

China's role for Africa's energy transition: a critical review

State of knowledge paper

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Introduction

Many countries in the sub-Saharan Africa (SSA) region face multiple challenges in the transition to a modern and sustainable energy system. At the outset, there is a severe shortage of energy supply after a decade of fast-growing economic activity in many SSA countries. Currently over 55% of the population, or 635 million people, still lack access to electricity (International Energy Agency (IEA), 2016). In the past decade, *per capita* electricity consumption in SSA actually decreased from 520 kwh to 484 kwh, leading to a widening gap with both developed and other developing countries (World Bank database, 2019). Even within the areas that do have energy supply, the quality of the service is often low and unreliable, with frequent power cuts that are crippling industrial and service sectors. According to the World Economic Forum (WEF), the quality of the electricity system in most SSA countries ranked below 100th in the world (Schwab and WEF, 2019). Although SSA is not a significant source of greenhouse gas emissions, the widespread use of biomass such as straw, wood, and animal waste for cooking and heating, and diesel engines for agricultural energy use, has caused various mainly local environmental and health concerns. Only 15% of the population have access to clean cooking facilities and technologies, and the reliance on biomass has exacerbated deforestation and desertification problems (Schlag and Zuzarte, 2008). In addition, the indoor air pollution caused by these activities claims millions of lives each year (World Health Organization, 2018). As a result, energy transition in SSA means promoting and managing urgent and multi-dimensional transformations of energy access, reliability, and sustainability almost simultaneously, which impose tremendous political, financial, and technological challenges that go beyond the capabilities of many SSA countries.

The SSA region has enormous potential for various traditional and renewable energy resources (IEA, 2014; Schwerhoff and Sy, 2016; Wu *et al.*, 2017); the question is: who can work with African governments and the private sector to tap these potentials by overcoming technological and financial barriers? In the past two decades, China has emerged as a major player in Africa's energy sector, along with traditional Western donors and international organisations. Under the banner of a 'going out' strategy since mid-1990s, and the Belt and Road Initiative (BRI) more recently, Chinese national oil corporations (NOCs) and state-owned enterprises (SOEs) are actively involved in various energy subsectors in SSA, participating in nearly all segments of the energy production chain: from extraction and energy generation, to energy transmission and distribution. Chinese activities come in different forms, ranging from greenfield investment, turn-key projects, construction contracting, or technology supply. These activities are often backed by large policy banks, such as China Eximbank (CHEXIM), China Development Bank (CDB), and other development finance institutions, through various instruments including massive concessional loans, export credit, and equity finance. The IEA estimated that between 2010 and 2015 over 30% of newly added electricity capacity in the SSA region was provided by Chinese contractors, who also added at least 28,000 km of transmission lines (IEA, 2016). This trend is likely to continue in coming decades.

The fast expansion of Chinese involvement in Africa's energy sector has attracted tremendous academic and public attention. Various recent studies concentrate on the impacts and implications of China's growing presence in Africa's energy development, using multiple analytical lenses. At macro (global) level, the discussion often focuses on the geopolitical implications of Chinese overseas energy activities in Africa, particularly contextualised in a broader debate about China as a rising power shaping the *status quo* of global energy security, governance institutions and rules, and power structures with the traditional players (Alden, 2005; Taylor, 2007). At meso (national) level, the effect of these activities on host governments in SSA, particularly regarding their impacts on debt sustainability and national energy pathways are the key areas for debate (Alden and Jiang, 2019; Onjala, 2018). At micro (project) level, the impact of these activities on local environment and communities is the centre of analysis, as the lion's share of Chinese projects goes to fossil fuel industries or large hydro power stations that have a significant environmental footprint (Bosshard, 2009; Monasterolo *et al.*, 2018). In addition, the decision making processes around Chinese projects are not inclusive and transparent, which has led to concerns about these activities' long-term impact on the local natural and social environment (Cooke *et al.*, 2016; Yankson *et al.*, 2015).

This article will review these literatures to understand the current debates around China's involvement in and contribution to Africa's urgently needed energy transition. It tries to provide an answer regarding the ways in which Chinese government actors, investors, financiers, and project developers are shaping the transition pathways in various SSA countries. It also helps to identify issue areas that require further investigation.

Boundary and framework of the review

China's involvement in Africa's energy sector and its critics can be roughly divided into two stages. The first stage is characterised by China's massive investment in the crude oil sector since late 1990s, which is mainly driven by China's fast-growing domestic demand for energy and natural resources, after decades of break-neck economic and industrial development (Alden, 2005; IEA, 2000; Zweig and Jianhai, 2005). China became a net oil importer in 1993 and since then its NOCs have been actively seeking to maintain energy security by diversifying oil imports from different regions, including SSA. China engaged major oil supply countries in Africa including Nigeria, Sudan, and Angola (Andrews-Speed and Dannreuther, 2011; Brookes, 2007; Downs, 2004; Lieberthal and Herberg, 2006; and many others), and by 2010 over 28% of China's oil imports were from these countries. The academic debate and criticism at this stage mainly focused on the issues of geopolitical impact and changing foreign relations with the West, and particularly the US; the highly controversial so-called resource-credit swap model, where loans were repaid in local products and primary goods including shipments of coal and oil; and the dubious impacts of Chinese investment on African countries' domestic problems, such as corruption, transparency, and social-environmental impacts. Beijing is therefore often viewed as a 'new colonist' or 'new imperialist' that exploits Africa's vast natural and energy resources only for its own benefit and continuous economic growth at home, without any consideration for improvements to these countries' security (for example in Sudan), national governance, and local communities' social welfare (Downs, 2004). Many researchers, however, believe that most of these claims lack strong supporting evidence (Brautigan, 2011a; Downs, 2004; Dreher and Fuchs, 2012).

Most of these debates remain unresolved and became arguably less relevant as China's investment in Africa's crude oil sector has been decreasing. Oil imports from SSA fell to around 15% in 2018 (National Statistical Bureau, 2019) with Angola as the only major African oil exporter to China. This is mainly due to rising imports from Russia and other regions in the past decade. Instead, Chinese involvement in Africa's energy sector has entered a new stage, which is characterised by a large number of activities around electricity generation and transmission infrastructures. Although there is not yet any authoritative database to reveal the exact scale of China's role in these activities, the IEA estimates that over 120 power plants and grid expansion projects across the African continent have seen significant Chinese involvement since 2010, and more are in the pipeline (IEA, 2016). These Chinese energy infrastructure projects sparked another round of debates among academics, practitioners and the general public regarding the role and impact of Chinese finance and technology on African countries' economic, social, and environmental development, which is the main focus of this review.

