sector governance

Lack of regulatory enforcement. In many African countries, the regulatory framework governing environmental and social aspects of infrastructure projects may be incomplete or not fully enforced. This can be due to limited financial or human resources or a lack of political will.

In Ethiopia, the environmental and social impact assessment (ESIA) for Gilgel Gibe III was only undertaken well after construction had begun. Population resettlement has generated local controversy around the Souapiti dam in Guinea and the Olkaria geothermal plant in Kenya. While this is largely a host country issue, Chinese financiers, relative to multilateral development banks (MDBs) or Northern donors, have historically been less focused on enforcing ESIA requirements and standards.

Limited competition in procurement. Chinese-financed projects limit the degree of competitive procurement, since financing arrangements and export credit are conditional on procurement of Chinese contractors and suppliers.

Non-competitive procurement, as in the case of Kenya's SGR, which was procured directly under government-to-government arrangements without being subject to an open market test, led to allegations of corruption and public investigations in 2018–2019. Similarly, the use of sole source procurement to supply digital equipment from ZTE has prompted public concern around transparency and value for money.

Inadequate fiscal oversight. Infrastructure projects carry substantial fiscal risks, generating contingent liabilities for the state. Good fiscal governance is necessary to ensure that only projects that are technically and financially sound go forward. Frameworks are also needed to guide corrective actions when risks materialise. In many of the cases studied, loan approval and due diligence processes did not sufficiently weigh the potential risks associated with project delays, non-repayment and shortfalls in projected revenues. As a result, some projects had major impacts on national budgets, sometimes even before they were commissioned and able to generate sufficient revenues. More broadly, overall macroeconomic management has been an important concern in determining access to and cost of funds. Where governments have managed fiscal policies poorly, borrowing for infrastructure investments has been more costly.

Lack of oversight and monitoring of borrowing and procurement by parastatals and utilities, as in Zambia and Ethiopia, contributed to exuberant borrowing that inflated government debt exposure. In Guinea, the scale of the Souapiti dam relative to the local economy itself created challenges of macroeconomic management.

4.3 Lessons

The challenges discussed in this paper are endemic in development financing for major infrastructure projects in weak governance environments. While they are not limited to Chinese-financed projects, the nature of Chinese financing has in many cases exacerbated them. An important reflection is that the responsibility for many of these issues is shared between host governments and their financing partners. Host governments could do more to address foundational sector governance challenges, while financiers could further strengthen their due diligence to highlight and manage potential associated risks.

As African governments seek to transform their economies, they face an increasingly diversified array of external financing partnerships, including the EU's Global Gateway and Gulf partners, and new blended models of financing and investment that these external partners bring. Given the shifts in China's overseas finance, and the borrowing constraints African sovereigns face, the policy recommendations highlighted here are intended to ensure that future infrastructure investments maximise the benefits to host countries.

Provide a sound macroeconomic and fiscal context. Good macroeconomic management is critical to reduce risks for investors, thereby lowering the cost of capital and improving the sustainability of projects. In the context of infrastructure, public investment management is particularly important to ensure economic and financial screening of investment projects, and that associated fiscal risks are quantified, minimised, monitored and managed. Oversight of parastatals is central to infrastructure service provision and debt sustainability.

Undertake careful investment planning. Infrastructure projects should be selected as the outcome of a socially transparent and technically optimised planning process that identifies the most cost-effective solutions. Given complementarities and technological convergence between different types of infrastructure, the planning process needs to be coordinated across sectors with synchronisation of implementation timelines to ensure that projects function effectively. Infrastructure planning should incorporate stress testing to ensure that projects are climate-resilient.

Strengthen procurement frameworks. Competitive procurement is essential to ensure a favourable balance of cost and quality, and to promote innovation. Ideally, international competitive bidding promotes the widest possible field. At the same time, adopting transparent and competitive procurement procedures helps to secure value for money and improves public legitimacy, safeguarding against corruption. Direct negotiation, or sole source procurement, particularly for large projects, should be avoided.

