Chinese and multilateral development finance in the power sector

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Abstract

Public developmental institutions are pivotal in shaping the contours of the electricity sector of the developing world and its associated greenhouse gas emissions pathways. However, we have a fragmented and incomplete picture of the evolution of their investments over time and space. This is particularly the case for the recent rise of various Chinese Developmental Institutions (CDIs) for which infrastructure investment estimates range in the trillions under China's Belt and Road Initiative (BRI) and for which data is mostly not publicly disclosed. We address this gap in two ways: first, we compile and analyze a novel dataset that draws on commercial data tracking, publicly available datasets, and more than 1,000 supporting documents to match financial transactions by the main CDIs and traditional Multilateral Development Banks (MDBs) to power plant projects worldwide. This allows us to conduct a quantitative, comparative analysis of the role of CDIs and MDBs to understand the relative size, technology, and country focus of such investments in the period 1999-2020. Second, we complement the quantitative dataset with 39 expert interviews to shed light on the drivers behind the Chinese investments, with a particular focus on coal projects. The analysis shows that CDIs have rapidly emerged as the largest public finance provider for the electricity sector in the developing world. We also find that, in contrast with the increasingly green BRI rhetoric, the technology portfolio of CDI investments in power plants is still heavily dominated by coal plants. Over time, however, CDIs have increasingly supported more efficient coal plants and increased the share of their portfolio supporting non-hydro renewables and supported a growing number of projects jointly with MDBs. Steering China's bilateral coal finance flows through international efforts into a more sustainable direction to meet climate goals will require careful consideration of a set of drivers and enablers of the involvement of CDIs and recipient countries in coal projects, which we discuss, as well as of the role of other finance providers, including traditional MDBs.

Key words: China, Belt and Road Initiative, Multilateral Development Banks, Development Finance, Electricity Sector, Coal

1. Introduction

Delivering universal access to electricity in low and middle-income countries will require power plant infrastructure investments that are estimated to $3.1 trillion in the period 2016 - 2030 (Global Infrastructure Hub, 2017). Whether the mobilized investments will flow into fossil-fuel or renewable energy-based technologies will play a crucial role in avoiding potentially catastrophic consequences of global warming (Rogelj et al., 2018). Due to the high investment risk that private investors face in developing countries (Granoff et al., 2016) public finance plays an important role (Steffen and Schmidt, 2019; IEA, 2019a). For the past 50 years, traditional multilateral development banks (MDBs), such as the World Bank, have been considered as crucial actors in financing power plant projects in developing countries (Tirpak and Adams, 2008; Delina 2011; Miyamoto and Chiofalo, 2016; Wright et al., 2018). Since the initiation of China's Going Out policy in 1999, Chinese actors, however, are rapidly emerging as an additional development finance provider (Kong and Gallagher, 2017). In 2013, China's Going Out policy evolved into the Belt and Road Initiative (BRI), also labeled as the largest infrastructure program since the Marshall Plan (Shen and Chan, 2018). With estimates of the level of foreign infrastructure investment of this initiative ranging from $1 trillion to $8 trillion (Balding 2017; Hillman 2018; Stanley, 2018), the evidence available points to the notion that the majority of the investments so far have been allocated towards power plant infrastructure (Gallagher et al., 2018; Eder and Mardell, 2019). In other words, there is growing evidence that Chinese Developmental Institutions (CDIs) have started to significantly shape the contours of the evolution of the global electricity sector and its associated emission pathways.

Despite receiving increasing attention from scholars and practitioners, the full impact of CDIs on the deployment of different power generation technologies around the globe is still not sufficiently understood. The sparse number of existing studies is limited in terms of its coverage of different CDIs, the length of the time period considered, and/or the level of detail regarding the power plant technology supported (see Table A.1). This can be explained by the difficulty of tracking the international activities of the various CDIs (see Table A.2). The official information that China publishes on its public financing activities abroad is not aligned with OECD standards and is provided at an aggregated level with very limited information on projects and recipients (Dreher et al., 2018; Dolan and McDade, 2020). Dreher et al. (2018) note that International Organizations with official monitoring responsibilities (e.g., the Development Assistance Committee) and academics do not seem to be able to keep up with the rapid evolution of China's overseas investments. There is an urgent need to improve our understanding of Chinese foreign state finance flows because they are expected to significantly affect environmental, economic and social outcomes in developing countries and beyond (Dreher et al., 2018).

The present study addresses this gap in the power sector by applying a new approach to construct a dataset that draws on a dataset tracking power plants, other publicly available datasets, more than 1,000 supporting documents and expert interviews. With this information we match financial transactions by CDIs and traditional MDBs to power plants around the world at the unit level for the period between 1999 and 2020. We use this to answer the following research questions: first, how have power projects outside of China funded by CDIs evolved when compared to those supported by MDBs in terms of recipient country and technology focus? And second, what mechanisms have driven the investment by CDIs in coal power plants abroad? The resulting analysis is, to the best of our knowledge, the most comprehensive on this topic available. It allows us to assess globally and over a substantial time period the technological expansion patterns of financial transactions by CDIs and MDBs between 1999 and 2020 and the ongoing projects and planned grid connections beyond 2030. Furthermore, it allows us to increase our understanding of the underlying mechanisms of the Chinese expansion with a particular focus on the climate-critical and dominating coal finance flows in the observed CDI portfolio.

In answering these questions, we contribute to literature in the following two ways:

First, by providing a systemic comparative analysis of global power plant capacity additions facilitated by CDIs outside China since 1999 in comparative perspective to Western-backed MDBs. We expand on recently published research from Chen et al. (2020) - the only other available global estimate of Chinese development finance in the global electricity sector to date in terms of the institutional coverage and a more comprehensive comparison with MDBs. Our study goes beyond the China Development Bank (CDB) and the Export-Import Bank of China (ExIm) in that we also include projects supported by China-backed development funds and two newly established multilateral institutions with China as major shareholder as defined in a recently compiled list of relevant CDIs in the energy sector (see Table A.2). We also present a direct comparison of the relative role of CDIs when compared to that of Western-backed MDBs over a long time period. In doing this, our comparison of the role of CDIs and MDBs between 1999-2020 builds on and expands previous literature analyzing the role of MDBs by Steffen and Schmidt (2019), which covers the period 2006-2015. In addition, our work distinguishes itself with extending the analysis of developmental institutions towards a systematic comparison with trends in domestic China and recipient countries, thereby providing a more comprehensive picture with being able to compare various portfolios over time.

Second, we increase the understanding on the underlying mechanisms of the Chinese expansion with a particular focus on drivers behind the dominating coal support in the observed portfolio. This part builds on the literature on the political economy behind coal power in recipient countries to cover the demand side (e.g., Steckel and Jakob, 2021; Ordonez et. al., 2021; Dorband et al., 2020), as well as literature on the Chinese political economy behind foreign energy related state-finance flows (e.g., Kong and Gallagher, 2017; Kong, 2019) to cover the supply side. Furthermore, it builds on a recently published work from Kong and Gallagher (2021a,b) who established the link between supply and demand in the electricity sector for China's two major policy banks as well as on a study from Gallagher et al. (2021) that conducted expert interviews in four recipient countries of Chinese coal finance to investigate the drivers on the demand side. This study expands on these works by creating an integrative perspective of both demand and supply side factors along with influencing factors from an international level including traditional MDBs (see Table A.3 for a more detailed delineation of the current study and existing literature).

The remainder of the paper is structured as follows: Section 2 describes the methodology and data. Section 3 presents the analysis of the longitudinal global data on international development related investments in power projects. Section 4 presents a framework for understanding the drivers and enablers of Chinese coal finance. To conclude, Section 5 discusses possible opportunities to influence the evolution of the role of CDIs in the power sector towards a more sustainable direction.

2. Methodology and Data

2.1 Main dataset with financial transactions

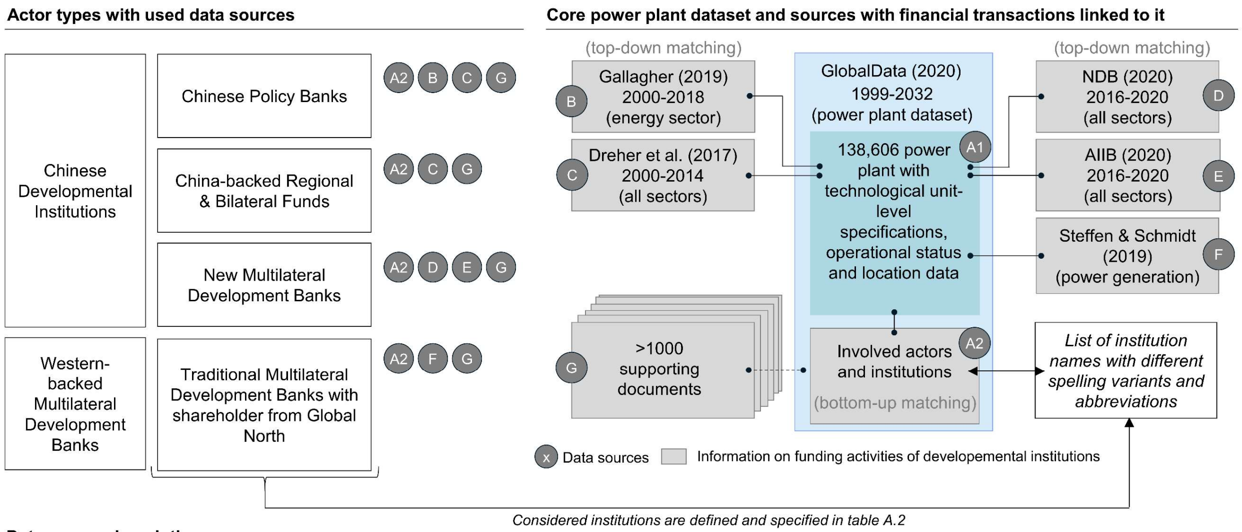
The construction of the quantitative dataset of power projects globally aimed to unveil the trends in investment activities for CDIs and traditional MDBs starting with China's Going out Policy in 1999 until 2020. We consider the following CDIs: China's two major policy banks (China Development Bank (CDB), Export-import Bank of China (ExIm)), twenty regional and bilateral development funds (e.g., Silk Road Fund) and two newly established multilateral institutions with China as a major shareholder (Asian Infrastructure Investment Bank (AIIB), New Development Bank (NDB)). These institutions cover the full set of CDIs active in the energy sector as listed in Gallagher et al., (2018). To enable a comparison of the evolution of financial involvement of CDIs with that of Western-backed MDBs (i.e., traditional MDBs with at least one country from the global north among their shareholders and boards, as defined by Steffen and Schmidt (2019)), we further expand the dataset to include MDBs investment activities. A more detailed description of the CDI and MDB actors covered is available in Table A.2 in the Appendix A.

Like Steffen and Schmidt (2019), who compiled a bottom-up dataset for power generation investments of traditional MDBs for the period 2006-2015, and to enable comparability, we consider all type of financial instruments employed by the institutions under consideration and exclude transactions limited to capacity building (for the period 1999-2020). The majority of the transactions constitute loans with differing degrees of concessionality, but the data also occasionally includes underwriting and equity investments. The Multilateral Investment Guarantee Agency (MIGA) in the MDB sample, for example, focuses on guarantees and the newly established development funds partly constitute equity funds (see Table A.2 for covered financial instruments by institution). As previously mentioned, the various datasets and review of over 1,000 documents allow us to link the transactions by the different institutions to power plants at the unit-level. The commercial power plant dataset GlobalData (2020) allows us to populate at the unit level a broad set of additional variables for nearly all power plants in the world, including the plant technology and the unit-level power plant capacity: The incremental power plant capacity additions facilitated by the actors under consideration are used as the main unit of analysis[1]. For greenfield investments and rehabilitations, the full power plant capacity is listed; for extensions, only the added capacity is included; and in the case of modernizations that do not result in new power plant capacity, the incremental capacity is set to zero. In addition, available information for used boiler types in coal plants as well as the presence of emission control technologies is used whenever available to analyze trends in supported coal-plant efficiencies and prevalence of pollution abatement technologies.

Our extensive analysis of datasets used in academic literature, as well as commercial databases of financing activities and power plants (including comparative analyses of obtained data extracts for the most promising sources) resulted in the dataset design that is summarized in Figure 1. The left-hand side of the figure provides a summary of the financial actors covered, and the right-hand side of the figure summarizes the process and data used in the development of the dataset. Two other parallel research papers that were published when we were finalizing details of this work also leveraged a commercial power plant database to enhance the understanding of Chinese activities in the global power sector (Li et al., 2020; Chen et al., 2020). Li et al. (2020) used the Platts World Electric Power Database to track direct investments of Chinese companies (as opposed to developmental institutions) and Chen et al. (2020) linked a more recent version of dataset B (see Figure 1) containing information on the ExIm and CDB to the Platts World Electric Power Database. This study includes in the analysis the commercial power plant database GlobalData (2020) (see Figure 1). In contrast to Chen et al. (2020), our study builds on a broader set of sources of information (see Figure 1, A-G) and it covers projects supported by a wider set of Chinese and international actors (see

[1] Finance from Chinese Developemental Institutions usually covers a substantial part of the overall plant costs. Chen et al. (2020) estimated that for the ExIm and the CDB the share of financed costs usually lies above 50% across all technologies (Chen et al. 2020, Figure S.3)

Figure 1, left). Furthermore, in order to allow the matching between financial transactions and power plants, triangulate financial transactions in GlobalData (2020), and capture additional variables (i.e., year and type of financial transactions), this work involved analyzing over 1000 supporting project reports and media articles (see explanations in Figure 1 for more details). A more detailed specification of the data sources used can be found in Appendix B.



Data source description

(A) **GlobalData (2020):** Unit-level power plant database, contains nearly all power plants in the world (138,606 power plants) including technical plant details (A1) and information on involved actors along the power plant value chain, including finance providers (A2).

(B) **Gallagher (2019):** China's Global Energy Finance Database is a media-based data collection effort between the Global Economic Governance Initiative (GEGI) from the Boston University and the China-Africa Research Initiative of the Johns Hopkins University. It provides the first (comprehensive) estimate for the development finance volume of China's two major policy banks (China Export-Import Bank, China Development Bank) in the energy sector (Gallagher et al. 2018).

(C) **Dreher et al. (2017):** A media-based data tracking effort of the William & Mary's Global Research Institute. The obtained dataset captures Chinese development finance flows across all sectors (including the energy sector). It considers a broad range of Chinese actors, covers financing activities from 2000-2014 with a focus on Africa and has been widely used in academia (e.g., Dreher et al. 2018).

(D)(E) **AIIB (2020), NDB (2020):** In contrast to the fully Chinese policy banks the two newly established Multilateral Development Banks with China as major shareholder, namely the Asian Infrastructure Investment Bank (AIIB) and the New Development Bank (NDB), provide a list of financed projects for which some descriptions provide enough information to identify the financed power plants.

(F) **Steffen & Schmidt (2019):** Steffen and Schmidt (2019) have recently filled the gap of a missing comprehensive compilation for all relevant MDBs for the period 2006-2015 by constructing a bottom-up dataset out of 1,751 documents obtained from banks and additional secondary data and expert interviews (Steffen and Schmidt, 2019).

(G) **Other sources:** Other publicly available sources (mainly project reports of multilateral development banks and media articles) are used to 1) further triangulate and enrich the financial transactions identified in GlobalData (2020) and to 2) support the matching process (see below)

Matching and linking procedure

◄► *Identification of developmental institutions in GlobalData (2020):* In addition to technological power plant details, GlobalData (2020) captures finance providers in structured and unstructured (e.g., asset notes) data fields. A list of the names of the relevant developmental institutions (as displayed in Table A.2) with different spelling variants have been created. This enabled tracking the presence of those actors through the application of simple matching algorithms between the institution name lists and data fields in the GlobalData database. The matched cases have been reviewed manually to understand the context and to verify if they have been mentioned as finance providers. For each identified transaction in GlobalData a web research was conducted to validate the supporting activity and to capture the year and type of transaction (new construction, extension, modernization, rehabilitation) wherever traceable, as this information is not provided by GlobalData (2020) in most cases.

•—• *Linking the core dataset A1 to datasets B-F:* Datasets have been matched at the unit-level. Due to varying spellings for power plant projects, locations and other variables that have been used to match Chinese and Western involvement to power plants, it was not possible to automatize the matching, which is why it resulted in a highly time-consuming manual process. Major matching variables included country, location, power plant (unit) name, plant capacity, the year of transaction and the (expected) first year of plant-unit operation. In cases where the dataset B-F did not provide sufficient information to identify the supported power plant (unit), publicly available information has been used to further investigate if it is possible to specify the power plants supported by the indicated transaction. This included, in particular, project documentation of Multilateral Development Banks for dataset F. Appendix D provides additional information on the data triangulation and matching results.

Fig. 1. Simplified illustration of dataset design. The data sources (GlobalData, 2020; Gallagher, 2019; Dreher et al., 2017; AIIB, 2020; NDB, 2020) are noted by the circles in grey with the letters.

Given the various involved datasets avoiding duplications has been an important consideration in the dataset development and analysis process. Specifically, in cases where one institution has been identified as funder for one power plant unit more than one time across different datasets, further checks were conducted to verify whether those datasets report the same transaction or two subsequent transactions of the same institution into the same plant unit. These checks included comparing the reported type of transaction, loan amounts, the year of contract signatures and searching for explicit mentions of the presence of a follow-up contract. Using this process we were able to determine that for the CDI sample, for example, in 55 % of the observations we found that one developmental institution has been identified as funder for one power plant unit more than one time across different datasets. Of those observations, the majority (89%) constituted duplicates. In addition, the capacity of each power plant unit - our main unit of analysis - to which the transactions are matched is only listed once in the power plant dataset GlobalData (2020). Hence, in the hypothetical case of double-counting of financial transactions our main variable of interest (supported plant capacity) would be unaffected by it as every power plant unit is a unique record.

The application of the approach specified above resulted in the dataset summarized in Figure 2. The newly constructed dataset results in 352 power plants and 623 plant sub-units (as defined by GlobalData (2020)), with support from at least one of the CDIs considered. Figure 2 also shows that, when compared to power plants identified with the help the of the established and publicly available datasets B-E (see Figure 1), our final analysis includes 106 additional power plants with support from the two major Chinese policy banks and another 35 for the new developmental institutions, which we cover in our analysis. Supplementary Figure D.4 provides possible explanations for the additionally identified power plants (namely a broader time frame, potentially more stringent inclusion criteria in dataset B and C, insufficient information to match covered transactions in dataset B-E to power plant units, and the commercial power plant database GlobalData (2020) being more comprehensive in identifying potential transactions from CDIs in comparison to the hereto used datasets). Hence, the newly constructed dataset reflects the involvement of CDIs to a considerably greater extent than what has been collated before and illustrates how existing estimates regarding China's global role in the power sector, in particular for the CDB and ExIm (as discussed in more detail in section 3.3), might be too conservative.