The rationale for conducting this review is threefold. First, given that the Chinese government is not releasing any official information on these activities, the exact scale and size of Chinese activities in Africa's energy sector remains uncertain. In the past decade, researchers have adopted various methodologies to identify ongoing and potential projects, and several comprehensive databases have been established based on different energy sources, transaction models, and time periods, which need to be systematically reviewed and compared to verify information and identify existing gaps. Second, there is a burgeoning literature on the role and practices of various Chinese actor groups and institutions, particularly around China's distinctive policy banks and large SOEs, yet it remains largely unclear how the governance system or decision making process actually functions, and how these institutions interact within China, and engage with African institutions, to select, design, negotiate, finance, and implement specific projects. These negotiations and interactions within China and with recipient countries are often obscured to outside view due to the exclusive nature of the processes on both sides. Lastly, many discussions focus on the

environmental, social, and economic impacts of Chinese energy infrastructure activities, yet most studies are based on individual case studies of specific projects, which need to be reviewed comprehensively to identify general trends and implications. Consequently, this review will be organised to focus on these three issues, namely the database, governance, and impacts. Both academic and grey literature are examined as it is noted that many updated studies on Chinese energy activities in Africa are published as research reports and working papers.

Chinese energy infrastructure in Africa: how big is the picture?

It is very difficult to give a precise estimation regarding the overall statistics on Chinese energy infrastructure in Africa for several reasons. First, no official data is available from the Chinese government and banks, as the portfolio of Chinese overseas projects is still treated as classified information in China. This problem is particularly acute regarding potential projects that are still being negotiated (often behind the closed doors). In addition, it is also uncommon for the recipient governments of Chinese financing to fully disclose transaction and financing details. As a result, acquiring official information from either end is notoriously difficult. Secondly, there are various types of 'Chinese' project, in the forms of either direct or equity investors, project developers, contractors, or technology suppliers. Some of these activities are not financed in line with traditional definitions of OECD-DAC categories (Bräutigam, 2010 and 2011b). It is highly challenging to include different types of activities within a single dataset. Lastly, the information from media reports and coverage on Chinese energy activities in Africa is often incorrect, as some reported projects are either non-existent, abandoned, or taken up eventually by a non-Chinese organisation (Hwang *et al.*, 2015). Therefore, the various attempts to estimate Chinese aid and loans result in wide variance (Bräutigam, 2011b; Lum *et al.*, 2009; Strange *et al.*, 2013a).

Despite these challenges, many researchers in the past decade have collected and validated information on Chinese energy projects by adopting different methodologies for identifying and filtering information via various channels and sources. Several comprehensive and authoritative databases were established including information on specific energy subsectors, recipient countries, transactional models, and financial instruments. In this section, these databases and methodologies are reviewed with a discussion of their advantages and limitations.

AidData

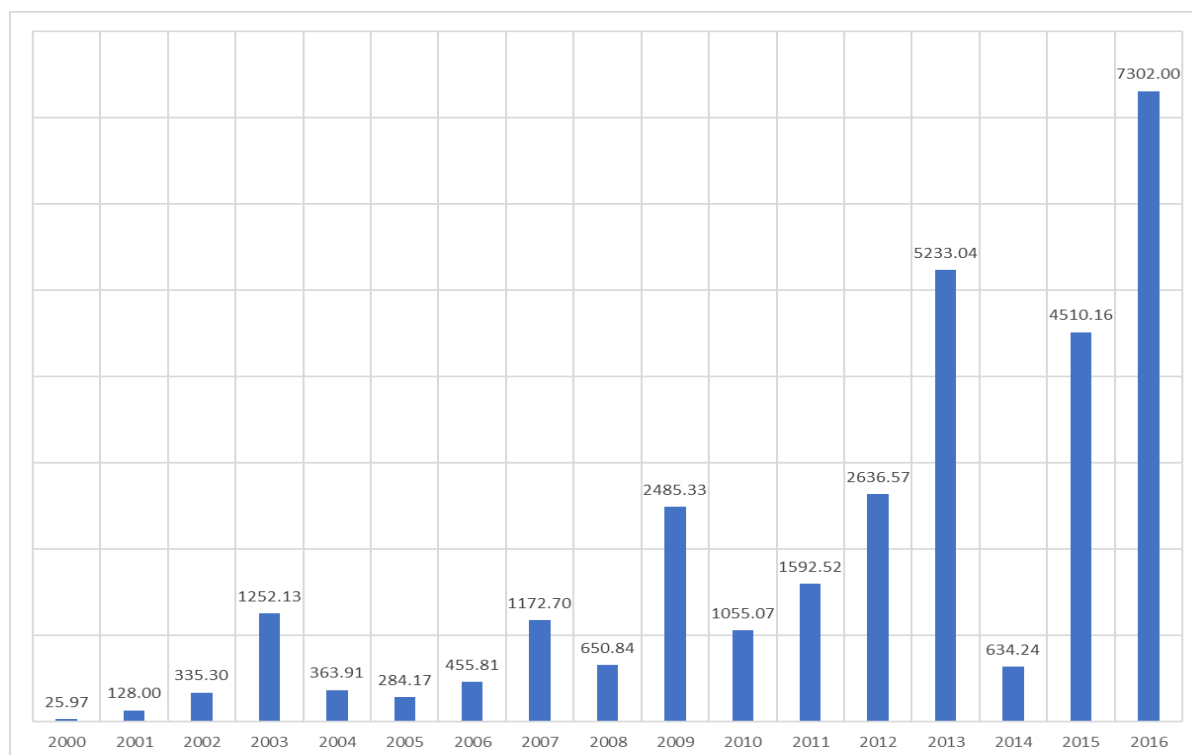
AidData was first developed in 2009 as a research and innovation lab located at the College of William and Mary. It is one of the largest databases covering various types of foreign aid provided by both bilateral and multilateral donors with project-level information (Tierney *et al.*, 2011). In 2013, it released its first database on Chinese-backed aid projects from 2000 to 2011, which includes information on 1,673 projects in 50 African countries with over US\$ 75 billion in commitments of official finance (Strange *et al.*, 2013a). The database is based on a Media-Based Data Collection (MBDC) methodology that gathers and standardises project-level information with two stages of data processing (Strange *et al.*, 2013a; 2013b). In the first stage, relevant projects are identified through a coded search via Factiva, a Dow Jones-owned media database. In stage two, once these projects are targeted, refined research is conducted through public search engines to extract valuable information on the projects (Strange *et al.*, 2013b). This two-stage investigation aims to avoid duplication and incorrect project information by triangulation among various information sources. This methodology was later revised and relabelled as the tracking underreported financial flows (TUFF) method (Strange *et al.*, 2014; 2017a), which is designed to mitigate many of the risks associated with using media sources to collect data. The most updated version of the TUFF methodology includes machine-learning software and adds other information sources, such as Chinese embassy reports, for project identification in stage 1 (Strange *et al.*, 2017b). TUFF also added a third stage of quality control that seeks to identify and eliminate potential errors, biases, and data holes wherever possible (Strange *et al.*, 2017b).

AidData China is a massive database that includes all the Chinese official development assistance (ODA) and non-ODA projects around the globe, plus those activities that are hard to categorise. The current version of the database includes 100 Chinese energy infrastructure projects (48 ODA projects, 32 non-ODA projects, and 20 unidentified projects) in Africa (AidData, 2019), with the total commitment of more than US\$ 25.5 billion (as some projects' value remain unidentified). There is no subcategory for different energy sources or transaction types, such as between fossil fuels and renewables, or between power generation and transmission projects. However, such information can be obtained from the project descriptions under each project code if needed. AidData China also differentiates projects that are already completed or still in their implementation stages. Yet it contains no information on current outstanding payment under each project and loan facility. The other limitation is that this database does not cover any activities contracted before 2000, some of which may be as long ago as 25 or even 30 years and still within repayment periods. Hence, while the database can roughly illustrate the aggregate amount of Chinese lending in the energy sectors since 2000, it cannot provide accurate 'snapshots' of current outstanding liability with particular countries or debtors. Last, the accuracy of the information is often questionable as there are omissions and duplicate projects, and others simply do not exist due to various reasons, such as when reported project plans were later cancelled.