Ensure financial and operational sustainability. Infrastructure projects are long-lived, necessitating attention to financial and operational sustainability after the construction phase. Financial modelling is therefore a critical part of project preparation and should be underpinned by projections of demand grounded in the reality of local and international markets. Financial flows must be adequate to cover both debt service and ongoing maintenance to sustain service provision. This, in turn, requires that tariffs are set at cost recovery levels, or that any shortfalls can at least be reliably covered by fiscal transfers. Beyond financial resources, operational sustainability also calls for adequate human resources and capacities.

Improve environmental, social and broader governance. Infrastructure projects carry major environmental and social risks. Safeguarding against these calls for a sound legislative and regulatory framework, as well as the requisite technical and institutional capacity to ensure that these are adequately enforced.

References

Afreximbank (2024) *Annual Report 2025. African Trade in a Changing Global Financial Architecture*. Cairo. (https://www.bing.com/search?q=afreximbank%20annual%20report%202025&qs=n&form=QBRE&sp=-1&lq=0&pq=afreximbank%20annual%20report%202025&sc=12-30&sk=&cvid=6319C86A287F4C64A1DE16FE8574DAE7).

Africa Intelligence (2023) 'Ethiopian shipping lines loses monopoly as Abiy liberalises logistics sector'. Website, 3 February. (https://www.africaintelligence.com/eastern-africa-and-the-horn/2023/02/03/ethiopian-shipping-lines-loses-monopoly-as-abiy-liberalises-logistics-sector,109909919-ar2).

All Africa (2011) 'Ghana: Bui project needs additional U.S.$168 million funding'. Website, 1 March (https://allafrica.com/stories/201103021063.html).

Baraka, C. (2021) *Kenya's first smart city promised everything. 13 years on, it's still a construction site, Rest of World* (https://restofworld.org/2021/the-failed-promise-of-kenyas-smart-city/).

Boston University Chinese Loans to Africa Database (2024) (https://www.bu.edu/gdp/chinese-loans-to-africa-database/).

Bhamidipati, P.L. and Hansen, U.E. (2021) 'Unpacking local agency in China–Africa relations: Frictional encounters and development outcomes of solar power in Kenya' *Geoforum*, 119: 206–217 (https://doi.org/10.1016/j.geoforum.2020.12.010).

Brautigam, D. (2020) 'A critical look at Chinese "debt-trap diplomacy": the rise of a meme' *Area Development and Policy*, 5(1), pp. 1–14 (https://doi.org/10.1080/23792949.2019.1689828).

Brautigam, D. (2022) 'China and Zambia: creating a sovereign debt crisis' *International Affairs* 98(4): 1347–1365 (https://doi.org/10.1093/ia/iiac109).

Brautigam, D., Bhalaki, V. and Deron, L. (2022) 'How Africa borrows from China: and why Mombasa Port is not collateral for Kenya's standard gauge railway'. Policy Brief 62. Washington, DC: SAIS China Africa Research Initiative (CARI).

Bui Power Authority (2024) 'Bui Generating Station'. Website (https://buipower.com/bui-hydro-project/).

Business Daily (2020) 'SGR allocated Sh.15.5 billion 'subsidy' for operations.', December 20th, Nairobi. (https://www.businessdailyafrica.com/bd/economy/sgr-allocated-sh15-5bn-subsidy-for-operations-2139694).

Calabrese, L. and Chen, Y. (2024) 'FOCAC 2024: a revival of China-Africa relations'. London: ODI Global, Think change (https://odi.org/en/insights/focac-2024-a-revival-of-china-africa-relations/).

Carmody, P., Taylor, I. and Zajontz, T. (2021) 'China's spatial fix and "debt diplomacy" in Africa: constraining belt or road to economic transformation?' *Canadian Journal of African Studies / Revue canadienne des études africaines* 0(0): 1–21 (https://doi.org/10.1080/00083968.2020.1868014).

Carrai, M.A. (2021) 'Adaptive governance along Chinese-financed BRI railroad megaprojects in East Africa' *World Development*, 141 (May): 105388 (https://doi.org/10.1016/j.worlddev.2020.105388).

Chatham House (2023) 'Kenya's debt struggles go far deeper than Chinese loans'. Website, 23 May (https://www.chathamhouse.org/2023/05/kenyas-debt-struggles-go-far-deeper-chinese-loans).

Chen, Y. (2018) 'Comparing North-South technology transfer and South-South technology transfer: the technology transfer impact of Ethiopian Wind Farms' *Energy Policy* 116: 1–9 (https://doi.org/10.1016/j.enpol.2017.12.051).