		Datasets with funding activities from Chinese Developmental Institutions				Datasets with funding activities of MDBs			
Datasets with funding activities		NDB (2020)	AIIB (2020)	Gallagher (2019)	Dreher et al. (2017)	GlobalData (2020)	Steffen & Schmidt (2019)	Additionally identified plants via GlobalData and document review	Newly constructed datset
Covered time period		2016-2020	2016-2020	2000-2018	2000-2014	1999-2020	2006-2015		
Number of transactions / mentions of relevant actors		76	147	244	5466	2927	1067		
Thereof out of scope (e.g., other infrastructure type, pure capacity building)		65	132	71	5338	641	140		
Thereof insuffcient information for clear match to at least one plant		10	1	11	42	0	475		
Matched to one or more power plants in GlobalData (2020)		1	14	162	86	2291	452		
Period of grid connections of matched plants		2015-2020	2017-2025	2003-2030	2004-2030	1999-2032	2006-2025		1999-2032
Chinese Developemental Institutions (CDIs)								**138 (208/213)**	**352 (623/661)**
Chinese Policy Banks	Export-import Bank of China (ExIm)	n/a	n/a	112 (189/226)	63 (113/141)	135 (211/233)	n/a	77 (110/113)	202 (350/376)
	China Development Bank (CDB)	n/a	n/a	69 (161/174)	19 (26/35)	78 (140/145)	n/a	46 (74/76)	118 (248/258)
	Sum (Exim and/or CDB)	n/a	n/a	175 (330/373)	80 (135/169)	191 (317/344)	n/a	106 (159/164)	293 (542/571)
New Developmental Institutions	Asian Infrastructre Investment Bank (AIIB)	n/a	27 (32/41)	n/a	0	25 (30/39)	n/a	0 (0/0)	27 (32/41)
	New Development Bank (NDB)	1 (6/6)	n/a	n/a	0	18 (20/20)	n/a	18 (20/20)	19 (26/26)
	China backed Development Funds	n/a	n/a	n/a	1 (1/1)	18 (41/41)	n/a	17 (40/40)	18 (41/41)
	Sum (AIIB and/or NDB and/or funds)	1 (6/6)	27 (32/41)	n/a	1 (1/1)	61 (91/100)	n/a	35 (60/60)	64 (100/109)
Western-backed Multilateral Development Banks (MDBs)		n/a	n/a	n/a	n/a	875 (1347/1418)	336 (633/723)		**1068 (1725/1830)**
World Bank Group		n/a	n/a	n/a	n/a	304 (470/491)	55 (104/114)		363 (594/621)
International Finance Corporation		n/a	n/a	n/a	n/a	56 (85/85)	97 (165/187)		143 (234/255)
Multilateral Investment Guarantee Agency		n/a	n/a	n/a	n/a	51 (74/81)	26 (50/65)		71 (118/126)
African Development Bank		n/a	n/a	n/a	n/a	137 (223/232)	37 (75/93)		148 (255/269)
Asian Development Bank		n/a	n/a	n/a	n/a	277 (389/420)	52 (91/107)		293 (429/469)
European Bank for Reconstrcution and Development		n/a	n/a	n/a	n/a	29 (41/41)	45 (99/108)		73 (134/143)
European Investment Bank		n/a	n/a	n/a	n/a	155 (268/284)	56 (99/119)		175 (310/331)
Inter-American Development Bank		n/a	n/a	n/a	n/a	19 (21/21)	29 (41/45)		44 (61/64)
Supporting data									

Top down matching; Power plants in GlobalData (2020); See figure D.1

Triangulation and expansion based on >1,000 documents (e.g., project reports and articles)

138 additional plants (39% of total dataset) identified when compared to established datasets

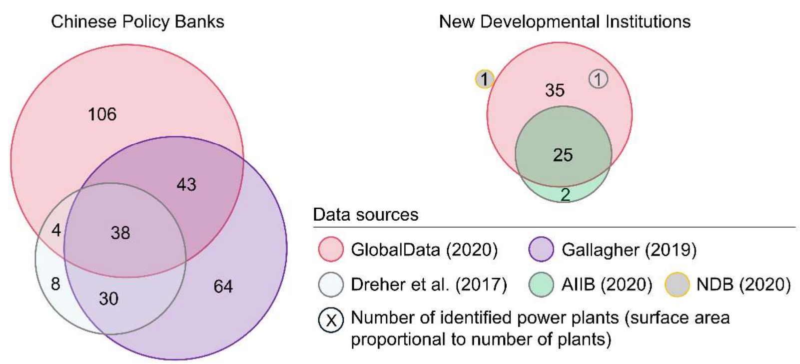


Fig. 2. Composition of constructed dataset with financial transactions of CDIs and Western-backed MDBs. The number of power plants and subunits thereof (in brackets) with identified financial transactions by institutions and used data sources is displayed (in brackets: supported sub-units/total number of sub-units as reported by GlobalData (2020)). A disaggregation by type of transaction can be found in Table A.5. A comparison between frequencies of main dataset variables (actors, technologies, geographies, years) between the matched and total dataset from Steffen and Schmidt (2019) indicates that frequencies for all variables follow the same patterns, albeit Chi-Square Goodness of Fit tests indicate that there are statistically significant differences (see Figure D.3). More details for the excluded transactions are provided in figure D.4-D.7 in Appendix D. Although substantial effort has been invested to validate and triangulate the existing findings, they should be seen as estimates and not as precise figures for total involvement.

2.2 Dataset of semi-structured expert interviews to shed light on drivers and enablers of CDI investment patterns

We conducted 39 semi-structured expert interviews throughout 2020 to enhance our understanding of the underlying mechanisms behind the expansion and evolution of CDIs and MDBs in the global power sector with a particular focus on coal drivers on the supply side for Chinese institutions, as well as on the demand side in the case of recipient countries. We guided our approach by best practice for qualitative data collection (Gibbert et al., 2008) and expert and elite interviews in particular (e.g., Littig, 2009) Due to COVID-19 travel restrictions, the 30- to 60-minute-long interviews were conducted remotely via telephone or videocall (i.e., via Skype or Zoom). Remote interviews via telephone (Vogl, 2013) and to an even greater extend via videocall (Evans et al., 2008) are seen as viable alternatives to face-to-face interviews. The interviewees were based in China as well as in recipient countries and represent a broad range of subject matter experts, including from financial institutions, government officials, local NGOs, think-tanks, academics, consultancies on financial flows that occur in the context of China's BRI (see Appendix C for a list of the experts and the sector represented by their organizations). All participants had personal exposure to Chinese-supported projects or extensive knowledge in Chinese overseas development investments.

The participants have been selected through: (i) an initial sample based on expertise by the authors of this work (13 interviewees), (ii) snowball sampling techniques (23 interviewees based on novel referrals) (iii) cold-calling (3 interviewees). Prior personal contacts, sample seed diversity and persistence contributed to achieve sample diversity, in terms of 'range of viewpoints' (Kirchherr and Charles, 2018). The same set of questions was used to guide the discussion. Interviews were coded with letters indicating the sector (PS = private sector, PU = public sector, AC = Academia, NP = nonprofit) and numbers counting the interview within the sector. The data was analyzed to extract the drivers and enablers of CDI investment stemming from China and recipient countries as well as on an international level, which made up the coding system. A limitation of our resulting sample in terms of understanding the demand side of Chinese coal support is that only a limited number of interviewees is from major coal recipient countries as indicated by the main dataset (section 2.1). We complement our work with recently published interview-based research on the domestic political coal economy in major CDI recipient countries (Indonesia, Vietnam, South Africa e.g., Ordonez et. al., 2021; Dorband et al., 2020; Burton et al., 2019) that has been conducted independently of the Chinese context to ensure a complete picture.

3. Systematic comparative analysis of the evolution of power plants supported by Chinese and Multilateral development finance

3.1 Evolution of cumulative capacity

Since first identified financial transactions shortly after the initiation of China's Going Out Policy in 1999, the CDI-supported power plant capacity accumulated to more than 62% of the cumulative capacity supported by all Western-backed MDBs combined (1999-2020). The percentage rises to 74% when considering the cumulative capacity that is still in the pipeline (89 GW > total installed capacity of the UK in 2020). The total CDI supported active and pipeline capacity (as of April 2020) amounts to 151 GW which represents 2.9% of the World's total power generation outside China in 2017 (IEA, 2018) and which surpasses recent estimates for global capacities supported by foreign direct investments of Chinese companies equaling to 81 GW in the period 1999-2017 (Li et al., 2020). Thus, in a very short period, CDIs have emerged as the largest public finance providers in the global electricity sector, which is in line with Chen et al.'s (2020) parallel research examining the two major Chinese policy banks. After a sharp uptake of financial transactions after 2008, however, more recently the identified transactions seems to decline which will be elaborated in more detail in section 4.

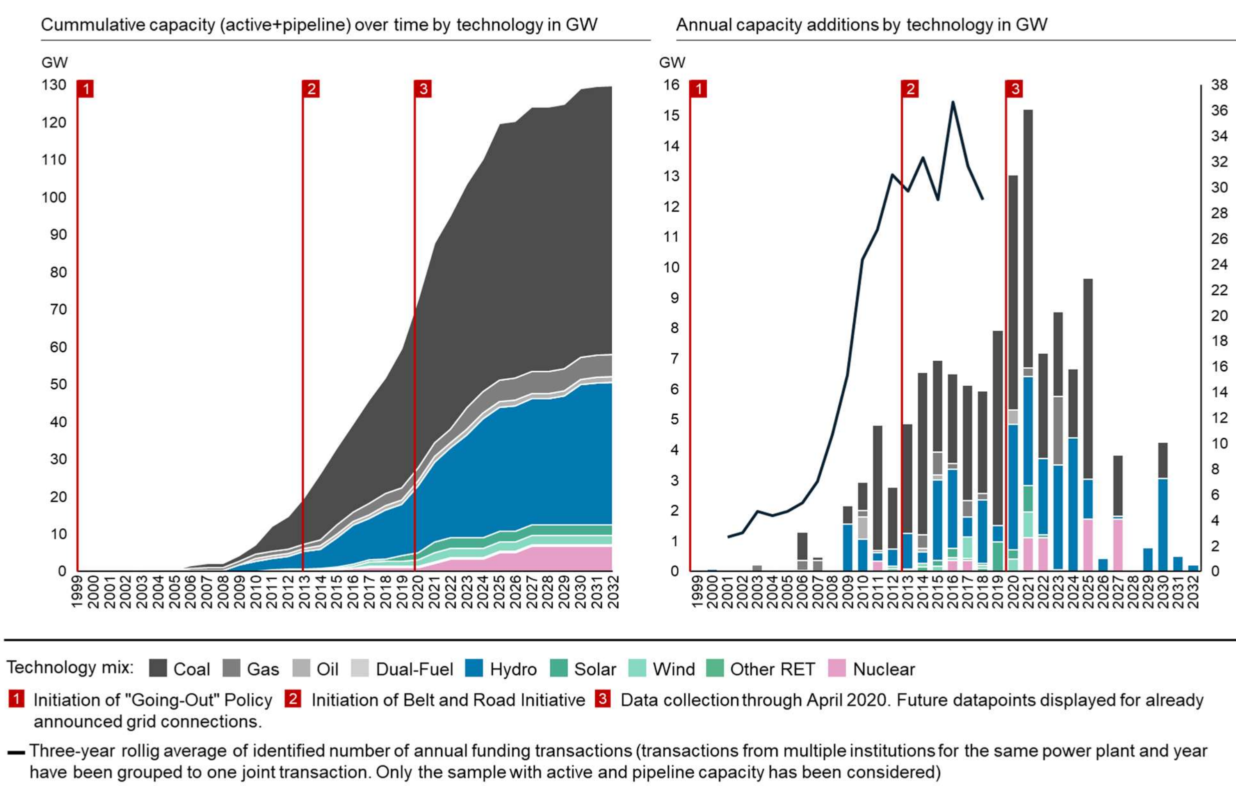


Fig. 3 Evolution of CDI-supported power plant capacities for identified funding activities in the period 1999-2020. For 21 GW of CDI-funded capacity, the grid connection year was not (yet) available.

3.2 Technological expansion patterns

Figure 4 displays the supported technology portfolio of CDIs and MDBs, differentiating between the technologies for the currently installed capacity and the supported pipeline capacity for planned grid connections in the period March 2020 - 2032.

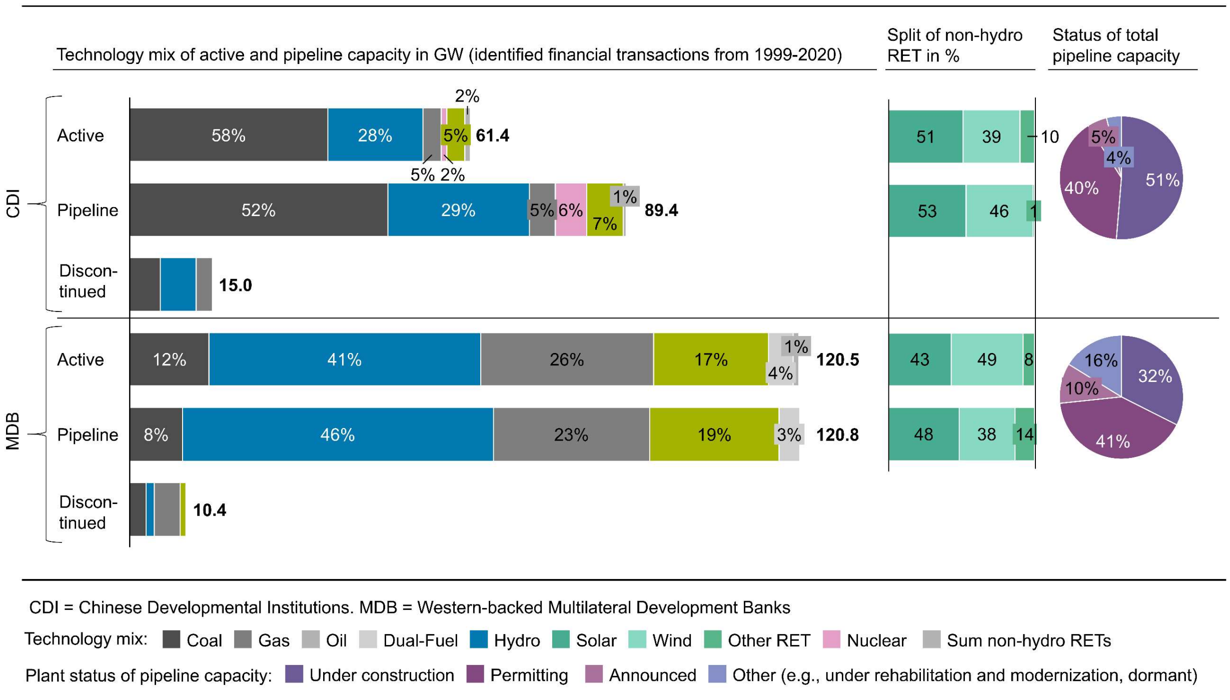


Fig. 4 Technology mix of active and pipeline capacity of CDIs in comparative perspective to Western-backed MDBs based on identified funding transactions in the period 1999-2020. As the ability to capture financial transactions of Western-backed MDBs seems to be limited in the period 1999-2004 (see Figure A.2), the identified active capacity financed by Western-backed MDBs represents a conservative estimate, albeit still in the same order of magnitude than the only other available comprehensive estimate from Steffen and Schmidt (2019) for all traditional MDBs in the period 2006-2015 equaling to 118 GW.

Coal-fired capacity

As shown in Figure 4, more than half (58%) of the currently installed CDI funded capacity is coal-fired and even more coal-fired capacity is in the pipeline (46.5 GW). The total identified capacity of 82 GW represents nearly half (48%) of the installed coal plant capacity of the European Union that is estimated to 170 GW for 2017 (IEA, 2018). Furthermore, it lies above the estimate from Chen et al. (2020) of 56 GW, which only included the two major Chinese policy banks. The focus on coal plants in the CDI portfolio stands in stark contrast to the MDB portfolio and what can be observed in China domestically. China's domestic coal share nearly halves from 61% in the currently installed capacity to 31% in the capacity that is in the pipeline according to GlobalData (2020) as of April 2020. This decrease is larger in percentage terms than that identified for Western-backed MDBs where the coal plant share decreases from 12% (active capacity) to 8% (pipeline capacity). With only ten coal plant units excluding dormant plants in the MDB-supported coal pipeline capacity (of which three are under rehabilitation and modernization and with no recent identified transactions after 2015), we find that the data reflects MDB commitments to limit and more recently to stop (e.g., US Department of the Treasury, 2021) their support for coal plants. Hence, in stark contrast to the decarbonization efforts in domestic China (prior to the pandemic), the portfolio of MDBs as well China's previous international commitments and the increasingly green BRI rhetoric[2], the CDI portfolio is heavily dominated by coal-fired capacity.

[2] For instance, in 2015, following an announcement of comparable nature by the OECD, China announced it would "work towards strictly controlling public investment flowing into projects with high pollution and carbon emissions both domestically and internationally" (OPS, 2015, p.1). In several BRI policy documents, China further emphasizes principles of sustainable and green development for its BRI (e.g., "The Guidance on Promoting Green Belt and Road" (MEE, 2017) and the "Belt and Road Ecological and Environmental Cooperation Plan" (BRP, 2017)).

However, in contrast with prior case-based studies claims (e.g., Taylor 2007; Kurlantzick, 2006; Van Dijk, 2009) and quantitative analysis (e.g., Uneo et al., 2014), this study observes a trend towards highly efficient and thereby less polluting coal plants in the CDI portfolio following trends in domestic China. The share of sub-critical coal-fired technologies (which involve steam pressures below 22 MPa and thus relatively low efficiencies for combustion) in the active power plant capacity (21%) is more than three times higher than that in the pipeline capacity (6%). At the same time, there is a strong shift towards ultra-supercritical technologies (at higher pressures with higher conversion efficiencies) rising from 3% to 44%, an increase that is more than twice as high as the increase observed for remaining power plants in the recipient countries, as well as for Western-backed MDBs (see Table A.4 in the Appendix). A possible explanation for the increasing trend towards more efficient coal plants might be technological progress by China in this area (Chang et al., 2016) that is exported by Chinese companies that are frequently tied to public development-related finance flows (Bräutigam, 2011). Nevertheless, the cumulative active capacity of CDIs is still considerably less efficient than the one financed by Western-backed MDBs, which is in line with the findings of Chen et al. (2020) that plants financed by the ExIm and CDB were less efficient than plants financed by the MDB for the period 2013-2017. Furthermore, we find tentative evidence that the share of emission control technologies in CDI's pipeline capacity is lower than for Western-backed MDBs and in domestic China, albeit the results would require further backing by future research (as the availability of information might be different across the samples and only the presence of different emission control technologies is tracked, see Table A.4 in the Appendix).