China–Africa Research Initiative (CARI) Loan Financing Database

Launched in 2014, the China–Africa Research Initiative (SAIS-CARI) is based at the Johns Hopkins University, and CARI's China–Africa Loan Finance Database was developed in order to build a highly reliable source of data that can be used to better understand the scope, nature, and modalities of China's loan finance (CARI, 2019). One of distinctive features of this database is that its methodology relies heavily on process tracing to track projects from initial reports to completion by using in-country contacts and field visits as opportunities to update and verify information (Bräutigam and Hwang, 2019b). This method largely improves the reliability of the datasets, compared to those that are developed almost entirely through distant desktop research. CARI's methodology also uses both Chinese and African official and unofficial online sources as complements to standard investigation through Western media sources, which makes the work 'more akin to investigative reporting or detective work than accounting' (CARI, 2019). The CARI's database is said to be based on a more stringent scrutinisation process. For example, in one working paper on Chinese hydro power stations, it is noted that only 17 out of 51 hydropower projects reported by AidData and International Rivers involve actual commitment from Chinese banks (Hwang *et al.*, 2015).

According to this database, total Chinese finance to Africa's energy sector between 2000 and 2016 amounted to US\$ 30.12 billion. There is a dramatic but non-linear growth trend in Chinese activities throughout these years (Figure 1). The top ten destination countries for Chinese financing are Angola (US\$ 1.54 billion), Botswana (US\$ 0.83 billion), Cote d'Ivoire (US\$ 1.27 billion), DRC (US\$ 1/04 billion), Ethiopia (US\$ 2.55 billion), Ghana (US\$ 2.24 billion), Nigeria (US\$ 1.14 billion), Sudan (US\$ 2.89 billion), Tanzania (US\$ 1.16 billion), and Uganda (US\$ 1.93 billion).

Figure 1. Chinese development finance in energy sectors in Africa (US\$, millions)

Source: CARI China–Africa Loan Finance Database

One of the limitations of this database is that there is no breakdown of project types and specific energy sources, and each entry contains little descriptive information compared to AidData. It covers only power generation activities, whereas power transmission and distribution lines are not included. CARI have separate datasets for Chinese ODA and foreign investment, but with no sectoral breakdown, so it is difficult to estimate the percentage of different energy sources in these types of activities. Like AidData, the current CARI database does not include any project information before 2000, and it does not provide information on the repayment of loans under each transaction. Therefore, the database cannot reveal current outstanding liability of Chinese loans for individual recipient countries, sectors, or projects.

The China Global Energy Finance database

The China Global Energy Finance database is based at Boston University, and it tracks and displays Chinese overseas development finance in the energy sector provided by China's two policy banks – CDB and CHEXIM. It is the only database focusing solely on energy activities, including both extractive and electricity sectors. It is noted that this database shares its data collection methodology and data with CARI's database (Ma *et al.*, 2019) mentioned above. The datasets are available only in the format of interactive webpages without any downloadable file, as the master file is kept in-house. One of the biggest advantages of this database is its subcategories based on various energy sources (coal, hydro, wind, solar, and others) and project types (extraction, energy efficiency, power generation, transmission, etc). According to this database, the total Chinese finance to Africa's energy sector between 2000 and 2018 amounted to US\$ 41.6 billion, which actually lagged behind other regions such as Latin America (US\$ 61.5 billion) and Asia (US\$ 64.2 billion). However, the percentage of China–Africa finance increased dramatically from around 7% of total finance each year between 2008 and 2012, to 55% in 2018 (Ma *et al.*, 2019).

The database only includes two Chinese policy banks, CDB and CHEXIM, which are believed to be the major engines behind Chinese overseas energy activities and provide more development finance than the World Bank and its counterparts (Gallagher, 2018). The finance provided by other Chinese commercial banks and ODA loans is not included. The database also illustrates that, currently, Chinese energy financing in Africa

still concentrates on coal-fired and large hydro power stations, but it has tremendous potential to support cleaner energy technologies, given their more flexible financial models (Cabr  *et al.*, 2018; Gallagher, 2018).

Other databases and sources

The China Global Investment Tracker (CGIT), based at the American Enterprise Institute, focuses on China's global investment and construction activities. The database has an interactive webpage with downloadable dataset, which includes 3,100 large transactions across energy, transportation, real estate, and other industries since 2005. It reveals little of its methodology and its estimate of Chinese energy activities in Africa is much bigger than that of the previous databases, amounting to US\$ 96.54 billion between 2005 and 2019 (CGIT).

Besides the abovementioned databases, researchers at the University of Cape Town's Power Futures Lab have an in-house database on Chinese-funded power generation projects larger than 5 MW in SSA, based on their decade-long primary and secondary research (Eberhard *et al.*, 2016 and 2017). The secondary sources include World Bank databases, the Private Participation in Infrastructure database, Energy Information Administration (EIA), AidData, CARI's database and the OECD, among others. Primary data is collected from regulators in the recipient governments, and Chinese contractors. This database documented a total of 78 projects amounting to US\$ 44 billion and 23 GW power generation capacity, among which hydropower took 51% and coal-fired power stations took 39%. Viewed alongside the IPP database that similarly tracks investment in utility-scale private power projects, it is clear that China has quickly become the most prominent funder of power generation projects in SSA.

To sum up, despite tremendous academic efforts being exerted to precisely estimate Chinese overseas energy activities in Africa, the wide range of estimations from different databases (from around US\$ 25 billion to over US\$ 96 billion) illustrates that there is still tremendous potential to further improve these estimations. The recent methodology in data collection indicates two notable trends. One is reliance on machine learning and big data technology to expand online searching capability to identify unreported projects (AidData, 2017); the other is to combine data collection with fieldwork and visits to stakeholders in China and recipient countries to verify different projects through first-hand information (Br utigam and Hwang, 2019b). Both techniques are needed to avoid omission and erroneous project information from different open public sources from China, recipient countries, and internationally.

Another significant limitation among all the databases is that they can only provide a cumulative estimation of Chinese finance, and cannot reveal current outstanding liability. Considering that some of these loans were contracted in the early 2000s, there can be a significant gap between total commitment and outstanding amount. For example, CHEXIM's annual report in 2017 calculates only RMB 417.56 billion (roughly US\$ 60 billion) as outstanding liability for its buyer and seller credit loans around the world (CHEXIM, 2018). Outstanding liability is more relevant to evaluate the crucial impacts of Chinese finance, such as the debt service in the recipient countries, and Chinese institutions' current priority SSA countries and sectors for investment.