Chen, Y. (2020) 'Railpolitik: the strengths and pitfalls of Chinese-financed African railways' (https://pandapawdragonclaw.blog/2020/03/16/railpolitik-the-strengths-and-pitfalls-of-chinese-financed- african-railways/).

Chen, Y. (2021) *Laying the tracks: the political economy of railway development in Ethiopia's railway sector and implications for technology transfer*. GCI Working Paper 014. Boston University Global Development Policy Center, p. 25.

Chen, Y. (2024) 'Technology transfer on the Belt and Road: pathways for structural transformation in Ethiopia's standard gauge railways' *The European Journal of Development Research* [Preprint] (https://doi.org/10.1057/s41287-023-00610-z).

Chen, Y. and Emery, T. (2025) *Greener on the other side? Mapping China's overseas co-financing and financial innovation*. Report. London, UK: ODI Global (https://odi.org/en/publications/greener-on-the-other-side-mapping-chinas-overseas-co-financing-and-financial-innovation/).

Chen, Y. and Hart, T. (2025) 'Common framework, uncommon challenges: lessons from the post-COVID debt restructuring architecture'. London: ODI Global, Think Change, 21 February (https://odi.org/en/insights/common-framework-uncommon-challenges-lessons-from-the-post-covid-debt-restructuring-architecture/).

Chen, Y. and Liu, Z.Z. (2023) *Hedging Belts, De-risking Roads: Sinosure in China's overseas finance and the global challenge and response*. Report. London: ODI Global.

Chimits, F., Ghiretti, F. and Stec, G. (2023) 'EU: De-risking as the new mantra for defining relations with China.' Mercator Institute for China Studies (MERICS), July 27th, Berlin. (https://merics.org/en/eu-de-risking-new-mantra-defining-relations-china).

China Daily (2023) 'China to strengthen digital cooperation with African countries'. The State Council of the People's Republic of China (https://english.www.gov.cn/news/202310/20/content_WS653213d0c6d0868f4e8e0799.html).

China Internet Network Information Center (2023) *The 51st Statistical Report on China's Internet Development*. Beijing: China Internet Network Information Center (CNNIC) (www.cnnic.com.cn/IDR/ReportDownloads/202307/P020230707514088128694.pdf).

China Lusophone Brief (2018) 'Angolan government prepares privatization of railways'. China Lusophone Brief, 9 October (https://www.clbrief.com/angolan-government-prepares-privatization-of-railways/).

Corkin, L., Burke, C. and Davies, M. (2008) 'China's Role in the Development of Africa's Infrastructure'. *SAIS Working Papers in African Studies*, p. 21.

CPCS – Canadian Pacific Consulting Services (2009) *The East African Railways Master Plan – Final Report*. East African Community.

Custer, S. et al. (2023) 'Tracking Chinese development finance: an application of AidData's TUFF 3.0 Methodology'. Williamsburg, VA: AidData at William & Mary.

Dreher, A., Fuchs, A., Parks, B., Strange, A.M. and Tierney, M.J. (2017) *Aid, China, and growth: evidence from a new global development finance dataset*. AidData Working Paper 46. Williamsburg, VA: AidData at William & Mary.

Engel, L. et al. (2024) 'Relative Risk and the Rate of Return'. GCI Policy Brief 023, 08/2024, Global China Initiative, Global Development Policy Centre, Boston University, Boston. (https://www.bu.edu/gdp/files/2024/08/GCI-PB-23-CLA-2024-FIN.pdf).

Euronews (2024) 'Ongoing African drought has plunged Zambia into daily blackouts as hydroelectric dam unable to run'. Website, 14 October (https://www.euronews.com/green/2024/10/14/ongoing-african-drought-has-plunged-zambia-into-daily-blackouts-as-hydroelectric-dam-unabl).

Fernandez, J.A., Xu, B. and Zhou, D. (2018) 'China's Digital Revolution' *The LINK*, 3 (www.ceibs.edu/alumni-magazine/china%E2%80%99s-digital-revolution).

FOCAC – Forum for China-Africa Cooperation (2023a) 'China-proposed BRI provides solid platform for international cooperation: Symposium speakers' (www.focac.org/eng/zfzs_1/202308/t20230829_11134482.htm).