Gas-fired capacity

The CDI portfolio is marked by low and stagnating gas-fired capacity shares of 5% in the active and pipeline capacity portfolio (see Figure 4). This is in line with comparably small shares of gas-fired capacity in domestic China (see Figure A.1) that seem to be hindered by more expensive imported gas and more costly turbine technologies in comparison to coal-fired power (Qin, 2020). In contrast, gas-fired power stations are still an important part of the MDB portfolio. Approximately one fourth of the supported active (26%) and pipeline capacity (23%) of the MDB portfolio is gas-fired with an increasing focus on the Asia-Pacific region (where CDIs strongly reduce their fossil-fuel investment focus from active (79%) to pipeline (50%) capacity, see Table A.5). However, a recent executive order of the Treasury of the United States (a major donor across MDBs) narrows future support for gas-fired projects down to instances with a strict set of preconditions (e.g., alignment with goals of the Paris Agreement; proof for no economically and technically feasible clean energy alternative) (U.S. Department of the Treasury, 2021). This policy is likely to result in a decline in gas-fired capacity shares in the future MDB portfolio which might also affect demand for Chinese coal finance to address the need for firm capacity as will be elaborated in more detail section 5.

Hydropower capacity

Hydropower represents nearly one-third of the CDI-supported active and pipeline capacity (see Figure 3). As illustrated in more detail in Table A.8, the CDI-funded hydropower capacity (42.6 GW) accounts for approximately 5% of the total hydropower capacity in its 50 recipient countries. The pipeline capacity (25.5 GW) represents more than one quarter of the total identified hydropower pipeline capacity in China (102 GW) where the market is increasingly saturated (Kirchherr and Matthews, 2018). Furthermore, the CDI-funded hydropower pipeline capacity accounts for 44% of the identified pipeline capacity for all Western-backed MDBs together, which supports the view that China is manifesting itself as the world's largest investor in hydropower dams (Urban et al., 2018). Although there is a trend towards larger dams that are on average more than twice as large as the remaining hydropower dams in recipient countries, the average CDI-funded dam capacity seems to be on a par with dams financed by Western-backed MDBs. Furthermore, both CDIs and MDBs seem to have a comparable share of invested capacity into small-scale dams below 50 MW and 100 MW (see Table A.8 for more details). Thus, we do not find strong evidence supporting the notion that emerges from case study-based projects that China is investing in large-scale "white elephant" (Kurlantzick, 2006, p.3) projects (Ansar et al., 2014); it seems likely that there is selection bias in that case study based projects focus on large projects and not small-scale projects as also observed for dam research in more general (Kirchherr et al., 2016). There is another similarity between CDI- and MDB-backed projects in that we find a strong shift of the capacity towards Africa. For CDI-backed projects we find a shift of the capacity share from Asia-Pacific (active = 47%, pipeline = 32%) to Africa (active = 38%, pipeline = 52%), which might be caused by increasing opposition against large dam projects in Asia (Kirchherr et al., 2016). Similarly, we see a shift towards Africa for MDB-supported capacities from the active (23%) to the pipeline (38%) capacity share.

Non-hydro renewable capacity

As indicated in Figure 3, the sum of China's foreign non-hydro renewable capacity is growing from 5.3% (3.3 GW) in the currently installed capacity to 7.4% (6.6 GW) in the pipeline capacity and is thereby considerably lower (by around one third) than for Western-backed MDBs. Furthermore, it stands in stark contrast to China's higher domestic non-hydro RET shares that double from 10% in the installed capacity to 21% in the pipeline capacity according to GlobalData (2020). Solar and wind capacity is dominating (> 85%) for the non-hydro renewable portfolios of CDIs and MDBs alike with a comparably equal capacity split between solar and wind (Figure 4). However, we also observe a growing role of other non-hydro renewable technologies (namely geothermal technologies) for MDB-backed projects when looking at the change between the active to the pipeline capacity (Figure 4). An attempt to compare the capacity factors of CDI and MDB-funded wind projects (motivated by existing findings that capacity factors in China are considerably lower than in Europe and the US (Huenteler et al., 2018)) failed by insufficient data availability and might be addressed in future research. When compared to the other technologies, the regional distribution of CDI's involvement in non-hydro RETs is more equally distributed across the continents and has a relatively stronger focus on Europe, marked by reverse trends in comparison with traditional MDBs that decrease their focus on Europe and increase their focus on Africa (see Table A.5). Supplementary Note A1 provides possible explanations for the stronger focus on Europe which might be of commercial (e.g., more favorable investment conditions due to subsidies and lower implementation hurdles) as well as of geopolitical (e.g., expanding its BRI and political influence in Eastern Europe) nature.

Nuclear

Whereas MDBs do not support nuclear power stations CDI-supported nuclear capacity represents the technology with the highest relative growth rates from active (2%) to pipeline capacity (6%), but this is driven by just three large power stations. Two of them are in Pakistan and one in the United Kingdom (UK), where the CDB provided a $7.8 billion loan in 2015 to support the UK Hinkley Point C power station according to the dataset from Gallagher (2019).

3.3 Disaggregation by actors

Figure 5 breaks the CDI supported capacities down by institutions. The ExIm and CDB are the CDIs with the largest financed power plant capacities. The newly constructed dataset unveils 134 GW of power plant capacity up to April 2020 (127 GW including data up to 2018) where at least one of the Chinese policy banks has been involved as a finance provider. This represents 81% of the total CDI-backed capacity. In comparison, Chen et al. (2020) estimated the involvement of those two banks in the global electricity sector to 90 GW for financial transactions between 1999-2018. According to the newly constructed dataset underlying this paper both policy banks decreased their shares of fossil fuels in favor of nuclear, hydropower and non-hydro renewable capacity. Furthermore, there is an increase in the capacity that is jointly supported with Western-backed MDBs from the active (ExIm = 8%, CDB = 16%) to the pipeline (ExIm = 9 %, CDB = 20%) capacity share (see Figure 5). This indicates that there might be a conversion towards jointly used investment standards in the near future, as prospected in a recent joint report between the CDB and United Nations Development Programme (CDB and UNDP, 2019). Nevertheless, and in particular, in the case of the CDB, coal still dominates, and those two institutions will continue to be a global driving force for the expansion of coal-based electricity generation in the foreseeable future, as measured by the already supported capacity that is still in the pipeline as of April 2020 (see Figure 4).

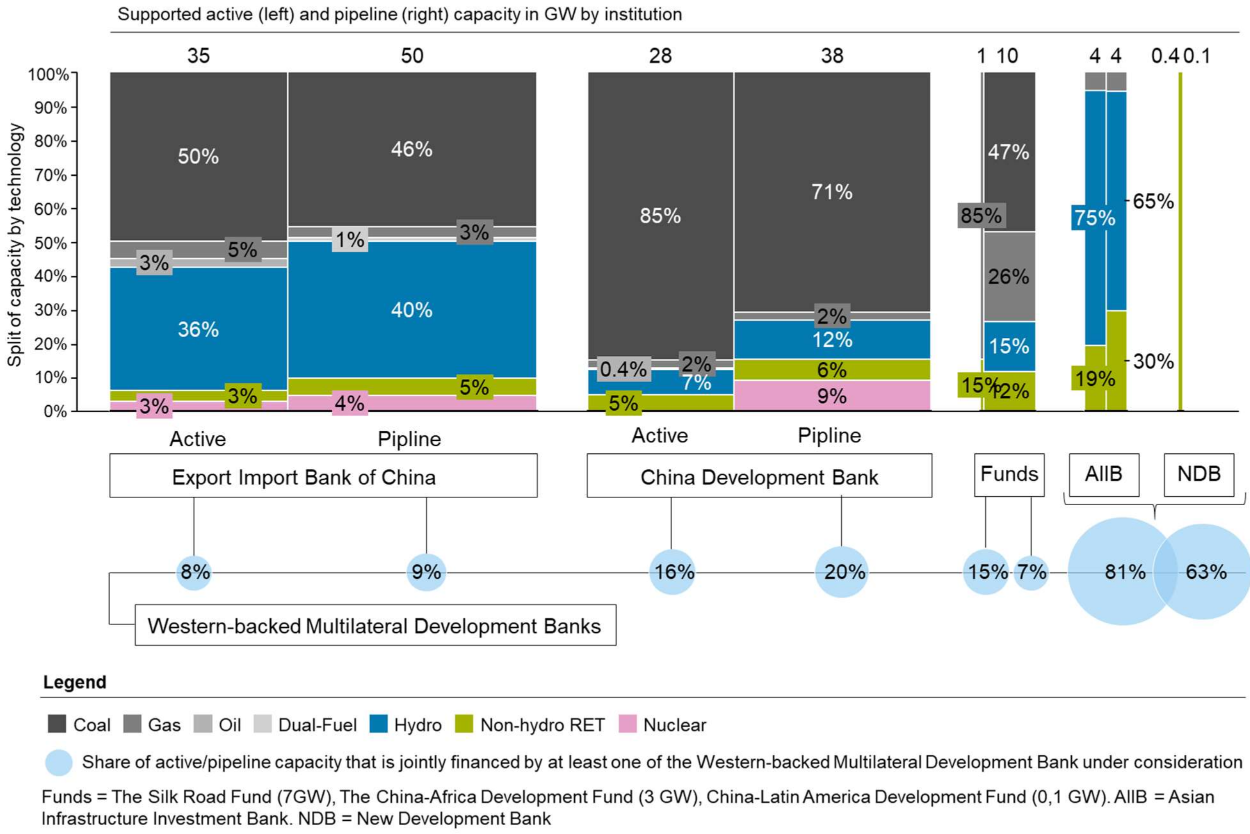


Fig. 5. Technology mix of active (1999-2019) and pipeline capacity disaggregated by Chinese Developmental Institutions and their joint investment capacity shares with Western-backed MDBs. The width of the left and right columns and the numbers at the top represent the active and pipeline capacity respectively.

In contrast to China's two major policy banks, the newly established development institutions, whose impact on global capacity additions in the electricity sector has not previously been collated, still seem to play a smaller role with amounting to 11% of the total CDI supported capacity (active + pipeline). The Silk Road Fund (7 GW), China-Africa Development Fund (3 GW) and the Asian Infrastructure Investment Bank (8 GW) are the most important new Chinese development institutions for the global electricity sector. As described in more detail in Table A.2, these smaller and newer CDIs are also open to shareholders beyond China. There has been a controversial discussion on the goals of China's newly established multilateral institutions (AIIB, NDB), which range on a spectrum from entities fulfilling China's foreign policy interests (e.g., Heilmann et al., 2014) to entities like MDBs dedicated to the common good (e.g., Callaghan and Hubbard, 2016). Although it is beyond the scope of this work to engage in this discussion, a view on financial flows directed towards the electricity sector indicates that the AIIB's technology portfolio is much closer to the aggregated portfolio of Western-backed MDBs, than to the one of China's major policy banks. Nevertheless, more than five years after their foundation the volume is still limited to 5% of the identified capacity of China's policy banks and stagnating from active to pipeline capacity. This is an interesting finding in so far as it is a direct proxy for the degree of multilateralization (of CDI finance flows) which is considered a crucial factor in shaping the future of China's BRI (Schulhof et al., 2021).

3.4 Spatio-temporal expansion patterns

Figure 6 provides the capacity distribution of CDI- and MDB-funded power plants across countries. It underscores that the involvement of CDIs expands significantly beyond the initial BRI corridors (marked by a red border in the figure as explained in the legend) covering large parts of the developing world.

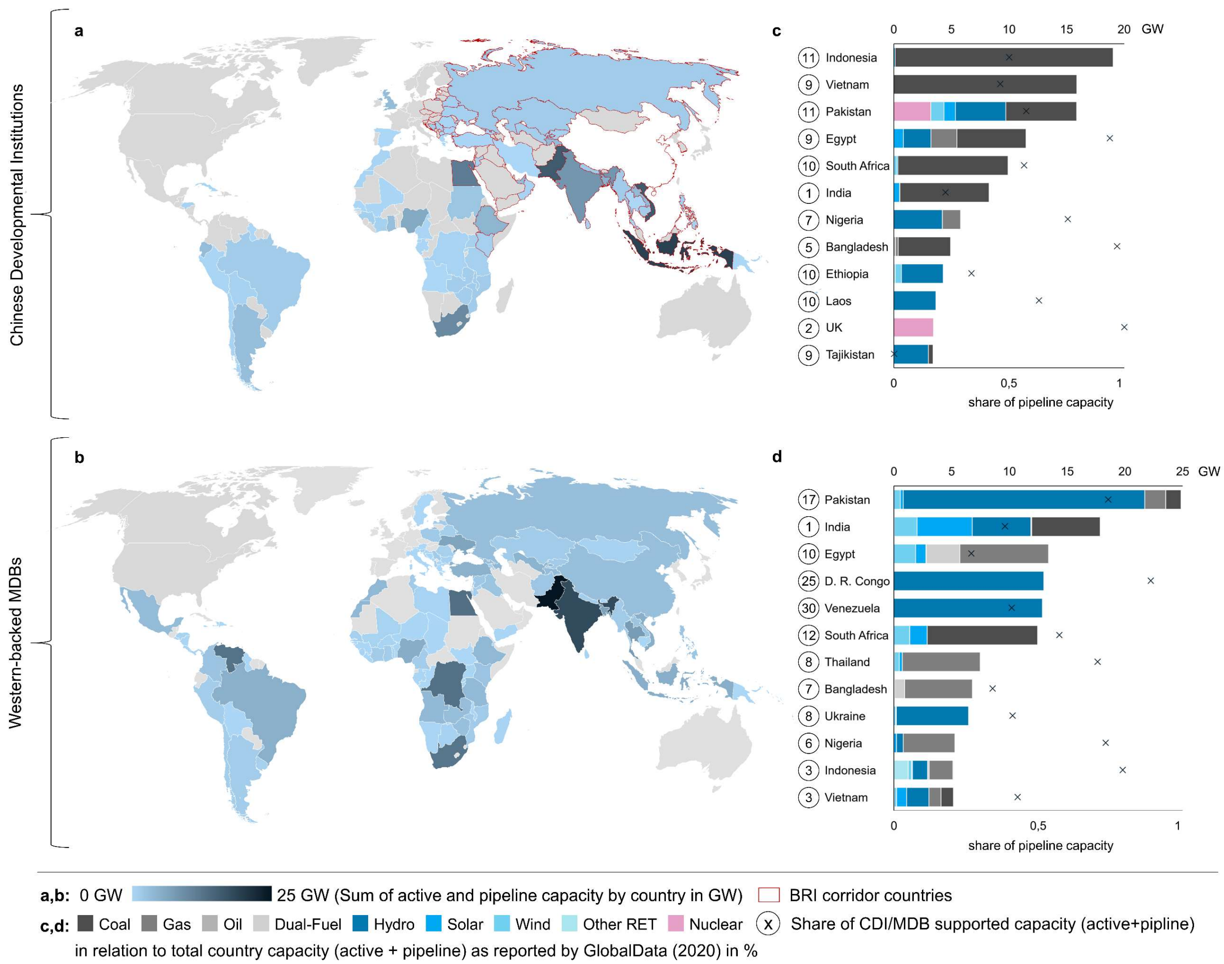


Fig. 6. Geographical distribution of active and pipeline capacity of CDIs and Western-backed MDBs in comparative perspective. The globally added incremental power plant capacity (active and pipeline capacity) resulting from identified financial transactions in the period 1999-2020 is displayed by country (a,b,c,d) and region (e). For the 12 major recipient countries, the capacity is broken down by technologies (c,d). BRI countries according to Hurley et al. (2019) represents a narrow definition along the initial BRI corridors and does not reflect (all) countries that signed a BRI cooperation agreement as stated in the Belt and Road Portal (2019). India, for example, lies along the initial BRI corridors but has refused to endorse the initiative with an agreement (Table A.7 in Appendix A provides the full list of BRI corridor and member countries).

Table 1 further disaggregates the regional capacity distribution highlighting the difference (Δ) between the share in active vs. pipeline capacity with respect to particular regions of the world. In both CDIs (Δ +16%) and Western-backed MDBs (Δ +11%) future capacity additions shift towards the Middle East and Africa, which is where the need (as measured by people without access to electricity) is the highest (IEA, 2019b). Whereas the active capacity of CDIs is strongly concentrated in Asia-Pacific (67%), the pipeline capacity is more globally dispersed with an increasing focus on Europe (Δ +8%). Western-backed MDBs show a reverse trend, with increasing capacities in Asia-Pacific (Δ +10%) and decreasing focus on Europe (Δ -12%). Whereas protectionist tendencies in India (Peng et al., 2017) might explain parts of China's reduced focus on Asia-Pacific, there is a decreasing overall trend for BRI corridor countries that are mostly located in Asia-Pacific (Δ -7%). Figure A.3 in Appendix A further details this counterintuitive observation by displaying the Chinese share of supported capacity in BRI corridor countries over time. Although there is an increased investment focus in BRI corridor countries directly after the initiation of the BRI initiative (2013-2016), there does not seem to be a lasting focus with a decreasing overall trend in the period 2013-2019.

Table 1
Regional distribution of supported active and pipeline capacity in comparative perspective for CDIs and MDBs for financial transactions in the period 1999-2020. The Δ refers to the difference of the capacity share between the active and pipeline capacity with respect to particular regions of the world. BRI countries according to Hurley et al. (2019) represents a narrow definition along the initial BRI corridors and does not reflect (all) countries that signed a BRI cooperation agreement as stated in the Belt and Road Portal (2019). Table A.7 in Appendix A provides the full list of BRI corridor and member countries.