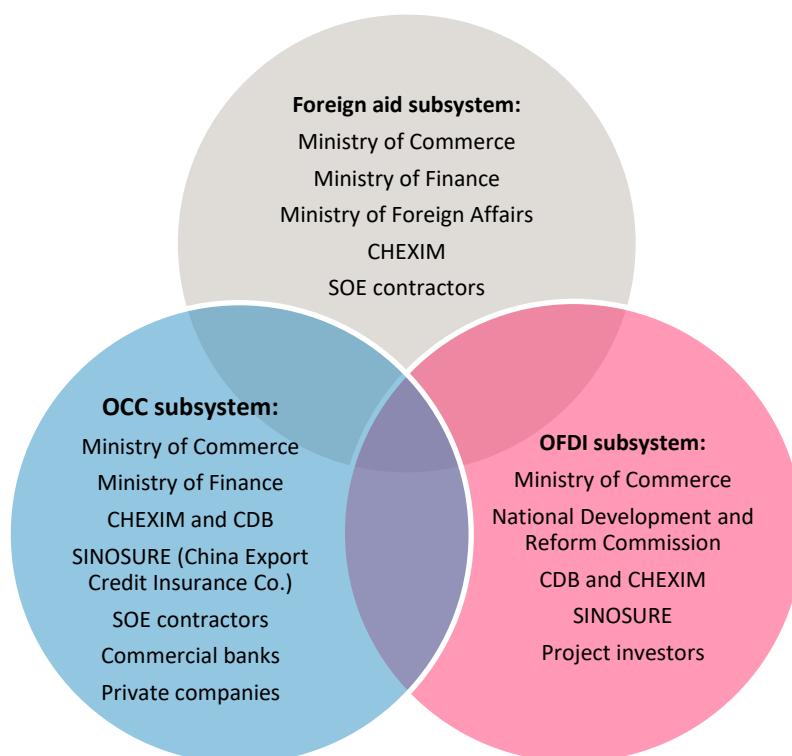
Lastly, none of the databases cover activities around Chinese energy equipment exports, which can play a significant role in Africa's energy transition. For example, Chinese solar panels dominate some SSA countries' local markets (Baker and Shen, 2017) highlighting China's contribution beyond the more notable roles of contractors, lenders or investors.

Governing Chinese overseas energy activities: actors and decision making processes

In China, the governance of overseas energy projects is situated in several regulatory subsystems overseeing foreign aid, overseas foreign direct investment (OFDI), and overseas construction contracts (OCC) respectively. All the databases analysed previously indicate that OCC is the most dominant project type. Each subsystem includes both core and peripheral actors ranging from government ministries and departments, development finance institutions, SOEs, and private companies. These regulatory subsystems function as enclosed and independent policy communities with intense interactions among their members that are often obscure to outsiders. Among these regulatory subsystems, foreign aid and OCC activities are relatively well studied (Bräutigam, 2011a and 2011b; Corkin, 2011; Lancaster, 2007; Tan-Mullings *et al.*, 2010; Varrall, 2016; Zhang and Smith, 2017) compared to OFDI activities (Abodohou *et al.*, 2018; Gopal *et al.*, 2018; Luo *et al.*, 2010; Tan, 2013). This is mainly because the majority of Chinese overseas energy activities in Africa are OCC and foreign aid projects. The actor maps of these three regulatory subsystems are illustrated below (Figure 2).

On the surface, there are notable overlaps of these regulatory subsystems, as many key organisations, such as the Ministry of Commerce (MOFCOM) and CHEXIM, are located in more than one subsystem. Yet previous studies illustrate that specific departments or operational units within these organisations are often in charge of specific types of activity (Zhang and Smith, 2017). For example, CHEXIM has dedicated departments for no-interest or concessional loans under the foreign aid subsystem, and another team for 'non-aid' loans (Bräutigam, 2011a). MOFCOM also set up dedicated departments on foreign aid, OCC and OFDI activities. As result, each subsystem is rather detached from the others and enjoys high levels of autonomy for strategic decisions and individual project approvals. In this section the roles of key ministries, financial institutions, SOEs, and other peripheral actors are reviewed.

Although MOFCOM is often treated as the key guardian ministry of Chinese overseas aid and investment activities (Corkin, 2011), other ministries' influence in the decision making processes cannot be overlooked, particularly that of the Ministry of Foreign Affairs (MOFA), Ministry of Finance (MOF), and National Development and Reform Commission (NDRC). Among these ministries, MOFA is a core member for overseeing foreign aid activities, which are viewed as an important instrument for promoting China's diplomatic relations with African countries (Tan-Mullins *et al.*, 2010). MOF is involved in both foreign aid and OCC subsystems because these activities are essentially funded by the state budget managed by MOF. Meanwhile, MOF is not involved in the OFDI subsystem, as these activities are driven mainly by private capital and funding. OFDI activities are actually regulated by NDRC within its Department of Inward and Outward Foreign Direct Investment.

Figure 2. Core members of Chinese foreign aid, OFDI, and OCT policy subsystems

Source: Bräutigam, 2011; Corkin, 2011; Luo *et al.*, 2010; Zhang and Smith, 2017

Key Ministries: coordination and struggles to serve national strategy

MOFCOM, as the key ministry involved in all three subsystems, has subtle relations with MOFA, MOF, and NDRC. Besides common struggles and competition over regulatory power and status (Corkin, 2011), these ministries often have different motivations and priorities. For example, the projects' contribution to the improvement of diplomatic relations is often MOFA's biggest concern, so MOFA officers usually care less about the economic viability of these activities. MOFA is the main organiser of the Forum on China–Africa Cooperation (FOCAC), the highest-level diplomatic platform for Chinese and African governments, established in 2006, which serves as the incubator for important bilateral aid and commercial projects (Taylor, 2010). Meanwhile, MOF, as 'the keeper of purse strings', is usually more risk averse and takes a more cautious and stringent attitude in scrutinising the financial viability of individual project activities and the overall portfolio (Zhang and Smith, 2017). As a result, MOFCOM has to balance these contrasted preferences in making policy and approving individual projects. MOFCOM also needs to prevent cutthroat competition among Chinese companies by hosting discussions between competitors in specific projects, recipient countries, or sectors. Despite these power struggles, these ministries in general share a common goal and vision of supporting the continuous expansion of Chinese overseas activities, which is also in line with China's grand 'going out' strategy or BRI. Some researchers conclude that they are just operational arms of the Chinese Communist Party (CCP), which is the ultimate commander of the overall strategy (Kong and Gallagher, 2017; Zhang and Smith, 2017).

However, it is noted that since late 2017 most of the OCC and OFDI project applications no longer require any approval from these ministries (State Council, 2017; MOFCOM, 2018; NDRC, 2017). According to the new policies, applications only need to be registered online with relevant ministries. Only those activities located in 'sensitive' countries, such as countries having no diplomatic relations with China, or 'sensitive' industries, such as cross-border water or hydropower projects, still require government approval. As a result, the decision making power of government ministries on individual projects is significantly weakened.

Previous studies indicate several other ministries that are also involved in policy-making processes, such as the State-owned Assets Supervision and Administration (SASAC), the People's Bank of China (the central bank, or PBC), the State Administration of Foreign Exchanges, etc. (Kong and Gallagher, 2017). However, it is noted that these government organisations are not responsible for the strategic planning of any subsystem, nor do they have significant influence on each project's approval. They are, rather, peripheral actors in the policy communities mentioned above. The newly established China International Development Cooperation Agency will be responsible for long-term strategy in the foreign aid sector while the implementation of current aid projects is still regulated by MOFA and MOFCOM.