FOCAC (2023b) 'Angolan president praises Chinese-built hydropower station for its socioeconomic contribution', 22 May 2022 update (www.focac.org/eng/zfgx_4/jmhz/202305/t20230522_11080964.htm).

Foster, V. and Briceno-Garmendia, C. (2010) *Africa's infrastructure: a time for transformation: a time for transformation*. World Bank (https://openknowledge.worldbank.org/handle/10986/2692).

Furness, M. and Keijzer, N. (2022) 'Europe's Global Gateway: A new geostrategic framework for development policy?' IDOS (German Institute for Development and Sustainability) Briefing Paper 01/2022, Berlin. (https://doi.org/10.23661/bp1.2022).

Gagliardone, I. (2016) *The politics of technology in Africa: communication, development, and nation- building in Ethiopia*. Cambridge University Press.

Gagnon et al. (2002) 'Comparing recommendations from the World Commission on Dams and the IEA initiative on hydropower' *Energy Policy* 30 (14): 1299–1304.

GEM – Global Energy Monitor (2024) 'China continues to lead the world in wind and solar, with twice as much capacity under construction as the rest of the world combined'. Policy Briefing (https://globalenergymonitor.org/wp-content/uploads/2024/07/GEM-China-wind-solar-brief-July2024).

Gocking, R. (2020) 'Ghana's Bui dam and the contestation over hydropower in *Africa' African Studies Review* 64(2), June: 339–362 (https://doi.org/10.1017/asr.2020.41).

Grigorian, D. and Bhayana, A. (2024) 'Zambia: a case study of sovereign debt restructuring under the G20 Common Framework'. Working Paper 707, Centre for Global Development, Washington DC (https://www.cgdev.org/sites/default/files/zambia-case-study-sovereign-debt-restructuring-under-g20-common-framework.pdf).

Hakeenah, N. (2023) Kenya's first Chinese-funded, built geothermal energy plant paves way for more similar projects. The China-Global South Project (https://chinaglobalsouth.com/2023/06/01/kenyas-first-chinese-funded-built-geothermal-energy-plant-paves-way-for-more-similar-projects/).

Haroz (2011) 'China in Africa: Symbiosis or exploitation?' The Fletcher Forum of World Affairs, 05/15, Charlotte. (https://www.tandfonline.com/doi/abs/10.1080/02589001.2011.555192).

Heeks, R. et al. (2024) 'China's digital expansion in the Global South: systematic literature review and future research agenda' *The Information Society* 40(2): 69–95 (https://doi.org/10.1080/01972243.2024.2315875).

Hensengerth, O. (2011) *Interaction of Chinese institutions with host governments in dam construction: the Bui dam in Ghana*. Discussion Paper 3. Bonn: Deutsches Institut für Entwicklungspolitik.

Higgins, V. (2015) *Alliance capitalism, innovation and the Chinese state*. London: Palgrave Macmillan UK (https://doi.org/10.1057/9781137529657).

ICA – Infrastructure Consortium for Africa (2014) *Infrastructure financing trends in Africa – 2014*. ICA Secretariat, African Development Bank.

ICA (2018) *Infrastructure financing trends in Africa – 2017*. ICA Secretariat, African Development Bank.

IEA (2023) *World Energy Outlook* – 2023. Paris

IHA – International Hydropower Association (2021) *Hydropower status report sector: trends and insights* (www.hydropower.org/publications/2021-hydropower-status-report).

IRJ – International Railway Journal (2021) 'Kenya railways to end SGR contract with Afristar' *International Railway Journal*, Blog, 12 March (https://www.railjournal.com/news/kenya-railways-to-end-sgr-contract-with-afristar/).

IRJ (2022) 'Ethiopia-Djibouti railway records 37.5 percent increase in revenue', IRJ, 12 January. (https://hiiraan.com/news4/2022/Jan/185109/ethiopia_djibouti_railway_records_37_5_increase_in_revenue.aspx).

IRJ (2024) 'Kenya secures more Chinese financing for standard gauge railway, IRJ, 21 May. (https://www.railjournal.com/freight/kenya-secures-more-chinese-funding-for-standard-gauge-railway/).