	Chinese Developmental Institutions			Western-backed MDBs		
	Active Capacity	Pipeline capacity	Δ	Active Capacity	Pipeline capacity	Δ
Asia-Pacific	41.3 GW (67%)	43.2 GW (43%)	-24%	39.6 GW (33%)	52.3 GW (43%)	+10%
Europe	0.1 GW (2%)	9.5 GW (10%)	+8%	23.2 GW (19%)	8.0 GW (7%)	- 12%
Middle East and Africa	15.4 GW (25%)	40.7 GW (41%)	+16%	37.1 GW (31%)	50.8 GW (42%)	+11%
North America	0 GW (0%)	0 GW (0%)		2.5 GW (2%)	0.9 GW (1%)	-1%
South and Central America	3.6 GW (6%)	6.7 GW (7%)	1%	18.2 GW (15%)	8.8 GW (7%)	- 8%
BRI corridor countries	46.1 GW (75%)	60.8 GW (68%)	-7%	67.5 GW (56%)	60.5 GW (50%)	-6%
BRI member countries	53.8 GW (87%)	78.6 GW (88%)	+1%	98.6 GW (82%)	107.0 GW (88%)	+6%
Total	61.4 GW (100%)	89.4 GW (100%)		120.5 GW (100%)	120.8 GW (100%)	

This contradicts, to some extent, more aggregated estimates including energy and transport infrastructure investments (e.g., Zhou et al., 2018; Gallagher and Qi, 2018). Zhou et al. (2018), for example, observed an increasing trend for Chinese energy and transport investments in countries located along the initial BRI corridors for the period 2014-2017. We note that the comparability between those studies and of quantitative BRI-related publications in general is not only inhibited by the fact that other studies considered different finance types and sectors, but also by how different studies define BRI countries. Over time, the number of countries that are considered to be part of the BRI increased beyond the initial BRI corridors to more than 130 countries that have signed BRI cooperation agreements (Belt and Road Portal, 2019). As evident from Table 2 and Figure A.3, CDIs redirect their capacity from initial BRI corridor countries to new BRI member countries, where 88% of the pipeline capacity cumulates and Western-backed MDBs seem to follow with strongly increasing their presence in those countries to the same pipeline capacity share as CDIs. In sum, this supports the dynamic nature of the BRI (Oliveira et al., 2020) from a geographical and temporal point of view which some researchers describe as ‘moving target’ (Schulhof et al., 2021).

While the rise of CDIs in the global electricity provides urgently needed support to address the severe infrastructure investment gaps in the developing world there is an need to steer the heavily coal-dominated technology portfolio into a less carbon-intensive direction. With the last planned plant decommissioning year of the Kusile power station in South Africa in 2073, Chinese-funded power plants will create lock-in for decades, just in a time where large-scale renewables are becoming cost-competitive in many contexts (Nature Energy, 2017) and scientists anticipate that all available pathways to limit global warming to 1.5 °C would require a steep reduction of coal-fired electricity with a virtual phase-out by 2050 (IPCC, 2018, p. 15). Edenhofer et al. (2018) illustrate how globally planned coal plants alone would nearly deplete the carbon budget for reaching the 2°C temperature target. Once the coal plants are connected to the grid advancements of renewables might be ‘too little, too late’ (Edenhofer et al., 2018, p.8) as they are unlikely to be shut down given the high sunk cost. Whether or not China’s recent pledge towards the end of 2021 that it will stop supporting coal power plants abroad (Xi, 2021) will change this remains to be seen.

4. Drivers and enablers of the Chinese coal expansion

Figure 7 maps the results of the semi-structured expert interviews and our literature review together with other recent advancements in this area along a structure that differentiates between coal drivers and enablers on the supply as well as on the demand side. Although this summary does not claim to be comprehensive, it attempts to create a good starting point for the design of promising interventions on how to steer CDIs from the current coal focus into a less carbon-intensive direction.

4.1 Drivers of coal finance on the demand side

The Chinese coal finance offering seems to be well-tailored to pressing needs for firm electricity capacity at minimal cost that occur in the context of rapid economic development and limited domestic resources. The seven major recipient countries[3] of CDI-funded coal capacity (84% of the total), for example, have not reached 100% of electricity access. All seven countries would need to invest a significant share of their GDP (1.8-3.8% between 2016-2030) to satisfy their rising electricity investment needs and to provide electricity to 100% of their population by 2030 (Global Infrastructure Hub, 2017; see Table A.6). Despite rapidly declining costs for renewables, coal might still have been the cheapest option, at least in the short term (Interview ID PS16, PS11; Steckel and Jakob, 2021). A lack of domestic financial resources (Interview ID NP3), comparably low and subsidized interest rates from CDIs (Interview ID PU8; Burke et al., 2019) and decreasing availability of finance from MDBs (in general and for coal in particular; Section 3; Steffen and Schmidt, 2019) made CDI finance particularly attractive to address development challenges (Interview PU3) and support various socio-economic development indicators (e.g., Moner-Girona et al., 2021) that are linked to electricity access (or at least constituted a powerful narrative for coal-supporting incumbents).

Beyond a purely techno-economic evaluation a network of political and economic coal interest groups and the resources that they possess seem to be an important driving force in all major CDI recipient countries. In Indonesia, South Africa and India (that together account for 44% of the CDI funded coal-fired capacity as of April 2020 excluding dormant plants, see Table A.4) path dependencies and diverse interests related to their coal mining history (e.g., local employment effects, coal royalties, transition costs, lobbying and bribery) seem to play a role (Steckel and Jakob, 2021; Spencer et al., 2018; Jakob et al., 2020; Burton and Winkler, 2014). Although additional coal drivers on the supply side seem to be diverse and country-specific (see Table A.3 for a review of relevant literature) a common similarity between the recipients is the presence of China as another powerful actor that exert its influence to support the expansion of its domestic coal companies (see section 4.2), oftentimes via confidential government-to-government negotiations and resulting bilateral infrastructure financing contracts (Interview ID PS17, PU8). China's involvement in Kenya, for example, "appears to be one of the major factors influencing the prospects of coal in the country" (Boulle, 2019, p.1). In 2017, the Kenyan president Kenyatta personally attended the signing of loan agreements in Beijing for infrastructure finance from the ExIm as well as an agreement between Amu Power and China Power Global for the intended construction of Kenya's first coal power plant (Breuer, 2017; Burrows, 2017).

[3] Indonesia, Vietnam, South Africa, India, Pakistan, Egypt, Bangladesh

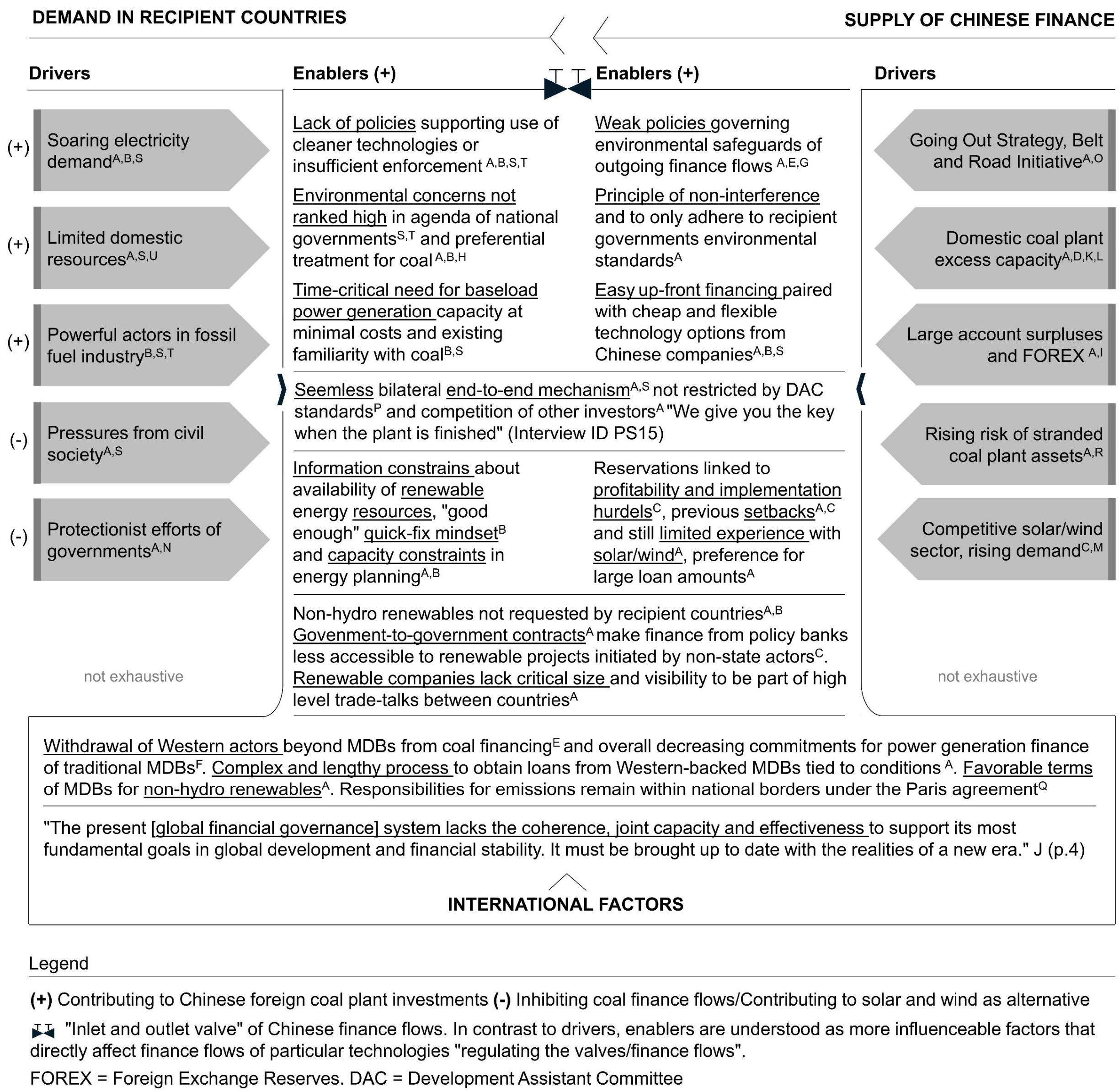


Fig. 7. Influencing factors of Chinese support for coal plants and more sustainable renewable alternatives mapped to a framework that differentiates between demand- and supply-related drivers and enablers. Analysis based on stakeholder interviews, descriptive trends and the literature. Authors' own depiction based on A) Own primary data collection (see Appendix C); B) Gallagher et al., 2021; C) Kong and Gallagher, 2021c; D) Kong and Gallagher, 2021a,b; E) Gallagher and Qi, 2018; F) Steffen and Schmidt, 2019 G) Coenen et al., 2021; H) Gray et al., 2018a,b; I) Kong and Gallagher, 2017; J) G20 Eminent Persons Group, 2018; K) Feng et al., 2018; L) Yang et al., 2018; M) Cabré et al., 2018; N) Peng et al., 2017O) Oliveira et al., 2020; P) Fan et al., 2014; Q) UNFCCC, 2021; R) Gray, 2018; S) Steckel and Jakob, 2021; T) Ordonez et al., 2021; U) Dorband et al., 2020.

Civil society plays a role by exerting pressure on the existing coal reinforcing structures, in particular, when facing projects that are reported to be marked by a lack of involvement of local communities (Interview NP1, NP3, PS6) and low environmental and social safeguards (Interview ID PU1, NP5). In 2014, for example, four community members were killed by the police in Bangladesh while protesting against the construction of a Chinese-funded coal power plant that had been initiated without environmental impact assessment or prior public consultation (Kotilkalapudi, 2016). More recent examples include the suspension of the Chinese-funded Lamu coal power plant in Kenya after strong resistance from environmental activists and members of the local community (Banik, 2021). Furthermore, several respondents reported an increasing Anti-Chinese sentiment across Southeast-Asia (Interview ID NP6) and beyond (Interview ID

PS6), something that may be exacerbated during the current pandemic (Interview ID PS1, AC4, PS5). This illustrates how grassroots movements not only have the ability to increase the financial risk for Chinese finance providers (linked to delays or stranded assets), but also come with a reputational risk for China's BRI. This again is a concern for the Chinese Communist Party, as it leverages the BRI as a success story to support its domestic legitimacy (Interview ID PU2).

4.2 Enablers of the coal finance pipeline

Several enabling factors (which we define as factors that can be influenced by interested parties that directly affect finance flows for particular technologies "acting as valve of the pipeline" (see Fig. 7)) worked in favor of the coal finance pipeline between China and recipient countries.

First, policies that serve as inlet and outlet valves of Chinese finance flows are important. In Indonesia, Vietnam, India, and Bangladesh for example, the weak or lack of policies in support of the diffusion of less polluting technologies (e.g., solar, wind) are in strong contrast to policies with explicit preferential treatment for coal (Gallagher et al., 2021; Burke et al., 2019). In Vietnam, for example, coal-fired power plants received long-term price guarantees for over 20 years, whereas solar and wind power stations where subject to short-term contracts (Steckel and Jakob, 2021) – this has been partly addressed by recent policy changes in favor of solar and wind (Do et al., 2021). Likewise, on the Chinese side coal finance flows have been facilitated by the principle of non-interference (e.g., acceptance of lower national standards in recipient countries) (Interview PS11, PS1, PU1) and weak environmental policies for outgoing finance flows. In contrast to China's increasingly restrictive domestic environmental policies (Interview ID PS12), foreign coal finance flows are facilitated by "still relatively weak and mostly voluntary" policies governing environmental safeguards of foreign finance flows (Gallagher and Qi, 2018, p.4). However, one respondent reported that this might change in near future following the cancellation of large foreign Chinese-funded projects with low environmental and social safeguards (Interview ID NP5).

Second, in contrast to the conditional and bureaucratic process to obtain finance from traditional MDBs, the Chinese offering constitutes, in some cases a seamless "end-to-end" (Interview ID PS16) bilateral pipeline that is not restricted by OECD guidelines that (inter alia) limit tied aid (DAC, 2020) and impose environmental standards on financing activities (DAC, 1992). "Much faster, much less complicated" (Interview PU7) financing coupled with cheap and flexible technology options for highly efficient coal plants from Chinese (state-owned) companies is well-tailored to pressing electricity needs and existing acquaintance with coal on the side of the recipient countries ("we give you the key when the plant is ready" Interview ID PS15). (Interview ID PU8, PS9, PS16, NP5, AC5) According to some respondents, some bilateral Government-to-Government contracts are further facilitated through corruption and a lack of transparency and bidding requirements (Interview ID NP1, NP3, NP5, AC4, PS10). However, it is important to mention that we did not attempt to verify claims of corruption and that we are not able to make any assertions about their global or regional prevalence.

Additional coal-enabling factors hindering a shift of CDI finance flows towards solar and wind projects that were mentioned by the interviewees are capacity and information constraints in energy planning in recipient countries (Interview ID PU5) and more favorable conditions of Western-backed MDBs for solar and wind finance in comparison to CDIs (Interview ID AC4, AC3). Ultimately, those factors result in recipient countries oftentimes not asking CDIs for solar and wind finance in the first place (Interview ID AC3). On the Chinese side, a preference for large loan amounts (Interview ID PU5), previous setbacks (Interview ID AC3) and still limited experience with solar and wind financing (Interview ID PU5) might play a role. In addition, (non-hydro) renewable companies oftentimes lack the critical size and visibility to be part of high-level trade talks between governments (Interview ID PU5). "So, this all feeds into a sort of a vicious circle where only the largest, dirtiest infrastructure companies are able to participate in these overseas, going abroad projects" (Interview ID PU5).

4.2 Drivers on the supply side

On the Chinese side, coal finance flows are driven by its domestic political economy needs, which seem to be well matched to the ones observed on the demand side of the major recipient countries. The creation of commercial opportunities for Chinese state-owned companies (which are frequently tied to Chinese state finance and that suffered domestic overcapacity at home) seemed to play an important role (e.g., Interview ID AC3, AC4, NP3, PU2). One respondent estimated that "almost 90% of the contracts in Chinese projects go to Chinese companies" (Interview ID NP3) that are closely aligned with the Chinese government (Interview ID 97, PS16). As illustrated in more detail in Figure A.1, China's share of coal in power generation strongly declined in the period after the initiation of its Going Out policy in the context of increasingly restrictive domestic regulations (Gallagher and Qi, 2018; Tang et al., 2019). The domestic coal-fired power equipment manufacturing sector suffered from this development with accumulating large production overcapacities and the Chinese Government encouraged its financial institutions to facilitate the international expansion in the context of the Going-Out and BRI policy (Kong and Gallagher, 2021). In addition, and in contrast to many countries of the Western world, China's ability to provide development finance has been facilitated by strongly rising account surpluses since the turn of the century that accumulated into large foreign exchange reserves (FOREX) and available financial resources (Interview ID PS15, PS5, PU4); peaking to nearly four trillion US dollars in FOREX one year after the initiation of China's Belt and Road Initiative (PBOC, 2014). The sharp uptake of the CDI-funded capacity after 2008 (Figure 3) might be partly explained by the government's decision to channel parts of its large foreign exchange reserves to its financial institutions to support the implementation of its Going Out strategy in the aftermath of the financial crisis[4].

While domestic overcapacity and large account surpluses have played an important role in the past driving coal finance abroad, more recent developments might indicate a paradigm shift . China's account surpluses have decreased and are projected to further decrease in the coming years (Deb et al., 2019). China's recovery from the current pandemic seems to depend on significant investments in additional coal capacity (Steckel and Jakob, 2021; Gosens and Jotzo, 2021) which means more domestic demand for its coal-fired power equipment manufacturing sector. In addition, several interviewees expect a reduction in BRI-related infrastructure investments which they explained with domestic investment needs in the context of the pandemic (Interview ID NP4, AC3, NP6, PS14), decreasing dependence on external markets (Interview ID NP4), an expected shift of the BRI away from infrastructure to other focus areas (Interview NP6; AC7, PS15, PU8) and rising stranded asset risk for coal in particular (Interview ID PU5). In addition, debt distress and the decreased ability to repay loans on the side of recipient countries (Interview PU6, NP3, PU8, NP4) have been mentioned "of profound structural importance" (Interview NP4) with some participants estimating that for some countries already now "the chances of repayment are almost nil" (Interview ID NP4); a situation that is exacerbated through the current pandemic (Interview ID PU8, PU4). Those factors might partly explain and lead into a continuation of downturn for transactions from CDIs after 2016 as observed in our quantitative dataset (Figure A.3).