Lastly, the regulators of domestic energy sectors, such as the National Energy Administration (NEA) or Ministry of Industry and Information Technology, are also not included in the decision making processes on overseas energy activities. Therefore, unlike the governance of China's domestic energy sector, which sets clear targets for different energy sources, Chinese overseas energy activities are governed without specific short-term and long-term planning (Shen and Power, 2017).

Development finance institutions

The retreat of state ministries in both sectoral planning and project-level approval further elevated the role of development finance institutions, whose services and funding support are crucial for the success of the projects. The key financial institutions involved in China's overseas energy activities include two policy banks (CHEXIM and CDB), one policy insurance company, known as China Export Credit Insurance Co. (SINOSURE), plus several commercial banks such as the Industrial and Commercial Bank of China (ICBC) and Bank of China (BOC). CHEXIM and CDB jointly take the lion's share of total energy financing through various loan instruments including buyer or seller credit loans and preferential loans (Gallagher, 2018), whereas SINOSURE provides further insurance or guarantee packages for some of these loan facilities with higher repayment risks. ICBC became particularly active in African markets after their strategic investment in Africa's largest commercial bank, Standard Bank in South Africa (Corkin, 2008), and established ICBC Standard Bank in 2015. In addition, there are several sovereign equity funds that provide equity investment financing, such as the China–Africa Fund, managed by CDB (Gu *et al.*, 2016).

Many studies on Chinese development finance focus on the operation of the two policy banks (CHEXIM and CDB), particularly in comparing their loan instruments, interest rates, lending procedures, and risk appetite to Western standards and practices (Bräutigam, 2011a; Gallagher, 2018; Wang, 2016). The key finding is that the majority of Chinese development finance is not strictly in line with OECD foreign aid criteria and these loan facilities work more like commercial finance (Bräutigam, 2011a), even though many of the lending decisions are clearly not solely based on the financial viability of individual projects. Citing public speeches of former CHEXIM bank presidents, Tang (2014) argues that Chinese policy banks' evaluation criteria is different from those of traditional Western financial institutions, as Chinese policy banks focus more on these infrastructure projects' overall and long-term contribution to the development of recipient countries, rather than the financial return. Another often overlooked factor is that a significant segment of the CHEXIM and CDB loan portfolios to high-risk countries and sectors is covered by SINOSURE's export credit insurance services, which has further increased Chinese banks' risk appetite for high-risk projects.

However, it is still unclear how such unique risk appetite is translated into daily evaluation and decision making practices for both policy banks and the export credit insurance agency. In general, most of these organisations pursue rather aggressive strategies to expand their portfolios, but how such expansionary strategies are compatible with internal risk management policies is the crucial missing link for current analysis of Chinese development finance institutions.

SOEs: policy implementers or lobbyists?

The majority of Chinese overseas energy projects were undertaken by large SOEs, who have notable lobbying capacity to influence both African and Chinese governments (Zhang and Smith, 2017). This poses a crucial question regarding the autonomy of Chinese ministries and development finance institutions in making policy or loan decisions. It is noted that the strength of state control over the policy agenda is dubious, as SOEs' behaviour often contradicts the Chinese government's promises and articulated strategy (Xu, 2014). SOEs in the petroleum and electricity sectors in China have been particularly powerful interest groups for decades, and their bosses often have strong patronage ties with the highest political figures within the CCP (Cunningham, 2015). In addition, there are frequent personnel exchanges between senior SOEs' managers, and regulators (Zhang and Smith, 2017). It would be simplistic to view these SOEs as mere operational arms of the Chinese government.

Most SOEs actively involved in African energy markets have decades-long histories of business development in many SSA countries. Previous studies identified the most important companies in the power generation sector, including Sinohydro, Gezhouba, Three Gorges Corporation, China International Water and Electric Corporation (CWE), China National Electric Engineering (CNEEC), Shandong Electric Power Construction Corporation, and China Machinery Engineering Corporation (Hwang *et al.*, 2015; IEA, 2016). In addition, the State Grid Corporation of China, as China's oligopolistic grid operator, is the main contractor for transmission lines and distribution projects in Africa (IEA, 2016). However, since 2011, there have been significant mergers and reforms among these SOEs, and many of them have been integrated into various gigantic SOE groups under new banners known as Power China, Energy China, and SINOMACH (see Figure 3.)

Figure 3. Leading Chinese energy and infrastructure SOE groups and their key subsidiaries

Power China	Energy China (CEEC)	China Three Gorges Corp.	China Industrial Machinery Corp. (SINOMACH)
<ul style="list-style-type: none"> • Sinohydro • SEPCO • and over 70 subsidiaries 	<ul style="list-style-type: none"> • Gezhouba • and over 30 subsidiaries 	<ul style="list-style-type: none"> • CWE • and over 20 subsidiaries 	<ul style="list-style-type: none"> • CMEC • CNEEC • and over 50 subsidiaries

Source: SOEs' official websites

As illustrated in Figure 3, the majority of Chinese SOEs operating in Africa are contractors on energy infrastructure projects with strong expertise in the hydropower sector. Chinese energy utilities or project developers are less involved in overseas projects.¹ This therefore explains why hydropower and OCC contracts, financed by development banks, dominate the current project pipeline in the SSA region (IEA, 2016). In addition, the characteristics of these large SOEs as quasi-state actors means they have ample political resources to wield, and can establish close relations with African governments through the strong support of Chinese embassies or endorsement by Chinese political leaders during high-level diplomatic visits (Lam, 2017; Xu, 2014). Such strong connections also enable these SOEs to identify project opportunities early on, and to engage and negotiate deals with African governments behind closed doors.

¹ Among the largest Chinese energy utilities, none has significant operations overseas. There is a clear distinction between domestic and overseas business in terms of actors and institutions in China's energy sector.

Chinese SOEs therefore prefer bilateral negotiations and are often found to be less enthusiastic to participate in open auctions or tendering programmes. Such a preference can also explain why Chinese contractors are dominant in large hydro and coal-fired power plants, but less so in the non-hydro renewable energy sector: open auctions are rare for supersized infrastructure projects, but become increasingly popular for wind and solar energy projects (IRENA, 2017). For example, South Africa's flagship renewable energy procurement programme is the largest renewable IPP initiative in the SSA region, yet less than 2% of the transactions were awarded to Chinese project developers (Baker and Shen, 2017; Shen and Power, 2017). This indicates that Chinese SOEs' preferences have a strong influence over project selection and development. Chinese solar panel suppliers are also found to be more enthusiastic to export modules or be EPC (Engineering Procurement Construction) contractors than to make direct equity investment, due to lack of experience as project developers overseas; whereas leading wind farm developers in China tend to focus on the domestic market and only take on overseas project occasionally (Shen and Power, 2017). Yet such a situation may change as the growth of domestic markets for wind energy is slowing down (Baker and Shen, 2017).