International Telecommunication Union (no date) 'ITU Datahub' (https://datahub.itu.int/).

Jili, B. (2022) 'Chinese ICT and Smart City Initiatives in Kenya' *Asia Policy* 17(3): 40–50.

Ker, M. (2017) *China's high speed rail diplomacy*. Staff Research Report. US-China Economic and Security Review Commission, Washington D.C.

Kong'ani, L. N. S., Wahome, R. G., & Thenya, T. (2021). 'Variety and management of developmental conflicts: the case of the Olkaria IV geothermal energy project in Kenya.' *Conflict, Security & Development*, 21(6), 781–804. (https://doi.org/10.1080/14678802.2021.2000806).

Lin, Y., Qin, Y. and Xie, Z. (2021) 'Does foreign technology transfer spur domestic innovation? Evidence from the high-speed rail sector in China' *Journal of Comparative Economics* 49(1): 212–229 (https://doi.org/10.1016/j.jce.2020.08.004).

Liu, Z.Z. (2023) *Sovereign funds: how the Communist Party of China finances its global ambitions*. Cambridge, MA: Belknap Press.

Lobito Corridor Investment Promotion Agency (2024) 'The Lobito Corridor: what it is and why it matters'. Website, January (www.lobitocorridor.org/_files/ugd/9fa7ad_700894b8a8b9427faec094b5fbd0f5fc.pdf).

Lui, K. and Chen, Y. (2021) *The evolution of China's lending practices on the Belt and Road. Emerging Analysis*. London: ODI Global, p. 25.

Makena, L. (2023) *Discover Konza City in Machakos, Kenya: Africa's visionary smart city*. BuyRentKenya (www.buyrentkenya.com/discover/konza-city-silicon-savannah).

Marquis, C. and Qiao, K. (2022) *Mao and markets: the communist roots of Chinese enterprise*. Yale University Press.

MINTRANS (2019) 'Study for National Transport Sector Master Plan and preliminary feasibility study on the railway link between CFB and Zambia'. (https://studylib.net/doc/25965166/angola---study-for-national-transport-sector-master-plan-).

myNEWS (2024) 'China hands over the keys to the railway as African countries take control of 2 major belt and road projects'. Website, 7 June (https://www.scmp.com/news/china/diplomacy/article/3264793/china-hands-over-keys-railway-african-countries-take-control-two-major-belt-and-road-projects).

Nyabiage, J. (2025) 'China turns to PPPs as a "yellow brick road" solution to fund big projects in Africa'. |South China Morning Post, 18 May (https://www.chinastrategy.org/2025/05/18/china-turns-to-ppps-as-a-yellow-brick-road-solution-to-fund-big-projects-in-africa/).

Parks, B.C. et al. (2023) *Belt and Road Reboot*. Williamsburg, VA: AidData.

Power Technology (2014) 'Power plant profile: Bui dam, Ghana'. Updated 10 February (www.power-technology.com/projects/bui-dam-hydro-power-ghana/).

Power Technology (2024) 'Power plant profile: Gilgel Gibe III, Ethiopia'. Updated 21 October (www.power-technology.com/data-insights/power-plant-profile-gilgel-gibe-iii-ethiopia/).

Raina, A., Lawrence, M., Bullock, R., Budin, K.-J. and Olievschi, V. (2022) *Railways in developing countries: a global review*. Mobility and Transport Connectivity Series, Transport Global Practice. Washington, DC: World Bank (https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099515004292230157).

Reuters (2020) 'China plans to expand railway network to 200,000 km before 2035' (https://www.bing.com/search?q=Reuters+(2020)+'China+plans+to+expand+railway+network+to+200%2C000+km+before+2035'&cvid=90cda56e03a24b34a1502b702a3c2378&gs_lcrp=EgRlZGdlKgYIABBFGDkyBggAEEUYOTIHCAEQ6wcYQNIBBzc2OWowajSoAgCwAgA&FORM=ANAB01&PC=HCTS).

Rudyak, M. and Chen, Y. (2021) *China's lending landscape and approach to debt relief. Emerging Analysis*. ODI Global, p. 17 (https://cdn.odi.org/media/documents/ODI_emerging_analysis_Chinas_lending_landscape_and_approach_to_debt_relief_Oct_BKPn1Ix.pdf).