5. Conclusion and implications for policy

The newly constructed dataset reflects the involvement of CDIs to a considerably greater extent than that which has been done before and illustrates how CDIs rapidly emerged as major public finance provider of

[4] Since 2008, when Western economies have been hit by the financial crisis, China started to channel parts of its foreign exchange reserves to its financial institutions to support the implementation of its Going Out strategy. According to Kong and Gallagher (2017) the targeted diversification and internationalization of its US treasury-based FOREX reserves was also motivated by the states desire to preserve the value of its reserves in the context of a of a weakening US dollar. A major part of this billion-scale state capital injection is estimated to have been channeled into the energy and resource sector (Kong and Gallagher, 2017).

the developing world. Since the initiation of China's Going Out Policy in 1999, CDI-supported power plant capacity rapidly accumulated to more than 60% of the cumulative capacity supported by all Western-backed MDBs combined (1999-2020) and the percentage rises to 74% when considering the cumulative capacities that are still in the pipeline. After an initial focus on the Asia-Pacific region, Chinese development finance flows are becoming increasingly globally dispersed and now cover most of the developing world without an apparent focus on initial BRI corridors.

Although CDIs have supported a broad range of technologies, more than half (52%) of the CDI-supported installed capacity is coal-fired, with an even larger capacity from coal in the pipeline (46.5 GW as of April 2020). This heavily fossil-fuel dominated technology portfolio is mostly driven by China's major bilateral vehicles (ExIm, CDB) and we show that stands in stark contrast not only to China's domestic decarbonization efforts, the efforts of the power section of its newer CDIs, and the considerably greener portfolio of Western-backed MDBs, but also contradicts its international commitments to limit public finance towards coal and the increasingly green rhetoric linked to its BRI. Nevertheless, we find emerging signs towards a less carbon-intensive orientation with a trend towards more efficient and thereby less polluting coal-plants (e.g., the share of ultra-supercritical technologies rises from 3% to 44% from the active to the pipeline capacity portfolio), rising shares of non-hydro renewable capacities (active capacity = 5.3%, pipeline capacity = 7.4%) and the appearance of joint investments with MDBs (13% of total CDI funded capacity). Joint investments are particularly prominent for the newly established China-backed multilateral vehicles (AIIB, NDB), albeit their supported volumes are small (5% of the total CDI supported capacity) and stagnating. This is in so far an interesting finding as it is a direct proxy for the degree of multilateralization (of CDI finance flows in the electricity sector) which is considered a crucial factor in shaping the future of China's BRI.

While the rise of CDIs in the electricity sector provides urgently needed support to address the severe infrastructure investment gaps in the developing world, it is likewise severely undermining ambitions to limit global warming to 2° C above pre-industrial levels. There is an urgent need to steer the heavily coal-dominated technology portfolio into a less carbon-intensive direction while ensuring reliable energy supply. In an attempt to provide at least some answers to what actions may be needed, we also investigate what may have driven CDI coal investments in the first place using interviews and a synthesis of the existing literature. We find that Chinese development related coal-finance finance flows are, in large part, a bilateral pipeline that driven by demand for cheap and stable baseload electricity at minimal costs on the side of the recipient countries and overcapacity related pressures on the side of the Chinese domestic political economy. This well-matched supply-demand mechanism is stabilized by powerful incumbents and is lubricated by a multitude of enablers on the Chinese side, the side of the recipient countries, as well as on the side of alternative finance providers including traditional MDBs. However, more recently several trends that are partly catalyzed by the effects of the pandemic (e.g., debt distress of recipients, focus of shrinking resources on domestic recovery) and China's recent international pledge indicate that the window of opportunity for CDI coal finance might be closing. We use the trend analysis and the assessment of drivers to identify three areas for policy implications:

Strengthening alternative financial support and capacity building

Given the limited domestic resources and substantial electricity investments needs in major CDI coal-recipient countries (section 4.1) the mobilization of more sustainable financing alternatives is needed. The observed recent decrease of CDI electricity funding could be further accelerated by effects of the ongoing pandemic (according to our interview-based driver analysis). This highlights the importance of additional capital mobilization. The recent global commitment to accelerate the phase-down of unabated coal power in the Glasgow Climate Pact (UNFCC, 2021, Article 36), and recent commitments by Indonesia and Vietnam to achieve a transition away from coal "in the 2040s (or as soon as possible thereafter)" (COP 26, 2022, p.1) will require additional financial support. Traditional MDBs might consider reversing the declining financial commitments towards power plant infrastructure by leveraging their reputational and financial strength to also attract other investment types through risk mitigation (for example, via country and regional development platforms, see below). Supporting gas-fired capacity seems to be a viable and possibly necessary alternative in the short-term (given the need for stable baseload power as well as intermittency and grid integration hurdles for renewables). In this context, the recent executive order of the US Treasury to restrict (the currently well established) MDB support for gas-fired power plants (section 3.2) might prolong the closing of the window of opportunity for Chinese coal finance. Beyond financial resources, supporting recipient countries in expanding their domestic capabilities in the field of long-term energy planning and the development and implementation of policies to stimulate the deployment of cleaner technologies, seems to be an important area of (recipient country driven) external support. The hereto mentioned angles of external financial support and capacity building, however, will only be successful when driven by leadership and willingness to act of the central and regional governments of recipient countries to remove the multi-layered incentives for preferential coal treatment.

Introduction of more stringent environmental policies on outgoing Chinese finance flows

President Xi's recent announcement at the United Nations General Assembly that "China will step up support for other developing countries in developing green and low-carbon energy, and will not build new coal-fired power projects abroad" (Xi, 2021 p.4) is likely to require operationalizing existing highly conceptual, mostly voluntary, corporate self-regulatory guidelines (Coenen et al., 2020) into more stringent environmental policies and rules. On the one hand, such a policy effort seems to be inhibited by a highly fragmented and complex environmental governance architecture globally (Interview ID PU 2). Conversely, despite the complex stakeholder landscape as a whole, the majority of coal-finance can be traced to the CDB and ExIm. Both are fully owned by the Chinese state and under the direct leadership of the State Council (Table A.2). The State Council could request the application of stricter domestic environmental policies such as ultra-low sulfur standards to outgoing finance flows, something that would have an immediate effect of limiting coal finance flows and set incentive for more sustainable alternatives. Given the fact that 46.5 GW (57% of the total) of the CDI-funded coal plant capacity has not yet been connected to the grid (17.4 GW are still in permitting stage as of April 2020), it will be imperative to also consider the pipeline capacity in the concretization of China's commitment by, for example, supporting a conversion of already funded coal-fired boilers to use natural gas in cases where a switch to renewables is not feasible.

Establishment of development country and regional platforms

In large parts, Chinese development finance flows constitute a bilateral pipeline that is cutting through international Development Assistance Committee standards and the multilateral approach of traditional MDBs which were the dominating public finance providers in the electricity sector before CDIs emerged. In its magnitude, this has implications beyond the current risk and future opportunities for the decarbonization of the global electricity sector with drifting the global financial governance system into more fragmentation and posing a potential threat to the open liberal market economy order[5]. A promising proposal to address this trend from the perspective of the international community is a recent recommendation from the G20 Eminent Persons Group on Global Financial Governance that has been mandated by the G20 finance ministers to develop recommendations for the reformation of the global financial architecture and the governance system of International Financial Institutions (G20 Eminent Persons Group [G20 EPG], 2018). One of the proposals in their report "Making the global financial system work for all" is to establish country platforms that would comprise MDBs, as well as bilateral official agencies (e.g., ExIm, CDB). The underlying motivation is to leverage complementarities and increase

[5] Western policy makers and experts are accusing China of instrumentalizing its development program to secure unfair commercial advantage for its domestic companies (e.g., Naim, 2007) which might result into "market distortions to ripple across the world" (European Chamber of Commerce 2020, p.3). Furthermore, there is a controversial discussion on the underlying motives of China's Belt and Road Initiative ranging from accusations that it is a strategy to create vassal states to comparing it with a new marshal plan (European Chamber of Commerce, 2020)

coordination between countries' development partners, mobilize private sector investments and increase crisis response capacity. Although a coordinated and synergetic approach, including CDIs and Western-backed MDBs, seems to be the best choice to address climate and development challenges, the further development and implementation of the G-20 backed platform design might benefit from a from few considerations related to the need to reduce the risk of low environmental and social standards, to include a stronger involvement of civil society, and to increase incentives for Chinese participation (see Supplementary Note A.2). Providing reliable power to developing countries while addressing the climate challenge is crucially important and will require the support of CDIs as well as MDBs. An comprehensive and comparative understanding of the evolution of public finance over time can help identify priorities and tradeoffs and inform the design of country development platforms.

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CRediT authorship contribution statement

J.P.B., and J.M.T.S conceptualized the research. V.S. conducted primary interviews. J.M.T.S performed research, analyzed data, wrote the paper, and compiled the power plant finance dataset. L.D.A., J.K., J.P.B., and V.S. provided comments and J.P.B supported with validation. L.D.A. secured funding and is the main supervisor.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

The Appendix is provided at the end of this file.

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Appendix

Appendix A: Supporting Analyses

Table A.1

Summary of previous and ongoing publications on power generation-related financing activities of Chinese Developmental Institutions that go beyond the single case study approach. Authors' own depiction.

				Covered Chinese actors						Sector focus				Covered power generation technologies		
				Chinese Developmental Institutions[1]												
Publication	**Years covered**	**Geographical Scope**	**Database** (with information on development finance)	CDB	ExIm	Funds	AIIB	NDB	Other	All sectors	Infrastructure	Energy	Power	All major Tech.	Select technologies	**Technological Detail[2]**
Non-governmental organizations																
Barnett and Ladislaw (2018) [Center for Strategic and International Studies]	2016	Global	Own compilation from project documents				X		X			X			Oil & gas, hydro	aggregated
Eder and Mardell (2019) [Mercator Institute for China Studies]	not given	BRI countries	MERICS BRI Database (not accessible)	Sum of Chinese involvement (not disaggregated)									X	X		plant level
Galkin et al. (2019) [King Abdullah Petroleum Studies and Research Center]	2000-2018	Global	China's Global Energy Finance Database	X	X				X			X		X		aggregated
Chen and Schmidt (2017) [National Resource Defence Council]	2013-2016	Global	NRDC database	X	X				X				X		Coal and renewables	plant level for coal
Hervé-Mignucci et al. (2015) [Climate Policy Initiative]	2005-not specified		compilation from various sources	X	X				X						Coal	plant-level
Shearer et al. (2019) [Institute for Energy Economics and Financial Analysis]	Plants under development	Global	Own compilation guided by Global Coal Plant Tracker	Chinese financial institutions and corporations											Coal	unit-level
Gallagher (2016) [Center for International Environment and Resource Policy]	2001-2016	Global	China's Global Energy Finance Database	Chinese financial institutions (not disaggregated)									X		Coal	unit-level
International Organization																
Official AIIB (2020) data		Global	Internal AIIB data				X			X						partly plant-level
Official NDB (2020) data		BRICS countries	Internal NDB data					X		X						aggregated (except for one identifiable plant)
Scholarly articles																
Uneo et al. (2014)	2007-2013	Global	Own compilation from news reports	X	X				X				X		Coal	unit-level
Bräutigam and Hwang (2017)	2000-2013	Africa	Own compilation from various sources	X					X						Hydro	plant-level
Kong and Gallagher (2017)	2000-2014	Global	China's Global Energy Finance Database	X	X				X			X		X		aggregated
Zhou et al. (2018)	2014-2017	BRI countries	China's Global Energy Finance Database	X	X	X			X		X					aggregated
Gallagher et al. (2018)	2000-2017	Global	China's Global Energy Finance Database	X	X	(X)	(X)	(X)				X		X		aggregated/ plant Level
Kong and Gallagher (2019)	2002-2018	Global	China's Global Energy Finance Database	X	X								X		Coal	plant-level
Kong and Gallagher (2021c)	2000-2018	Global	China's Global Energy Finance Database	X	X								X		Solar, wind	plant-level
Chen et al. (2020) (parallel research effort[3])	2000-2018	Global	China's Global Energy Finance Database	X	X								X	X		unit-level
This study	1999-2020	Global	Newly constructed dataset	X	X	X	X	X					X	X		unit-level

1) CDB = China Development Bank, ExIm = Export-Import Bank of China, 20 regional and bilateral development funds as defined in Table A.1, AIIB = Asian Infrastructure Investment Bank, NDB = New Development Bank. (X) = First comprehensive compilation of funds with potential relevance for energy investments and aggregated estimates of total financial volume without information on the share of power generation investments or single financed power plants.
2) Aggregated = financed power plants not identifiable; Plant level = single financed power plants mentioned; Unit level = technological details für plants provided (e.g., plant efficiency).
3) Chen et al. (2020) published their work in an advanced stage of the present research effort. Their research is contrasted with the present research effort in more detail in the introduction.

Table A.2

Definition of Chinese Developmental Institutions and Western-backed Multilateral Development Banks for the purpose of this study with supporting details on financial magnitude, degree China can influence decisions and covered (simplified) finance types. Author's own depiction based on the following sources: Gallagher et al., 2018; Kong and Gallagher, 2016; Gallagher and Qi, 2018; AIIB, 2019; AIIB, 2021; NDB, 2021; Wang, 2019; Humphrey, 2020; Leksyutina, 2018; Mishra, 2016; Papagianneas, 2019; Wright, 2017. (x): Although the AIIB and NDB intend to issue guarantees they have not yet issued them; Lending to the private sector from the NDB (Humphrey, 2020) and equity investments from the ExIm and CDB are very limited (Kong and Gallagher, 2021a).

Finance Type	Institution Type	Institutions[1]	Key-facts and BRI relevance		Financial magnitude (estimates)	Degree China can influence decisions	Finance types and sectors: Loans with varying concessionality	Credit guarantees	Export credits	Equity investments	Public Sector	Private Sector
Chinese Develop-mental Institutions	Policy Banks	China Development Bank (CDB)	Major finance vehicles behind China's Going Out policy and Belt and Road Initiative with loans being issued in close collaboration with China's principal development planner (NDRC). Founded in 1994, they have been tasked to finance public sector investment at home as well as to support the international expansion of domestic companies. Both banks have been supported through capital injections from China's foreign exchange reserves in support of the Going out strategy and the BRI (Kong and Gallagher, 2016)	Considered as the world's largest financial institution for oversee loans (Kong and Gallagher, 2016). Focus on financing development-related infrastructure projects (Gallagher and Qi, 2018)	USB$278 of international loans by 2016 (Gallagher and Qi, 2018); > USB$170 in loans to BRI countries by 2017 (Wright, 2017). Project pipeline worth USB$170 billion (Gallagher and Qi, 2018)	Fully state-owned and under the direct jurisdiction of the state council (Kong and Gallagher, 2016; Gallagher and Qi, 2018) Strong ties to the Chinese government concerning top-tier executive appointment and evaluation mechanisms as described in detail by Kong and Gallagher (2016, Chapter 4) further increase the influence of the Communist Party on decisions fallen within its two major policy banks	x	x	x	(x)	x	
		China Export-Import Bank (ExIm)		In contrast to CDB, more inclined to support projects that involve Chinese exports. China's only bank that is designated to provide concessional loans based on the country's foreign aid budget (Kong and Gallagher, 2016; Gallagher and Qi, 2018)	> RMB 670 billion to BRI projects by 2017 (Gallagher and Qi, 2018)		x	x	x	(x)	x	
	Regional and bilateral funds	20 regional & bilateral development funds[2]	Regional and bilateral development funds are an important element for the distribution of Chinese development finance flows. Gallagher et al. (2018) provided the first comprehensive compilation of Chinese-backed funds with a focus on energy and infrastructure investments[1]. The majority of the funds have a regional focus on Asia and are established as part of China's Belt and Road Initiative. The Silk Road Fund represents the largest fund (US$54.4 billion), followed by the China-Brazil Investment Fund (US$20 billion) and the China-Central and Eastern Europe Investment Fund (US$11.5 billion (Gallagher et al., 2018)		Identified energy-related funds comprise an estimated Chinese development finance volume of more than US$160 billion (Gallagher et al., 2018)	The ExIm and CDB serve as finance provider for development funds amongst other providers as funds are also open for finance providers from other countries (Gallagher et al., 2018)	x			x	x	x
	New Multilateral Development Banks	Asian Infrastructure Investment Bank (AIIB)	The AIIB was proposed by the Chinese president Xi Jinping one month after his announcement of the BRI (Mishra, 2016) with explicitly mentioning that the primary task of the AIIB is to provide capital for BRI initiatives (Papagianneas, 2019). After the start of operations in 2015 with 17 member states, it has grown to more than 84 members (Gallagher et al., 2018). The official purpose of the bank is to "improve social and economic outcomes in Asia" with a focus on investing in sustainable infrastructure (AIIB, 2019). In the first years after its initiation, the AIIB cooperated with the western-backed World Bank form of joint-project financing (Gallagher et al., 2018)		USB$ 100 in subscribed capital (Wang, 2019). Estimated capital stock around US$250 billion by the end of 2020 (Gallagher et al., 2018).	China is by far the largest shareholder with 26,6 % of voting rights, followed by India (7.6%) and Russia (6.0%) (AIIB, 2021). This gives China a veto right over important decisions (e.g., recapitalization, membership admission, the composition of board of directors) that require a 75 percent majority. (Leksyutina 2018; Mishra 2016).	x	(x)		x	x	x
		New Development Bank (NDB)	Although headquartered in Shanghai the NDB is a joint initiative from China, India, Russia, Brazil and South Africa (BRICS countries) with equally distributed initial capital stock subscriptions and voting power. After the initial proposal by India in 2012 the bank was launched in 2015 (Wang, 2019). Its official mission statement is "to support infrastructure and sustainable development efforts in BRICS and other underserved, emerging economies for faster development through innovation and cutting-edge technology" (NDB, 2021)		Initial capital contribution equaled US$ 50 billion per country which is half of the amount that was used for the AIIB (Wang, 2019)	Maximum share of a founding member limited to 20% and the aggregated share of all non-founding members to 45%. This limits the influence a single country (e.g., China) or a group of countries can obtain at the cost of the potential to expand its capital base (Wang, 2019)	x	(x)		x	x	(x)
Multilateral Develop-ment Banks	MDBs as defined by Steffen and Schmidt (2019) with a country from the global north among their shareholders and boards		World Bank Group (operating formally through the International Bank for Reconstruction and Development, International Development Association), International Finance Corporation (IFC), Multilateral Investment Guarantee Agency (MIGA), European Investment Bank (EIB) for activities outside the European Union, Asian Development Bank (AsDB), Inter-American Development Bank (IADB), European Bank for Reconstruction and Development (EBRD), African Development Bank (AfDB)				x	x		x	x	x

1) Chinese Developmental Institutions with energy-related investments as defined and for the first time compiled by Gallagher et al. (2018)
2) Regional and bilateral funds = Silk Road Fund, Green Silk Road Fund, China-ASEAN Fund, China-Central, and Eastern Europe Investment Fund, Russia-China Investment Fund, China-Russia Regional Cooperation Development Investment Fund, China-VEB Innovation Fund, The China-Kazakhstan Production Capacity Cooperation Fund, China-Mexico Energy Fund, CELAC-China Investment Fund, China-LAC Cooperation Fund, China-Mexico Investment Fund, China-Portuguese Speaking Countries Cooperation Fund, China-Brazil Investment Fund, China-Africa Development Fund. Africa Growing Together Fund, China-Africa Production, Capacity/Industrial Cooperation Fund, South-South Climate Fund, South-South Cooperation Fund (As collated by Gallagher et al., 2018).