To sum up, the governance of Chinese overseas energy activities is implemented through several policy subsystems for foreign aid, OFDI and OCC activities. In each subsystem, government agencies, development finance institutions, and large SOEs work closely together with a shared expansionary goal, despite conflicts and power struggles over specific issues or projects. Whereas ministries such as MOFCOM, MOFA, and MOF are key actors responsible for overall strategy and planning via setting policies, rules, and guidelines, the project-level decisions are increasingly made by development banks and the export credit insurance company, whose autonomy is notably constrained by the large SOE contractors. Therefore, recent studies increasingly endorse the argument that instead of an orchestrated policy process led by the CCP and central government, there are actually highly diversified institutional interests at play driving Chinese overseas activities (Breslin, 2013; Downs, 2014; and many others). The common view of a highly coordinated, state-led 'China Inc.' model is rather missing the point (Taylor and Xiao, 2009). The pace of Chinese overseas renewable energy activities is actually determined by leading SOEs and, to some extent, the policy banks and export credit agencies.

Economic, environmental, and social impacts of Chinese energy projects in Africa

In the previous sections, I examined the literature on estimating the volume of Chinese energy projects in Africa and the key actors and institutions involved in the decision making processes. As China's contribution to Africa's energy sector has been increasing, the other major strand of studies focuses on various impacts of Chinese energy activities on a wide range of global, national, to local issues, such as climate change, technology transfer, environmental degradation, local employment, and community livelihood. In this section the main critics and debates are reviewed under the broad categories of political and economic, environmental (both global and local), and social impacts.

Political and economic impacts: governance, debt service, electrification, and technology transfer

There were once concerns that massive Chinese aid or financing in the energy sectors would crowd out Western donors and financiers (Downs, 2007). However, given the large funding gap for Africa's much needed energy transition, it is increasingly clear that Chinese finance can be a crucial additional source to Western funding. Another concern is whether Chinese activities are fuelling corruption in the recipient countries, given their less transparent negotiations and implementations, often referred to as 'rogue aid' (Naim, 2007). Based on analysis of AidData's China database, several studies present evidence that the increase of Chinese aid projects is indeed associated with a higher perception of corruption among local residents near the project sites (Isaksson and Kotsadam, 2018a; Brazys *et al.*, 2017). Chinese activities also

discourage trade union involvement (Isaksson and Kotsadam, 2018b). Dreher *et al.* (2018) further argue that between 2000 and 2012 China's less concessional loans are more likely to go to countries with higher levels of corruption. There can be multiple reasons for this. First, Chinese policy banks and SOEs have different financial modalities or risk appetite and are more tolerant of engaging highly corrupted governments, or China, as a relatively new player in bilateral projects, still lacks awareness the effect of corruption on project risk management, particularly during the earlier stage, before 2012 (Dreher *et al.*, 2018).

Another debated issue is the impact of Chinese infrastructure financing on the public debt service in many SSA countries, when the external debt-to-GDP ratios have been increasing since the early 2010s (Caulibaly *et al.*, 2019; Mustapha and Prizzon, 2018; Were, 2018). Countries like Sudan, Angola, Kenya, Gabon, and Mauritius have a collective GDP of more than US\$ 300 billion, and debt-to-GDP ratios above 60%, and other countries, including Ethiopia, Cameroon, Ghana, Mauritania, and Zambia, have been told by multinational organisations to rein in public spending (Gill and Karakülah, 2018). Since China is the single largest creditor for many of these countries, a narrative was developed that China was using debt to gain geopolitical leverage, by trapping poor countries in unsustainable loans (Were, 2018). Empirical analysis in Kenya and Zambia (Ofstad and Tjønneland, 2019; Onjala, 2017) echoes these concerns. Yet Gill and Karakülah (2019) present contrasting evidence that external public debt to China has remained low to moderate in the top ten recipients of Chinese official finance, and Chinese finance has not yet created an unsustainable burden on these countries.² However, as illustrated in the previous section, the debt issues are more likely fuelled by Chinese policy banks and SOEs' own expansionary behaviours, rather than an intentional outcome of an orchestrated strategy from Beijing.

Despite the weak consensus among academics, these early warnings have already sparked new measures from the Chinese government, with small-scale debt relief (mainly on interest free loans) and rescheduling arrangements being achieved in countries like Zimbabwe, Sudan, Zambia, and Ethiopia (Alden and Jiang, 2019). However, the lack of transparent rules and institutions on debt evaluation, relief, and management systems in China make the rescheduling processes slow and non-uniform (Alden and Jiang, 2019). Although most of the analysis on debt is cross-sectoral, it has significant implications for future Chinese projects in the energy sector because the growing concerns about debt service are pushing Chinese SOEs to consider becoming project owners and investors instead of contractors, hence a notable shift from the OCC model to the OFDI model (Alden and Jiang, 2019). The Chinese government is also encouraging policy banks to support BOT (Build Operation and Transfer) or PPP (Public-Private Partnership) transaction models (MOFCOM, 2019), which are less reliant on the sovereign debt service.

Since a large share of Chinese development finance goes to the power generation sector, it would be important to know what direct impact these projects are having on Africa's power generation capacity and energy access rates. A recent study noted that among most of the major recipients of Chinese official finance in the SSA region, there has been notable growth in both installed capacity and energy access rate since 2000, except for Zimbabwe and South Africa (Gill and Karakülah, 2019). The improvement is undeniable, but how much of this is attributable to Chinese finance and technical transfer is difficult to estimate, because some countries, such as Kenya, Cameroon, and Ghana, received less funding from China but are actually performing even better.

The last important but under-discussed issue is the impact of technology transfer (TT), which has long been an important element of China–Africa cooperation. TT may be described by different terms, such as knowledge transfer and knowledge learning, or take different forms via local employment, training, joint ventures, and equipment trade (Li, 2016). Rui *et al.* (2016) argue that although Chinese technologies are not necessarily superior, they are more relevant for the African context in terms of their applicability, assimilability, and affordability, and that such relevance will render Chinese companies more competitive in

² The top ten recipient countries include South Africa, Ethiopia, Angola, Sudan, Nigeria, Zimbabwe, Kenya, Cameroon, Ghana, and Cote D'Ivoire.

African markets. There have been several studies on the potential and challenges of TT, particularly in the renewable energy sector. For example, it is believed that massive imports of solar panels and cells from China is the key barrier to developing Africa's own solar firms, and some protectionist approaches need to be taken into consideration to enhance local technological capacity (Amankwah-Amoah, 2015). However, measures like local content requirements for government procurement programmes may further discourage potential investors (Kuntze and Moerenhout, 2012). Chinese solar panel exporters and contractors are also reluctant to establish local manufacturing facilities unless the market and policy prospects in host countries are promising (Baker and Shen, 2017; Shen and Power, 2017).

In the hydropower sector, most power plants will operate for more than 25 years and their maintenance depends on local skills and expertise, not just the transfer of hard technology or equipment (Urban *et al.*, 2015). By comparing the World Bank financed Lom Pangar dam and the Chinese financed Memve'ele dam in Cameroon (both contracted by Chinese companies), Chen and Landry (2018) argue that both projects involve hardware and software TT. However, in the Memve'ele project, all the machinery, construction equipment, and raw materials including steel and concrete were imported from China, mainly because of quality and cost concerns, which significantly reduced the opportunities to create local value chains and constrained TT (Chen and Landry, 2018). As for training, both projects included training on-site and programmes in China, showing Chinese contractors' deliberate engagement in skills and expertise transfers to local populations (Chen and Landry, 2018).