Shen, W. and Power, M. (2017) 'Africa and the export of China's clean energy revolution' *Third World Quarterly* 38(3): 678–697 (https://doi.org/10.1080/01436597.2016.1199262).

Shi-Kupfer, K. and Ohlberg, M. (2019) *China's digital rise: challenges for Europe*. Berlin: MERICS (https://merics.org/en/report/chinas-digital-rise).

Sunday, F. (2021) 'Queries as ministry takes over national fibre project from struggling Telkom'. *The Standard*, 28 February (www.standardmedia.co.ke/business/business/article/2001404817/queries-as-ministry-takes-over-national-fibre-project-from-struggling-telkom).

Taylor, I. (2020) 'Kenya's new lunatic express: the standard gauge railway' Africa Studies Quarterly, 19:3-4. China-Africa Relations: The Belt and Road Initiative and Impact on Africa, (https://journals.flvc.org/ASQ/article/view/136004).

The Economist (2018) 'Camel trains are holding up Ethiopia's new railway line'. The Economist, 10 February (https://www.economist.com/middle-east-and-africa/2018/02/10/camel-trains-are-holding-up-ethiopias-new-railway-line).

The National (2018) 'Kenya's dream tech city becomes a nightmare'. The National (https://www.thenationalnews.com/business/economy/kenya-s-dream-tech-city-becomes-a-nightmare-1.804768).

Transport, Public Works and Housing (Kenya) (2020) *Report inquiry into the use of standard railway gauge for the National Assembly (12th Parliament, Fourth Session*). Republic of Kenya, September.

Tugendhat, H. and Voo, J. (2021) *China's digital Silk Road in Africa and the future of internet governance*. Working Paper 50. Washington, DC: China Africa Research Initiative (CARI), School of Advanced International Studies (SAIS), Johns Hopkins University.

US Department of State (2024) 'Lobito Corridor expansion and US infrastructure on the African continent'. Digital Press Briefing, 28 August (https://2021-2025.state.gov/digital-press-briefing- lobito-corridor-expansion-and-u-s-infrastructure-on-the-african-continent-2/).

van Wieringen, K. and Zajontz, T. (2023) 'From loan-financed to privatised infrastructure? Tracing China's turn towards public–private partnerships in Africa' *Journal of Current Chinese Affairs* 52(3): 434–463 (https://doi.org/10.1177/18681026231188140).

Wang, Y. (2023) 'Struggle to reconstruct: a railway of neglect' in *The railpolitik: leadership and agency in Sino-African infrastructure development*. Oxford Academic, 14 December.

World Bank (2009) *Tracks from the past, transport for the future: China's railway industry 1990–2008 and its future plans and possibilities*. Washington, DC: World Bank (https://openknowledge.worldbank.org/handle/10986/3197).

World Bank Enterprise Surveys (2016) (https://www.enterprisesurveys.org/en/data).

World Commission on Dams (ed.) (2000) *Dams and development: a new framework for decision-making*. London: Earthscan (http://awsassets.panda.org/downloads/wcd_dams_final_report.pdf).

Wu, T. and Chen, Y. (2024) *China's creditor diversification in Africa: Impacts and challenges of infrastructure debt-financing by Chinese commercial creditors*. Working Paper. London: ODI Global (https://odi.org/en/publications/chinas-creditor-diversification-in-africa-impacts-and- challenges-of-infrastructure-debt-financing-by-chinese-commercial-creditors/).

Xinhua (2024) '(FOCAC) (2024) Full text: Keynote address by Chinese President Xi Jinping at opening ceremony of 2024 FOCAC summit. Xinhuanet (https://english.news.cn/20240905/e898a78004754f229763ad2bb5be7aa3/c.html).

Xue, X. and Larsen, M. (2025) 'China's green leap outward: the rapid scaleup of overseas Chinese clean-tech manufacturing investments'. Geopolitical Brief. Net Zero Industrial Policy Lab.

Zhou, Y. Miao, Z. and Urban, F.. (2020) 'China's leadership in the hydropower sector: Identifying green windows of opportunity for technological catch-up.' *Industrial and Corporate Change*, 29(5), October: 1319–1343 (https://doi.org/10.1093/icc/dtaa039).

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