Table A.3

Summary of recent literature contributing to the understanding of drivers behind Chinese foreign coal finance flows. The supply side refers to studies concerned with understanding why CDIs are providing finance for foreign energy infrastructure in the broader context of China's domestic political economy. The supply side refers to recent available studies explaining the domestic political economy of coal in major CDI recipient countries (Indonesia, Vietnam, South Africa, India, Bangladesh) that together account for 69% of the CDI-supported coal-fired capacity. The area marked by the rectangle contains the sparse number of recently published studies that analyze the drivers behind foreign CDI coal finance in more particular. Authors' own depiction.

#	Authors	Supply side	Demand side	Actor focus on CDIs	Interview-based	Country focus	Sector Focus	Details Methodology
1	Kong & Gallagher, 2017	X		X		China	Energy	Compilation of various data sources and literature
2	Kong, 2019	X		X		China	Energy	Compilation of various data sources and literature
3	Kotikalapudi, 2014		X			Bangladesh	Coal	Literature review-based analysis
4	Spencer et al., 2017		X			Multiple countries (including major CDI recipients)	Coal	Synthesis of existing literature and documents
5	Baker et al., 2015		X		X	South Africa	Electricity	Qualitative semi-structured interviews
6	Burton et al., 2019		X			South Africa	Coal	Literature review-based analysis
7	Jakob et al., 2020		X		X	India, Indonesia, Vietnam	Coal	Framework development, qualitative semi-structured interviews
8	Dobrand et al., 2020		X		X	Vietnam	Coal	Qualitative semi-structured interviews
9	Setyowati 2021		X		X	Indonesia	Electricity	Qualitative semi-structured interviews, field observations, document analysis
10	Ordonez et al., 2021		X		X	Indonesia	Coal	Qualitative semi-structured interviews
11	Montrone et al. 2021		X		X	India	Coal	Qualitative semi-structured interviews
12	Steckel & Jakob, 2021		X			Multiple countries (including major CDI recipients)	Coal	Review of case studies using the AOC framework (Jakob et al., 2020)
13	Gao et al. 2021	(X)[A]	X			Indonesia, Vietnam	Coal	Analysis of plant-level dataset, Qualitative semi-structured interviews
14	Hervé-Mignucci & Wang, 2015	X	X		(X)[B]	Multiple recipient countries & China	Coal	Interview supported analysis of plant level dataset
15	Kong & Gallagher, 2021a[C]	X	X	X		Multiple recipient countries & China	Coal	Analysis of plant-level dataset and desk-based research
16	Kong & Gallagher, 2021b[C]	X	X	X		Multiple recipient countries & China	Coal	Analysis of plant-level dataset and desk-based research
17	Gallagher et al., 2021[C]		X	X	X	India, Indonesia, Vietnam, Bangladesh	Coal	Qualitative semi-structured interviews
18	This study	X	X	X	X	Multiple recipient countries & China	Coal	Qualitative semi structured-interviews and novel plant-level dataset. Later primary data collection in comparison to study 17 allows to include effects of the pandemic

A) Gao et al. (2021) considered the supply side in more general terms with discussing why Vietnam and Indonesia are keen to get foreign financial support to build coal plants and linking finance from foreign countries including China to coal plants

B) Although the report supports its' arguments with interviews, it does not make any further methodological specifications beyond the specification "CPI interviews"

C) Parallel research efforts. Study 15 and 16 have been published after the submission of this study.

Table A.4

Aggregated shares of combustion technology types and emission control devices of Chinese funded foreign coal plants in comparison to remaining coal plants in recipient countries (B), domestic China (C) and plants financed by Western-backed MDBs (D). Plants for comparison groups B, D have been extracted from GlobalData (2020) with only considering plants with given grid connections in the same period than for the CDI sample (2006-2019). The comparison group B is based on 22 recipient countries of Chinese coal finance (see Table A.4 in the Appendix). Dormant plants have been excluded from the pipeline capacity for all groups. The share of emission control devices is based on identifiable information and does not reflect the actual shares. However, comprehensive data on the installation of emission control technologies is non-existent on a global level and so far, the World Electric Power Plants Database had been considered as the only available indicative database (Chen et al., 2020). This analysis introduces GlobalData (2020) as a second indicative database and an alternative perspective that could be used in future research.

	Active and pipeline capacity				Share of total capacity by combustion technology				Share of total capacity by traceable presence of emission control devices		
	Active Capacity	Pipeline Capacity	Average Unit Capacity in MW	Total capacity in GW	Subcritical	Supercritical	Ultra-supercritical	n/a	SO_2 Controls	NO_x Controls	Particulate Controls
A) Coal plants financed by Chinese Developmental Institutions outside China	X		379	35.7	.21	.42	.03	.34	.39	.34	.37
		X	596	40.9	.06	.33	.44	.17	.53	.30	.46
	Δ		x 1.6	x 1.2	-.15	-.09	+.41	-.17	+.14	-.04	+9
B) Remaining coal plants in recipient countries without Chinese development finance	X		260	188.7	.19	.33	.02	.46	.41	.23	.73
		X	478	314.7	.04	.50	.19	.27	.42	.30	.51
	Δ		x 1.8	x 1.7	-.15	+.17	+.17	-.19	+.01	+.07	-.19
C) Coal plants in domestic China	X		535	493.7	.05	.24	.31	.41	.51	.18	.23
		X	971	103.9	.00	.11	.85	.04	.64	.36	.48
	Δ		x 1.8	x 0.21	-.05	-.13	+.54	-.37	+13	+.18	+.25
D) Coal plants financed by Western-backed Multilateral Development Banks	X		385	14.3	.02	.56	.04	.38	.43	.37	.56
		X	675	6.8	.00	.71	.20	.09	.91	.31	.79
	Δ		x 1.8	x 0.47	-.02	+.15	+.16	-.29	+48	-.06	+.23

Table A.5
Regional distribution of active and pipeline capacity differentiated by technologies in comparative perspective for Chinese Developmental Institutions and Western-backed Multilateral Development Banks

		Chinese Developmental Institutions			Western-backed Multilateral Development Banks		
Technology Type	Region	Active Capacity in MW	Pipeline capacity in MW	Δ	Active Capacity in MW	Pipeline capacity in MW	Δ
Fossil	Asia-Pacific	31445 (79%)	26024 (50%)	↓	16796 (33%)	18867 (46%)	↑
	Europe	815 (2%)	3456 (7%)	↑	11757 (23%)	1909 (5%)	↓
	Middle East and Africa	7253 (18%)	20769 (40%)	↑	20401 (40%)	18150 (44%)	↑
	North America	0	0	→	0	875 (2%)	↑
	South and Central America	460 (1%)	1431 (3%)	↑	1939 (4%)	1673 (4%)	→
Hydro	Asia-Pacific	8090 (47%)	8046 (32%)	↓	15669 (32%)	24445 (44%)	↑
	Europe	40 (0%)	515 (2%)	↑	8860 (18%)	4430 (8%)	↓
	Middle East and Africa	6475 (38%)	13187 (52%)	↑	1124 (23%)	21538 (38%)	↑
	North America	0	0	→	0	0	→
	South and Central America	2528 (15%)	3747 (15%)	→	13208 (27%)	5607 (10%)	↑
Non-hydro RETs	Asia-Pacific	780 (24%)	2352 (36%)	↑	7116 (34%)	9006 (39%)	↑
	Europe	193 (6%)	1083 (16%)	↑	2536 (12%)	1619 (7%)	↓
	Middle East and Africa	1626 (50%)	2307 (36%)	↓	5445 (26%)	11133 (47%)	↑
	North America	3 (0%)	0	↓	2506 (12%)	25 (0%)	↓
	South and Central America	654 (20%)	776 (12%)	↓	3068 (14%)	1540 (7%)	↓
Nuclear	Asia-Pacific	1005 (100%)	2200 (39%)	↓	0	0	
	Europe	0	3440 (61%)	↑	0	0	
	Middle East and Africa	0	0		0	0	
	North America	0	0		0	0	
	South and Central America	0	0		0	0	
	Sum	61366	89434		120541	120816	

RET = Renewable Technologies. Capacity share increases (↑), decreases (↓), stays constant (→) from active to pipeline capacity.

Table A.6
Major recipient countries of coal plant capacity ranked by active and pipeline capacity which is financed by at least one Chinese Developmental Institution. For the seven major recipient countries, the share of the population with access to electricity and electricity infrastructure investment needs as reported by World Bank's Development Indicators and the Global Infrastructure Outlook (Global Infrastructure Hub, 2017), respectively, are provided

Recipient countries of CDI funded coal plant capacity	Active Capacity in MW	Pipeline Capacity in MW	Dormant pipeline capacity in MW	Sum of Active & Pipeline capacity in MW	Share of population with access to electricity in 1999 (left) and in 2016 (right)[1]	Electricity infrastructure investment need expressed as share of GDP [%], 2016-2030[2]
Indonesia	9505	9420	1620	18925	83.7 - 98.5	1,8
Vietnam	8548	7330	1200	15878	86.3 - 97.6	3
South Africa	3970	5594	0	9564	80.7 - 84.2	1,9
India	6420	1320	1320	7740	60.1 - 89.6	3,8
Pakistan	3960	2190	500	6150	70.3 - 71.4	2,7
Egypt	0	6000	0	6000	96.9 - 100	2
Bangladesh	0	4550	0	4550	30.0 - 75.9	2,8
United Arab Emirates	0	2400	0	2400		
Ghana	0	2000	0	2000		
Bosnia and Herzegovina	300	900	0	1200		
Malawi	0	1000	0	1000		
Russian Federation	0	990	990	990		
Brazil	350	600	0	950		
Kyrgyzstan	812	0	0	812		
Kazakhstan	0	636	0	636		
Philippines	600	0	0	600		
Sri Lanka	300	300	0	600		
Zimbabwe	0	600	0	600		
Tajikistan	400	0	0	400		
Morocco	350	0	0	350		
Serbia	0	350	0	350		
Georgia	0	300	0	300		
Uzbekistan	150	0	0	150		
Sum	35665	46480	5630	82145		

1) Retrieved from the World Bank's World Development Indicator database (https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS)
2) Retrieved from the World Infrastructure Outlook. The calculation is based on total electricity infrastructure investment needs, including delivering universal access to electricity for the time 2016-2030 (see Global Infrastructure Hub, 2017, p.43).

Table A.7
Number of identified power plants by received financial transaction type. Modernizations without capacity additions and power plants where finance type has been unclear have been set to zero in the analysis of capacity additions facilitated by financial institutions under consideration. The total number of displayed power plants does not equal the total number of power plants displayed in Figure 2 as one power plant can receive several financial transactions of different type.

	New construction or extension (with capacity addition)	Rehabilitation	Modernization (without capacity addition)	N/A
CDIs	345 (98%)	4 (1%)	4 (1 %)	
Western-backed MDBs	893 (87%)	54 (5%)	7 (1 %)	78 (7%)

Table A.8
Chinese-funded hydropower dams in comparison to remaining coal plants in recipient countries (B), domestic China (C) and plants financed by Western-backed MDBs (D). Plants for comparison groups B, D have been extracted from GlobalData (2020). The comparison group B is based on 50 recipient countries of Chinese hydropower finance.

	Total capacity in GW		Average Unit Capacity in MW		Share of capacity of small-scale dams in %			
					≤ 50 MW		≤100 MW	
	Active	Pipeline	Active	Pipeline	Active	Pipeline	Active	Pipeline
A) Hydropower plants financed by Chinese Developmental Institutions outside China	17.1	25.5	256	331	2.6	1.9	8.2	3.6
B) Remaining hydropower plants in recipient countries without Chinese development finance	305.7	571.7	112	126	6.9	6.7	12.4	11.4
C) Hydropower plants in domestic China	292.1	102.4	190	931	6.0	11.6	0.5	1.0
D) Hydropower plants financed by Western-backed Multilateral Development Banks	49.0	56.0	259	326	3.0	3.1	6.3	5.6

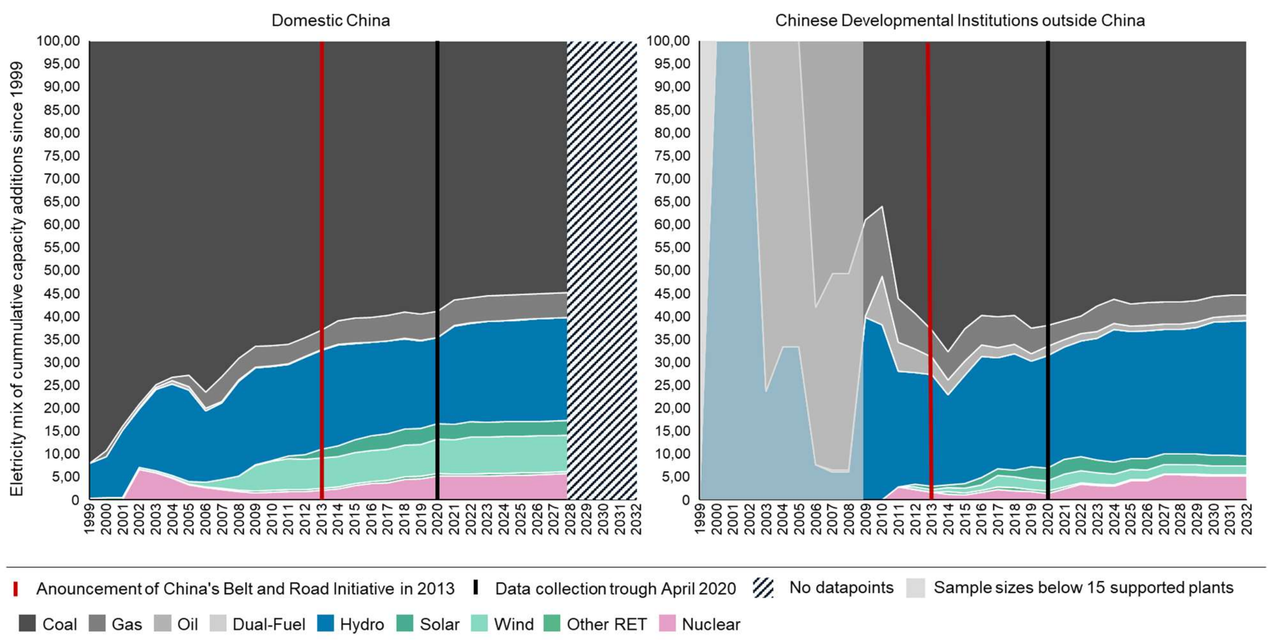


Fig A.1. Eletricity mix of domestic China (left) and Chinese Developemental Institutions outside China (right) over time for accumulated capacity additions since 1999 in comparative perspective. Data for domestic China has been retrieved from GlobalData (20202).

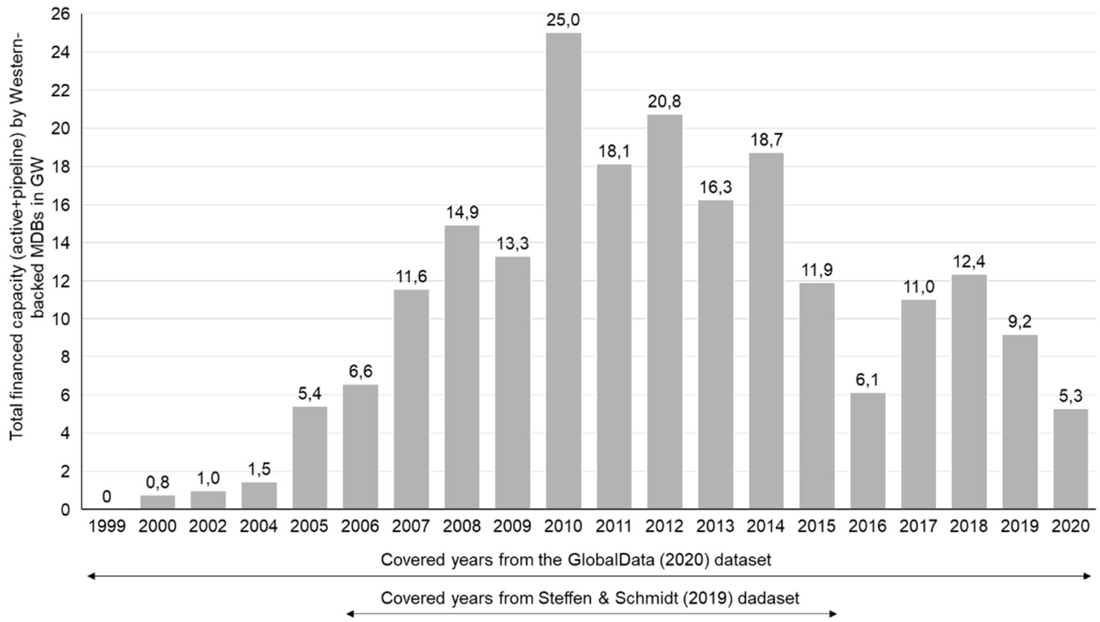


Fig A.2. Financed power plant capacities (active+pipeline) from Western-backed Multilateral Development Banks resulting from identified financial transactions in the period 1999-2020. For power plants that have received finance in multiple years the capacity (active+pipeline) has been spilt equally across the years where financial transactions have been approved or announced. The low identified capacities in the period 1999-2004 indicated that GlobalData's (2020) ability to capture financial transactions in the early 2000s is limited which is indicating that the estimate for the active capacity might be very conservative and is a general limitation of this study