Environmental impacts: from global climate change to local environmental degradation

The environmental footprint of Chinese energy projects in Africa has attracted tremendous attention. The debate is focused on coal-fired and large hydro power stations, which dominate the current project portfolio. CDB and CHEXIM provided US\$ 6.4 billion and US\$ 16.8 billion loans by 2018 in these two sectors (the China Global Energy Finance database, 2019), and new transactions are brooding across the continent. The main African countries that received Chinese coal power projects include Zimbabwe, South Africa, Mozambique, and Tanzania (Zaman *et al.*, 2018). According to IEA (2016), Chinese investment in coal-fired power stations has been gradually decreasing since 2010, but large hydropower projects are still on a rising trajectory (Hwang *et al.*, 2015). This is mainly because most Chinese new coal power projects are concentrated in Southeast Asia and South Asia since the launch of BRI (Ren *et al.*, 2017).

African countries are not a significant source of greenhouse gas emissions. SSA accounted for less than 3.7% of the world's carbon dioxide emissions in 2014, with emissions *per capita* being much lower than the world average and remaining stable at 0.85 metric tonnes over the past 30 years. Therefore, apart from coal-dominated South Africa, most SSA countries do not have either a moral or legal obligation to commit to cutting their carbon emissions under current international climate negotiations and agreements. However, huge investment in fossil fuels may have the effect of 'locking in' SSA countries to a high-carbon development pathway for decades (Zwan *et al.*, 2018). The fast dropping cost of renewable energy and rising protest against coal could also turn these fossil fuel investments into 'stranded assets' in the future (Gallagher *et al.*, 2018).

There are several concerns regarding China's investment in these coal power plants. At the outset, these investments may shape the political economy of energy transition in some of the coal abundant countries by helping to grow and strengthen coalitions around coal incumbency (Baker *et al.*, 2014; Jacob, 2017; Newell and Johnstone, 2017), and consequently discourage newly emerged political and commercial interests around the renewable energy sectors (Power *et al.*, 2016). Second, as most of the SSA countries have significant public finance constraints, as discussed earlier, investment decisions on fossil fuel projects will almost inevitably squeeze out opportunities for more sustainable and cost-effective energy sources.

Second, it is unclear what drives the impulse for huge investment in these coal power plants, either within China or in recipient countries. One reasonable guess is that increasingly stringent coal phasing-out policy and fast-growing renewable energy sectors within China have pushed Chinese fossil fuel industries to export their overcapacity overseas (Zhao and Alexandroff, 2019). However, whether such a 'survival' strategy has gained acquiescence or support from the Chinese policy banks who are actually the project-level decision makers, as explained previously, is unknown. Concerns have also been raised regarding the agency of African governments (Corkin, 2015; Mohan and Lampert, 2013) in hosting these projects willingly or autonomously. It is noted that there is no international agreement, such as a Fossil Fuel Non-Proliferation Treaty (FF-NPT) proposed recently by researchers on global climate governance (Newell and Simms, 2019), to ban or limit fossil fuel investment in developing countries. The key question that remained unsolved is how to change the incentives from both the demand and supply sides of these coal power projects. One potential solution is to provide further incentives to endorse investment in renewable energy projects; this will be further reviewed later.

The other strand of criticism is around China's large hydro power stations and their various local environmental impacts, as some of these dams are suspected of damaging aquatic biodiversity, national parks, and natural reserves, and causing riverbed sediment. It is noted that the latest round of fast expansion of Chinese hydro power stations is also closely linked with its domestic power sector reforms, particularly after 2003 when large utility SOEs were established and moved quickly to secure new assets through a surge in domestic and overseas dam building (McDonald *et al.*, 2009). In China's 13th five-year plan for the hydropower sector (2016–2020), international cooperation is an important element for implementing its 'going out' strategy and BRI, and the policy goal is to enhance the Chinese hydropower sector's international competitiveness and influence (NEA, 2016).

Both the Chinese government and policy banks require all Chinese projects to be developed and operated in line with local laws and regulations, which is stated clearly via various open statements or internal guidelines. However, the environmental impact assessments of many Chinese dams in Africa appear to be slack and failed to meet international standards, particularly at earlier stages in the early 2000s, when the adverse environmental impacts of Merowe Dam in Sudan and Bui Dam in Ghana attracted significant attention (Bosshard, 2009; Hensengerth, 2013; and many more). However, things changed slightly in the last decade when more foreign institutions were recruited to conduct EIA processes (Hwang *et al.*, 2015), and stringent guidelines and CSR (Corporate Social Responsibility) policies were gradually adopted by key SOE contractors (Tan-Mullins and Mohan, 2012). Major Chinese banks have adopted green credit policies similar to the Equator Principles (Sun and Tang, 2015). Yet these approaches produced mixed results and implementation of these guidelines or policies is often a bigger challenge (International Rivers, 2012). For example, both CHEXIM and SINOSURE have rules declaring that they should discontinue their loans or reject insurance claims if Chinese contractors have violated local environmental laws. However, triggering such clauses can be highly challenging in reality, due to the potential obstacle of the close relations between these organisations as a policy community, as explained earlier.

Another recent criticism is that China does not have significant investment in non-hydro renewables in Africa compared to other energy sectors (Gallagher *et al.*, 2018), despite it being a global leader in wind and solar energy investment domestically and despite Africa's huge untapped potential in renewable resources (Cabr e *et al.*, 2018). Chinese contractors have only been taking up renewable projects in Africa very recently in a piecemeal fashion (Tan *et al.*, 2014). According to Shen and Power (2017) there are several factors that affect Chinese engagement in renewable energy activities. First, leading Chinese SOE contractors in Africa are not specialised in the wind and solar sectors, compared to hydro and coal power projects. In addition, the Chinese domestic market is still more attractive than overseas markets, due to government subsidies and strong local state support, particularly compared with the relatively higher-risk markets in the SSA region. Yet the Chinese contribution to Africa's renewable energy market should not be underestimated, as Chinese supplies of solar panels dominate many SSA markets (Baker and Shen, 2017). To scale up Chinese green energy in OFDI and OCC, however, requires both innovative financial and risk

management instruments at global level to mitigate perceived high project risks (Stuart and Gallagher, 2018). Additional incentives are needed because renewable energy projects are often smaller in size, meaning a higher transaction cost for the financiers, and receive less political endorsement from both sides. In addition, further institutional reforms within China are required to nudge leading Chinese renewable companies to explore overseas markets more actively.