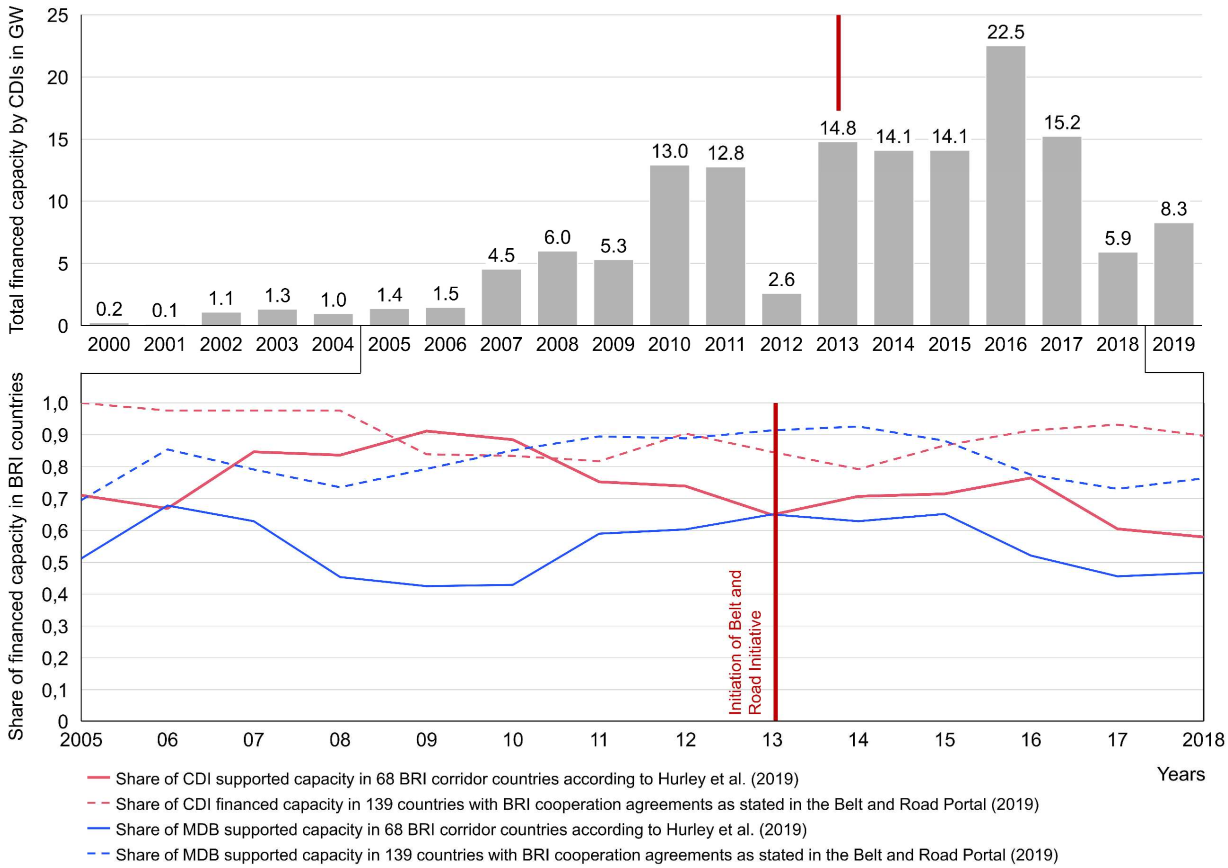


Fig. A.3. Supported power plant capacities from Chinese Developmental Institutions and share thereof in BRI countries over time. For power plants that have received finance in multiple years, the capacity (active+pipeline) has been spilt equally across the years where financial transactions have been approved or announced. The share of capacity in BRI countries is displayed as a three-year rolling average in comparison to Western Backed MDBs.

Table A.9
List of BRI countries. BRI corridor countries refer to a narrow definition of the geographical representation of China's Belt and Road initiative from Hurley (2019) that comprises 68 countries that are located along the initial BRI corridors (mostly Eurasia). The list of BRI member countries comprises 138 countries that have officially endorsed the BRI or signed a Memorandum of Understanding with China on the initiative. The list has been obtained from the official Belt and Road Portal (Belt and Road Portal, 2019).

Country	BRI corridor countries	BRI member countries	#	Country	BRI corridor countries	BRI member countries
Afghanistan	X	X	71	Madagascar		X
Albania	X	X	72	Malaysia	X	X
Algeria		X	73	Maldives	X	X
Angola		X	74	Mali		X
Antigua and Barbuda		X	75	Malta		X
Armenia	X	X	76	Micronesia (Federated States of)		X
Austria		X	77	Mongolia	X	X
Azerbaijan	X	X	78	Montenegro	X	X
Bahrain	X	X	79	Morocco		X
Bangladesh	X	X	80	Mozambique		X
Barbados		X	81	Myanmar	X	X
Belarus	X	X	82	Namibia		X
Benin		X	83	Nepal	X	X
Bhutan	X	X	84	New Zealand		X
Bolivia		X	85	Niger		X
Bosnia and Herzegovina	X	X	86	Nigeria		X
Brunei Darussalam	X	X	87	North Macedonia	X	X
Bulgaria	X	X	88	Oman	X	
Burundi		X	89	Pakistan	X	X
Cambodia	X	X	90	Panama		X
Cameroon		X	91	Papua New Guinea		X
Cape Verde		X	92	Peru		X
Chad		X	93	Philippines	X	X
Chile		X	94	Poland	X	X
Comoros		X	95	Portugal		X
Cook Islands		X	96	Qatar	X	X
Costa Rica		X	97	Republic of Korea	X	X
Croatia	X	X	98	Republic of Moldova	X	X
Cuba		X	99	Romania	X	X
Cyprus		X	100	Russian Federation	X	X
Czech Republic	X	X	101	Rwanda		X
Democratic Republic of the Congo		X	102	Samoa		X
Djibouti	X	X	103	Saudi Arabia	X	X
Dominican Republic		X	104	Senegal		X
Ecuador		X	105	Serbia	X	X
Egypt	X	X	106	Seychelles		X
El Salvador		X	107	Sierra Leone		X
Equatorial Guinea		X	108	Singapore	X	X
Estonia	X	X	109	Slovakia	X	X
Ethiopia	X	X	110	Slovenia	X	X
Fiji		X	111	Solomon Islands		X
Gabon		X	112	Somalia		X
Gambia		X	113	South Africa		X
Georgia	X	X	114	South Sudan		X
Ghana		X	115	Sri Lanka	X	X
Greece		X	116	State of Palestine		X
Grenada		X	117	Sudan		X
Guinea		X	118	Suriname		X
Guyana		X	119	Syrian Arab Republic	X	X
Hungary	X	X	120	Tajikistan	X	X
India	X		121	Thailand	X	X
Indonesia	X	X	122	Timor-Leste	X	X

Iran (Islamic Republic of Iran)	X	X	123	Togo		X
Iraq	X	X	124	Tonga		X
Islamic Republic of Mauritania		X	125	Trinidad and Tobago		X
Israel	X	X	126	Tunisia		X
Italy		X	127	Turkey	X	X
Ivory Coast		X	128	Turkmenistan	X	X
Jamaica		X	129	Uganda		X
Jordan	X	X	130	Ukraine	X	X
Kazakhstan	X	X	131	United Arab Emirates	X	X
Kenya	X	X	132	United Republic of Tanzania		X
Kuwait	X	X	133	Uruguay		X
Kyrgyzstan	X	X	134	Uzbekistan	X	X
Lao People's Democratic Republic	X	X	135	Vanuatu		X
Latvia	X	X	136	Venezuela		X
Lebanon	X		137	Vietnam	X	X
Lesotho		X	138	Yemen	X	X
Liberia		X	139	Zambia		X
Libya		X	140	Zimbabwe		X

Supplementary Note A.1 Potential explanations for higher focus on Europe of non-hydro renewable technologies in comparison to remaining technologies

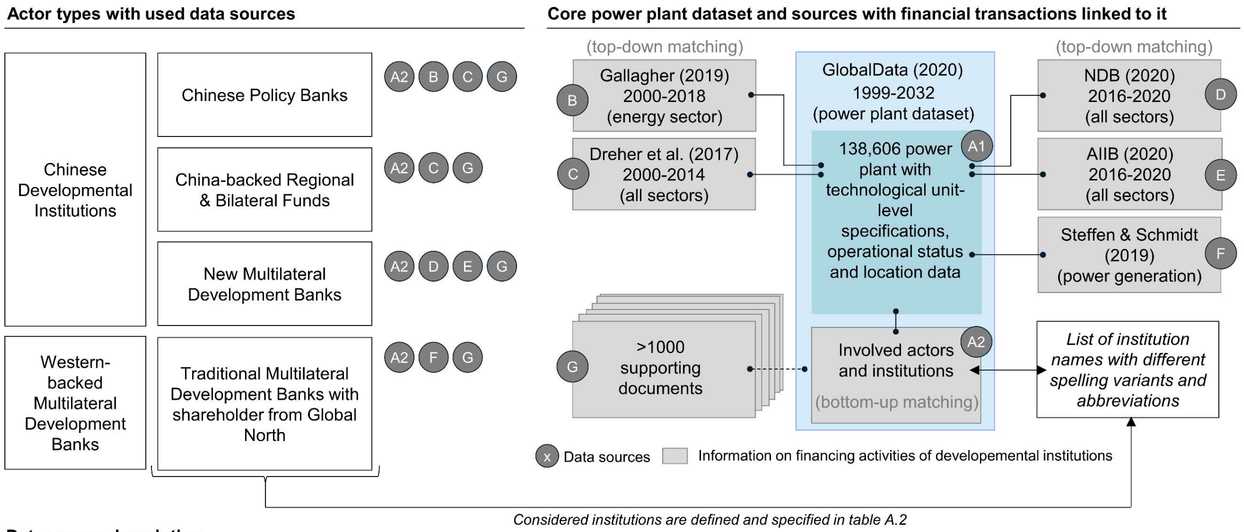
In comparison to the other technologies, the regional distribution of CDI's involvement in non-hydro RETs is more equally distributed across the continents and has a relatively stronger focus on Europe, marked by reverse trends in comparison with traditional MDBs (see Table A.3). Contrary to Western-backed MDBs, CDIs decrease the share of non-hydro renewables in the Middle East and Africa (active capacity = 50%, pipeline capacity = 36%) and increase the share from active (6%) to pipeline capacity (16%) in Europe. The increasing focus on Europe mostly comprises large scale renewable projects in eastern European countries, including Serbia (Plandiste Wind Farm), Bulgaria (Karlovo Silistra Solar PV Park, Cherganovo Solar Park, Pobeda Solar Park), Ukraine (Zophia Wind Farm), and Greece (Greece-Energy Resources Solar Park). One explanation for the higher focus on Europe is its favorable investment conditions concerning renewable subsidies and lower implementation hurdles in comparison to developing countries, both attracting Chinese firms that are tied to the development finance flows. The explanatory power of this hypothesis, however, is limited due to evidence for immense setbacks that Chinese renewable companies experienced in an attempt to gain a foothold in Eastern European countries after facing cuts in renewable energy subsidies and legal consequences after misappropriating Chinese development finance funds as described in more detail by Kong and Gallagher (2021c). Another explanation – which is also valid for other technologies – is of geopolitical nature, as it expands its BRI into Europe with infrastructure-related government-to-government contracts (beyond electricity) that could result in political rapprochement and support (Tonchev, 2017). Serbia is an example where heavy Chinese energy and transport infrastructure investments agreed on governmental level co-evolved with higher political support. It is estimated that Serbia received the highest amount of energy and transport infrastructure related loans from the Chinese government in the Eastern European region equaling to more than $1 billion. Both countries also aligned their political views on questions regarding the Kosovo and Taiwan recognition as well as China's One China policy and territorial disputes in the South China Sea (Tonchev, 2017). This geopolitical explanation would link to a broader controversial discussion in which critics argue that China is using its development finance flows as a strategic tool to "buy" political favor (e.g., Naim, 2007). However, due to a lack of data and conceptual confusion on Chinese development finance flows (Dreher et al., 2018), as well as insufficient considerations of sectoral differences (Dolan and McDade, 2020), empirical studies that test these claims with sufficient empirical and conceptual rigor are still very limited (Dreher et al., 2018).

Supplementary Note A.2 Recommendations for the further development of the G-20 backed country development platforms

Although a coordinated and synergetic approach, including CDIs and Western-backed MDBs, seems to be the best choice to address climate and development challenges, the further development and implementation of the recommended country platforms by the G20 Eminent Persons Group [G20 EPG] in their report “Making the global financial system work for all” (G20 EPG, 2018) might benefit from the following considerations.

First, the recommended convergence of standards in the platform design (G20 EPG, p.16) might result in low environmental and social safeguards and prolongation of fossil fuel investments. As shown in the previous sections, central governments in many developing countries have weak or no policies in place to foster the diffusion of low carbon technologies and Chinese policy banks seem to only adhere to domestic regulations. Given the central role of the government in the prospected platforms (G20 EPG, p.16) and the dominant role of Chinese policy banks, a recommended convergence of standards might cause the dilution of high social and environmental safeguards, as for example applied by traditional MDBs. Second, it might be considered to loosen the explicitly mentioned no-tolerance approach for subsidies (G20 EPG, p.36) in areas where this would stimulate additional green investments. It seems likely that participation and investments from the ExIm and CDB would grow when being allowed to support its domestic solar and wind industry. The benefits of additionally gained diffusion of non-hydro renewables would need to be weighted with the potential implications of market distortions. Third, given the important role of civil society in the context of governments with low environmental awareness, their role should be reflected more strongly in the platform design. Finally, given the key role of CDIs and MDBs in the electricity sector around the world, it seems beneficial to also align on core standards and complementarities between those two systems on a global level, before going into the fragmentation on the country level.

Appendix B. Description of used data sources (main dataset)



Data source description

GlobalData (2020): Unit-level power plant database from the data analytics company GlobalData, contains nearly all power plants in the world (138,606 power plants, 247,418 plant subunits) including technical plant details (A1) and information on involved actors along the power plant value chain, including finance providers (A2). According to GlobalData (2020), the data analytics company mines several hundred sources including but not limited to company reports and accounts, publications of national bodies and news sources which are enhanced by more than 5000 primary interviews in the power industry per year and further secures data quality trough triangulation. Wheras Farfan and Breyer (2017) identified GlobalData (2015) as a promising database to analyze the sustainability of power plants in a global context this study introduces the database as possibility to track financing activities of developmental institutions (and beyond) bottom-up with considering nearly all power plants in the world. Furthermore, it serves as a foundation to link other available "top-down" financing datasets that are at more aggregate level (see below) to the financed power plants with its technological specifications (e.g., unit-level capacities, technology type including information on boiler types and emission control technologies for coal plants, operational status, (planned) grid connection year, location).

Gallagher (2019): China's Global Energy Finance Database is a media-based data collection effort between the Global Economic Governance Initiative (GEGI) from the Boston University and the China-Africa Research Initiative of the Johns Hopkins University. It provides the first (comprehensive) estimate for the development finance volume of China's two major policy banks (China Export-Import Bank, China Development Bank) in the energy sector for the period 2000-2017 (Gallagher et al. 2018). Jin, Ma, and Gallagher (2018) provide a detailed description of the applied data collection methodology which uses a wide range of sources (e.g., official bank websites, host country ministries, news reports) which have been verified through interview contacts whenever possible.

Dreher et al. (2017): AidData is a data tracking effort of the William & Mary's Global Research Institute. The obtained dataset captures Chinese development finance flows across all sectors (including the energy sector). It considers a broad range of Chinese actors, covers financing activities from 2000-2014 with a focus on Africa and has been widely used in academia (e.g., Dreher et al. 2018; Dolan & Mcdade 2020). Strange et al. (2017) provides a detailed description of the methodology that is based on desk research-based screening of official sources and media reports.

AIIB (2020), NDB (2020): In contrast to the fully Chinese Policy Banks the two newly established Multilateral Development Banks with China as major shareholder, namely the Asian Infrastructure Investment Bank and the New Development Bank, provide a list of financed projects for which some descriptions provide enough information to identify the financed power plants.

Steffen & Schmidt (2019): Albeit investments from Multilateral Development Banks (MDB) into the electricity sector are publicly available they are distributed across multiple sources and lack comparability. Steffen and Schmidt (2019) have recently filled the gap of a missing comprehensive compilation for all relevant MDBs for the period 2006-2015 by constructing a bottom-up dataset out of 1,751 documents obtained from banks and additional secondary data and expert interviews (Steffen & Schmidt, 2019).

Other sources: Other publicly available sources (mainly project reports of multilateral development banks and media articles) are used to 1) further triangulate and enrich the financial transactions identified in GlobalData (2020) and to 2) support the matching process. 1) For each financial transaction identified in GlobalData a web research is conducted to validate the financing activity and to capture the year and type of financial transaction (new construction, extension, modernization, rehabilitation) wherever traceable as this information is not systematically provided by GlobalData (2020). 2) In cases where the datasets B, C, F did not provide sufficient information to clearly identify a power plant (unit) publicly available information has been used to further investigate if it is possible to specify the power plants financed by the financial transaction. This included in particular project documentation of Multilateral Development Banks for the Steffen & Schmidt 2019 dataset that has a high share of financial transactions where power plant names are not stated but more detailed project documentation is available)

Matching and linking procedure

↔ *Linking the core dataset A1 to dataset B-F:* Datasets have been matched at the unit-level. Due to varying spellings for power plant projects, locations and other variables that have been used to match Chinese and Western involvement to power plants it was not possible to automatize the matching, which is why it resulted in a highly time-consuming manual process. Major matching variables included country, location, power plant (unit) name, plant capacity, the year of financial transaction and the (expected) first year of plant-unit operation. Cases that have not been clear have been discussed with a second researcher.

•–• *Linking the core dataset A1 to dataset B-F*: Datasets have been matched at unit-level. Due to varying spellings for power plant projects, locations and other variables that have been used to match Chinese and Western involvement to power plants it was not possible to automatize the matching, which is why it resultet in a highly time-consuming manual process. Major matching variables included country, location, power plant (unit) name, plant capacity, the year of financial transaction and the (expected) first year of plant-unit operation. Cases that have not been clear have been discussed with a second researcher.

Fig. 1. Simplified illustration of dataset design with description of used data sources (authors' own depiction)

Appendix C. List of interviewees (supporting dataset)

Table C.1
Overview of Interviews. Data.