Social impacts: jobs, replacement, and inclusiveness

Another interrelated strand of criticism regards the social impacts of Chinese energy infrastructure. Discussions are mainly around whether these activities are delivering on their promises to enhance local welfare, including employment, education, and access to and consumption of electricity (Tang and Shen, 2019; Hwang *et al.*, 2015). In addition, there are studies that analyse such impacts of Chinese energy activities on local communities as unsatisfactory resettlement, affecting production activities (fishery and farming in particular), land seizure, and damaging cultural resources (Cooke *et al.*, 2016; Hensengerth, 2013; International Rivers, 2012; Kleinitz and Näser, 2011). The case studies around social impacts are focused on several large dams such as Bui Dam in Ghana, Gibe Dam in Ethiopia, and Merowe Dam in Sudan. The key finding is that these projects are not specifically increasing electricity access for local residents compared to the national average (Tang and Shen, 2019) and the livelihoods of the resettled communities are negatively affected by the construction of the dams, in terms of land, food, water, and energy access (Yankson *et al.*, 2015). These studies also revealed massive population dislocations, inadequate resettlement options, and little or no community engagement (Bosshard, 2009; Gleick *et al.*, 2012) when implementing these projects. In addition, cultural and archaeological heritage were also destroyed, partially due to project developers' lack of engagement with local communities (Kleinitz and Näser, 2012).

The debate, however, focuses on whether Chinese companies or policy banks should be responsible for these unfair outcomes. As mentioned earlier, for most of these projects Chinese companies are only contractors under the OCC arrangement, who normally do not get directly involved in residential or cultural heritage relocation and planning for energy distribution and access. Carrying out these works is mainly the responsibility of local government, whose capability and accountability in implementing these challenging tasks has varied significantly (Hensengerth, 2013). Some promises made in the early planning stage by government agencies, such as new irrigation systems, were eventually not kept (Yankson *et al.*, 2015), which caused further dissatisfaction and even massive local protest during the implementation stage (Bosshard, 2009; Gleick, 2012), which eventually put Chinese contractors on the frontline of the confrontations. In addition, Chinese policy banks often do not adopt existing international standards for environmental or social impact assessment, at least until recently. Cooke *et al.* (2016) proposed an extended environmental justice framework to make sense of the resettlement and compensation schemes for indigenous peoples who were affected by the large dams. They argue that besides a fairer distribution of cost and benefits and more transparent or inclusive procedures, a 'just' project should also aim to maintain the functioning of local communities and their bond with the natural environment (Cooke *et al.*, 2016). Yet it is still unclear what rules or standards should be deployed to achieve these goals, and who should be responsible for implementing them, and held accountable if they are not met.

China and Africa's energy transition: towards a new research agenda

China has been playing an increasingly important role in Africa's urgently needed energy transition, mainly by implementing many energy infrastructure projects in the past two decades. Chinese activities have sparked tremendous academic and public interest and concern. Current studies aim to precisely estimate the scale and volume of Chinese projects and finance, to understand the governance and decision making processes around these projects, and to evaluate their political, economic, environmental, and social impacts. In providing a critical review of this literature, I argue that a new research agenda is needed.

First, existing databases on Chinese aid and energy finance in Africa have laid a solid foundation for understanding the actual size, types, and trends of Chinese project activities, yet the available estimate is currently far from precise. Datasets on OFDI, trade and export, and transmission or distribution activities are particularly underdeveloped compared to OCC on power generation projects. Current databases cannot provide outstanding liabilities under each loan, which can be a useful indicator for analysing their economic impacts, such as the external debt burden. As for methodologies, most of the databases combine media content research with primary field investigations to triangulate the online information with interview data. Yet it is difficult to conduct primary investigation across all the SSA countries that host Chinese energy projects. In addition, it is difficult to keep updating the database with repeated field investigations. Therefore, a new methodology, particularly one based on big data or machine-learning technologies, could be potentially useful to expand the search scope and validate the research result.

Second, regarding the governance and decision making processes, current studies have identified several central ministries (MOFCOM), policy banks and financial institutions (CHEXIM and CDB), and large SOE groups as the key actors in driving these project activities. However, how these actors interact and coordinate to facilitate specific transactions, sectoral planning, and institutional development is not yet clear. The black box of governance is only half open to outsiders. In addition, little research is being done to understand the links between these Chinese actors and those from the recipient countries, apart from diplomatic activities between political leaders. Future research should focus on the analysis of actor networks to understand complex multilevel and bilateral interactions and power relations among these actors, which could help to improve our understanding of why some (controversial) activities can emerge and succeed in securing political endorsement and financing. Such investigation would be particularly valuable to our understanding of whether and in what way that China is influencing SSA countries' energy development pathways. In general, more country-specific case studies that focus on institutions, interactions, and agencies from both sides will be crucial to generate better insights on perceived project risks and governance structures.

Regarding the various impacts of Chinese activities, most of the current studies are based on country- or project-specific case studies. With more reliable databases being developed, future studies can test the correlations between Chinese activities and specific indicators of energy sector transition and modernisation in SSA regions, particularly around energy sufficiency, efficiency, and sustainability, such as in relation to the energy sector indicators developed by the WEF and UNEP (WEF, 2019; UNEP, 2016). The impact of Chinese activities on recipient countries' economic performance, technology capability, and social benefits also require further investigation and evidence.

As for environmental and social impacts, it is increasingly clear that improvement is needed but consensus on the role Chinese companies, policy banks and ministries in the current contractual arrangement is weak, if there is no international agreement or consensus on limiting fossil fuel or scaling clean energy investment in the global South. Current studies have proposed a global ban on coal-fired power projects and the development of a global guarantee system for renewable energy projects (Newell and Simms, 2019; Studart and Gallagher, 2018). Such proposals will surely provide the sticks and carrots needed to shape Chinese actors' overseas strategy and incentives. As for the local-level impacts, more stringent monitoring and accountability systems should be installed, particularly at the project implementation stage. Further studies should focus on in what way Chinese actors can contribute to institutional development on environmental justice and accountability. Another question is how to standardise these practices across different SSA countries to change the current *ad hoc* nature of environmental and social impact assessment and monitoring.

It should also be noted that China's overseas energy activities are closely linked with its domestic market and policy changes, which surely deserve further investigation to test assumptions that China is exporting its overcapacity in fossil fuel and large hydro sectors, and increasingly so in new sectors like nuclear, wind, and solar energy activities. It should be noted that China–Africa energy relations is hugely shaped not only

by China and SSA countries, but also by other major developed and emergent markets. The production chain of energy sectors is increasingly globalised, with more intense competition and division of labour among major technology suppliers, project developers, and financiers around the world (Lachapelle *et al.*, 2017). New research is therefore needed to understand how China and SSA countries' cooperation on energy transition is embedded and influenced by these fast changing technological developments, geopolitical implications, and market relations, and what new forms of trilateral or multilateral cooperation can emerge to further address some crucial technological, capacity, and financial challenges faced by SSA countries.

Last but not the least, more research attention should be focused on various barriers to Chinese actors in scaling up their non-hydro renewable energy activities in the SSA region. China is the world leading investor and innovator on wind and solar energy capacities and technologies, but their overseas activities, particularly in Africa, are limited and incomparable with their domestic wind and solar market development, or other overseas energy activities, such as large hydro or coal power facilities. Previous studies touched on several factors, such as reluctance towards equity investment, negotiation preferences on bilateral deals over open auctions, lack of experience or additional incentives for companies to explore more challenging markets. Little is done, however, to explore potential remedies to address these issues both from Chinese and recipient countries' perspectives, or the potential role of international actors. Empirical inquiries on how the perceived high risks can be changed, what are the potential co-benefits that can provide additional incentives, and what are the potentials for local green energy TT and green manufacturing capacity needs to be addressed in future studies.

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