Code	No	Position	Type of organisation	Sector	Country of organisation
NP1	1	Social Impact Consultant*	Self-employed / Development organisation	Non-profit sector	Laos
PS1	2	ESG Advisory Lead Asia-Pacific*	International finance Institution	Private sector	Myanmar
PU1	3	Advisor Infrastructure	Government development cooperation	Public sector	Germany / China
PS2	4	Export Sales Manager*	Multinational corporation	Private sector	China
NP2	5	Senior Advisor*	Sustainable infrastructure foundation	Non-profit sector	Switzerland / China
NP3	6	Social Impact Consultant*	Self-employed / Development organisation	Non-profit sector	Thailand, Laos
NP4	7	Chief Advisor	Chinese policy advisory board	Non-profit sector	Canada
PU2	8	Foreign Trade Lead*	Basel Chamber of Commerce	Public sector	Switzerland
PU3	9	Manager*	Ministry of Finance	Public sector	Nepal
PU4	10	Chief Advisor	Chinese policy advisory board	Public sector	Norway
AC1	11	Researcher	Tribhuvan University	Academia	Nepal
NP5	12	Project development China*	Sustainable development consultancy	Non-profit sector	Switzerland
PS3	13	Secretary General Low Carbon Committee	Association of Plant Engineering Companies	Private sector	China
PU5	14	Project Director	Government development cooperation	Public sector	China
AC2	15	Post-doc researcher	Development and reform commission	Academia	China
AC3	16	Research and Project Lead China	Global development policy centre	Academia	USA
AC4	17	Researcher ESG standards	Law association Asia-Pacific	Academia	Thailand
NP6	18	Board president*	River conservation Organization	Non-profit sector	Thailand
PU6	19	Policy Lead Infrastructure Investment	G20 forum	Public sector	Saudi Arabia
NP7	20	CEO	Infrastructure foundation	Non-profit sector	Switzerland
PS4	21	China representative	Forestry/wood products consultancy	Private sector	China
AC5	22	Researcher*	University	Academia	UK
PS5	23	Director Business Development	Hydropower company	Private sector	Thailand
PS6	24	Associate	Business / Infrastructure consultancy	Private sector	China
PS7	25	Senior Advisor	Private sector development	Private sector	Myanmar
PS8	26	Director Client Development*	Business Consultancy	Private sector	Malaysia
AC6	27	Senior Project Manager	Centre Asia Business/University	Academia	Switzerland
AC7	28	Professor	University	Academia	China
PS9	29	Project Manager	Business Consultancy	Private sector	Saudi Arabia
PS10	30	Senior Partner*	Business Consultancy	Private sector	Vietnam
PS11	31	Director/Senior Partner*	Business Consultancy	Private sector	China
PS12	32	Senior Partner	Business Consultancy	Private sector	China
PS13	33	Partner	Business Consultancy	Private sector	China
PS14	34	Partner	Business Consultancy	Private sector	China
PU7	35	Director Sustainable Infrastructure Policy	International Financial Institution	Public sector	UK
PS15	36	Senior Partner	Business Consultancy	Private sector	Hongkong
PS16	37	Associate Partner	Business Consultancy	Private sector	Southeast Asia
PS17	38	Cities and Planning Leader	Engineering firm	Private sector	Singapore
PU8	39	Director Infrastructure	Development bank	Public sector	China

* Interviewees part of the initial judgment sample. The dataset was also used by Schulhof et al. (2021), but we refer to a different section of the data in this work

Appendix D. Additional information on matching, linking and data validation procedures

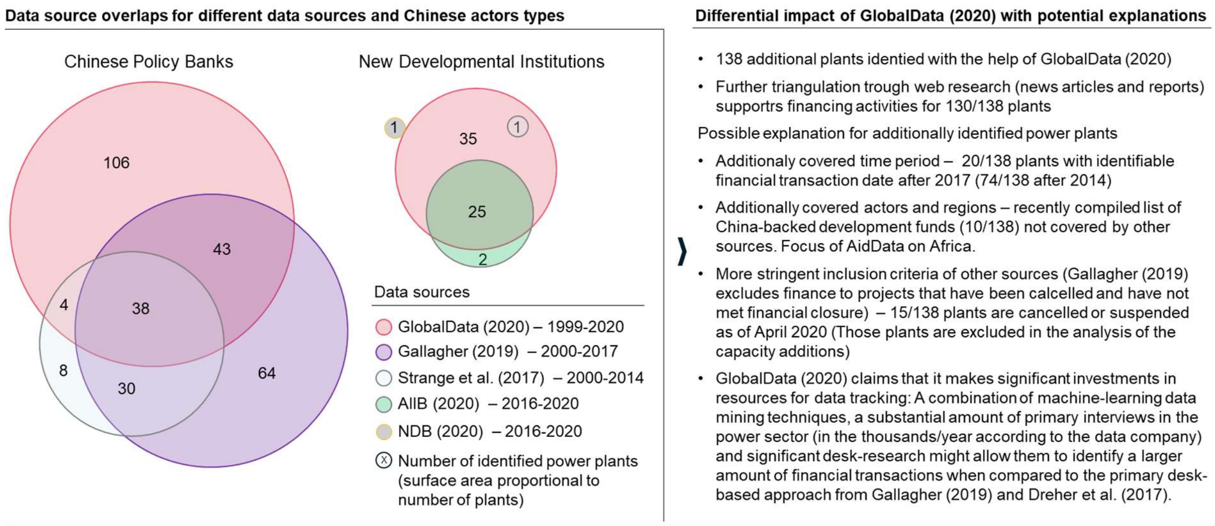


Fig. D.1. Overlap analysis of used data sources to track financing activities of Chinese Developmental Institutions (left) and the differential impact of GlobalData (2020) with potential explanation

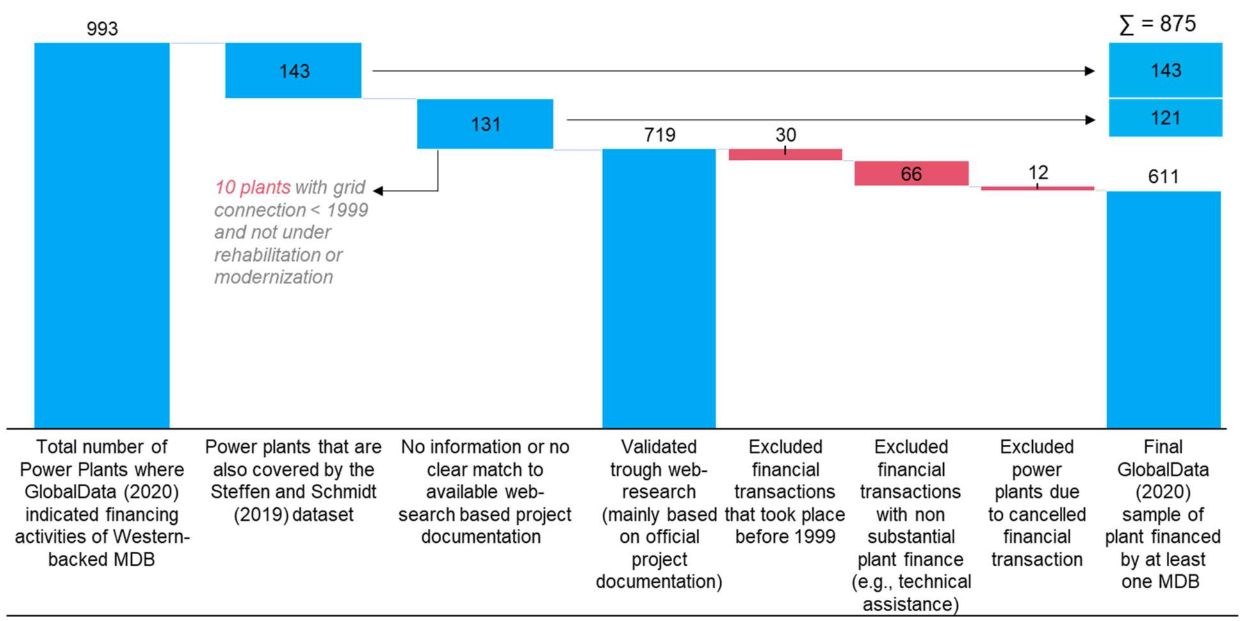


Fig D.2. Summary of triangulation process applied to validate identified financial transactions of Western-backed Multilateral development banks in GlobalData (2020)

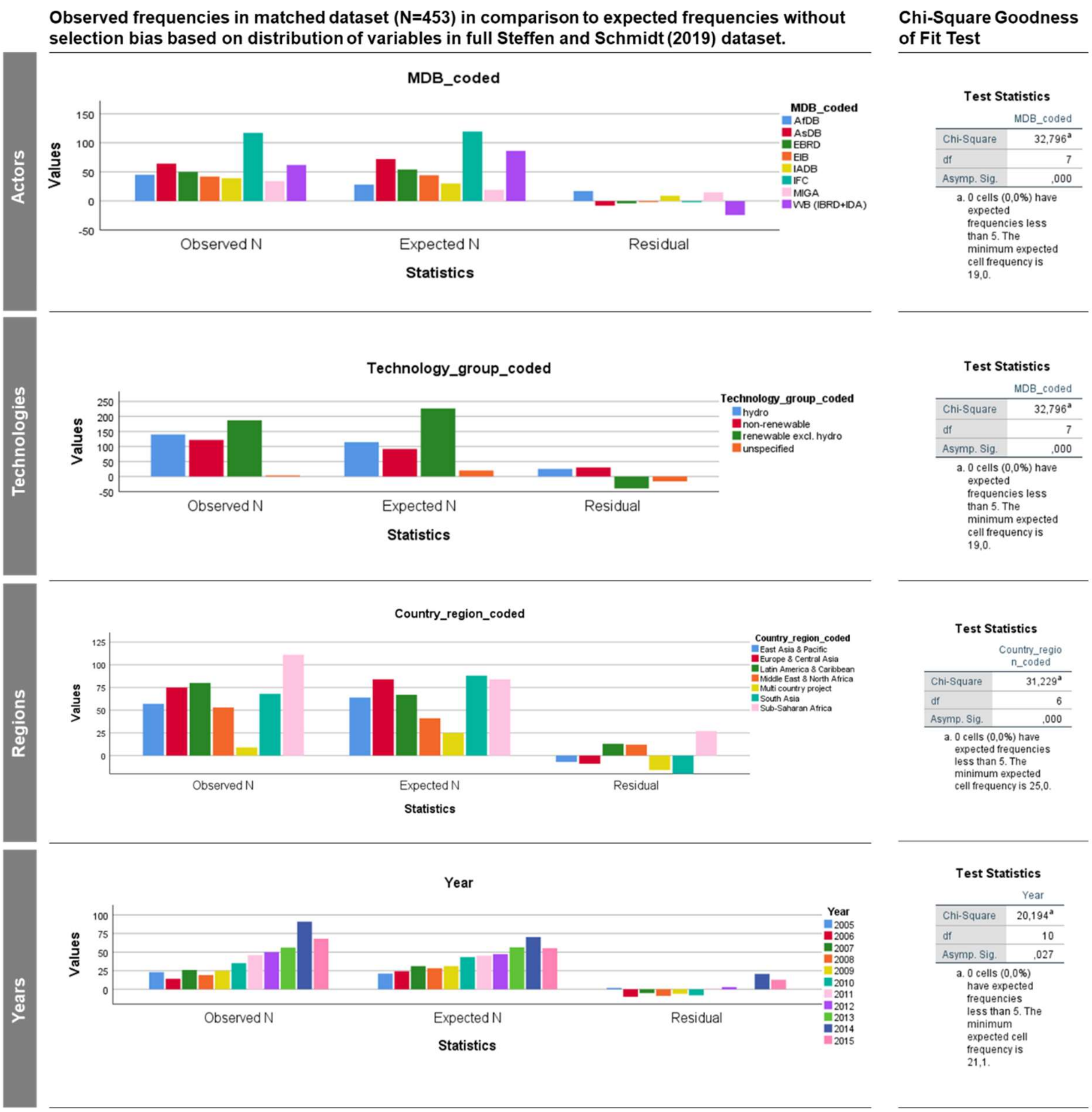


Fig. D.3. Analysis of potential selection bias in matched part of the Steffen and Schmidt (2019) dataset based in comparison of observed and expected frequencies and Chi-Squared Goodness of Fit Tests

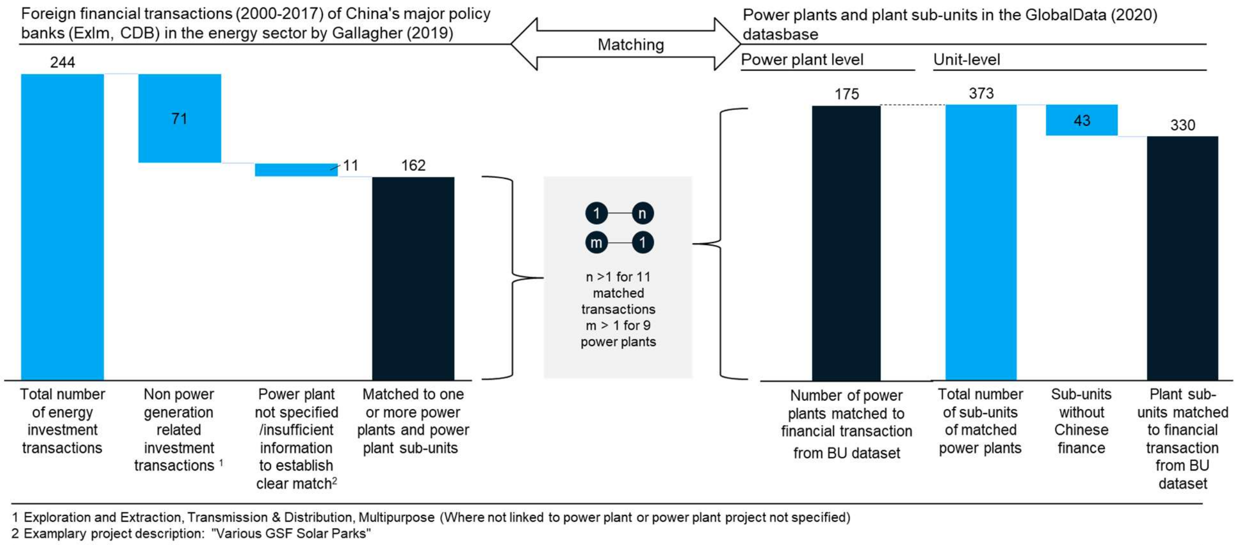


Fig D.4. Summary of dataset linking results between the dataset from Gallagher (2019) and GlobalData (2020)

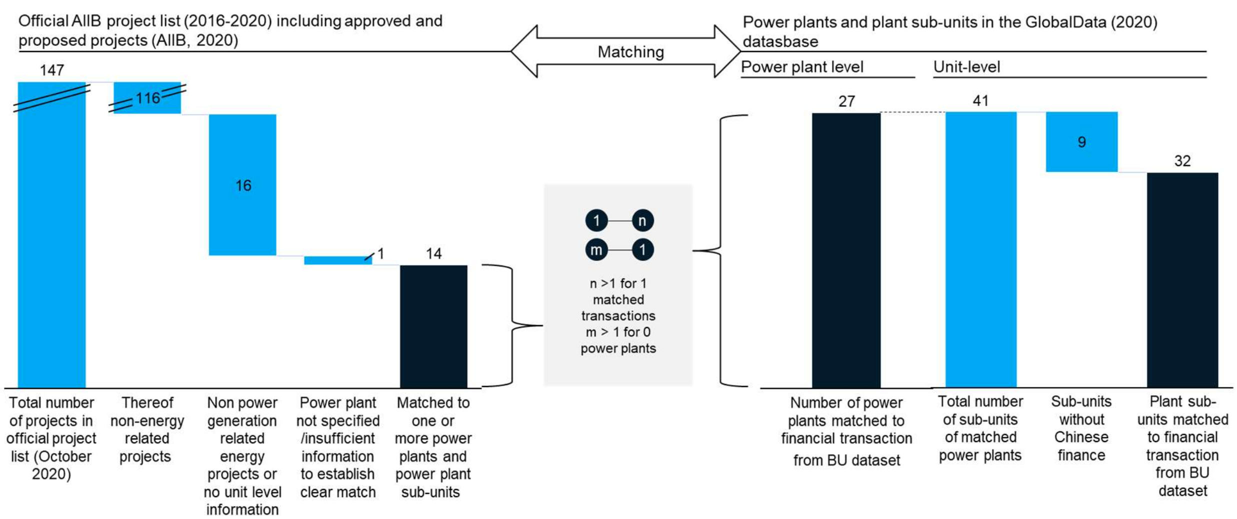


Fig D.5. Summary of dataset linking results between the official AIIB (2020) project list and GlobalData (2020)

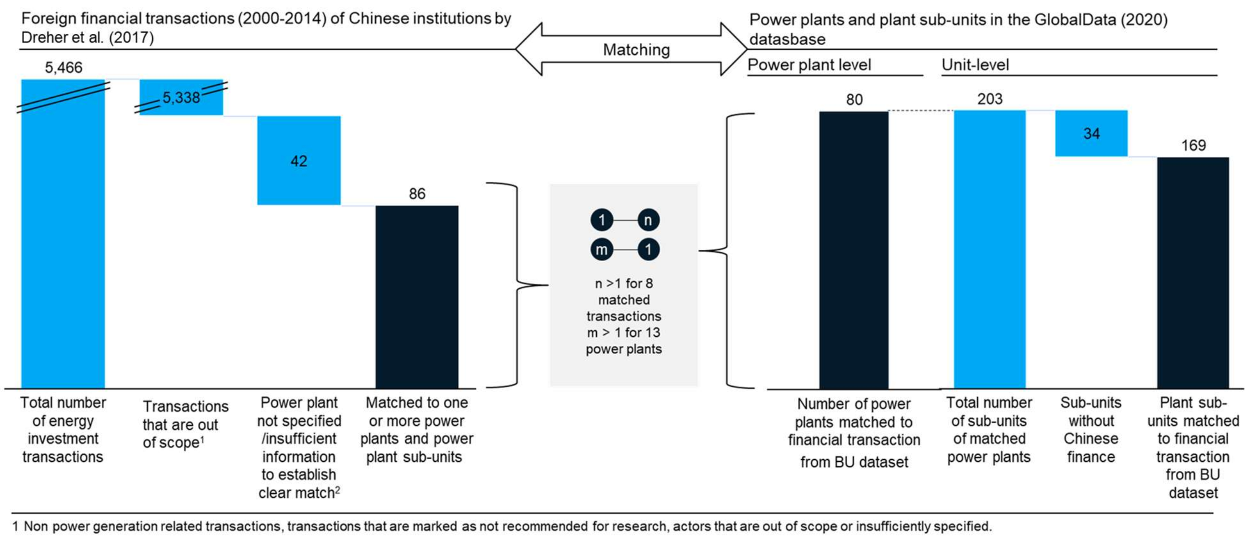


Fig D.6. Summary of dataset linking results between the dataset from Dreher et al. (2017) and GlobalData (2020)

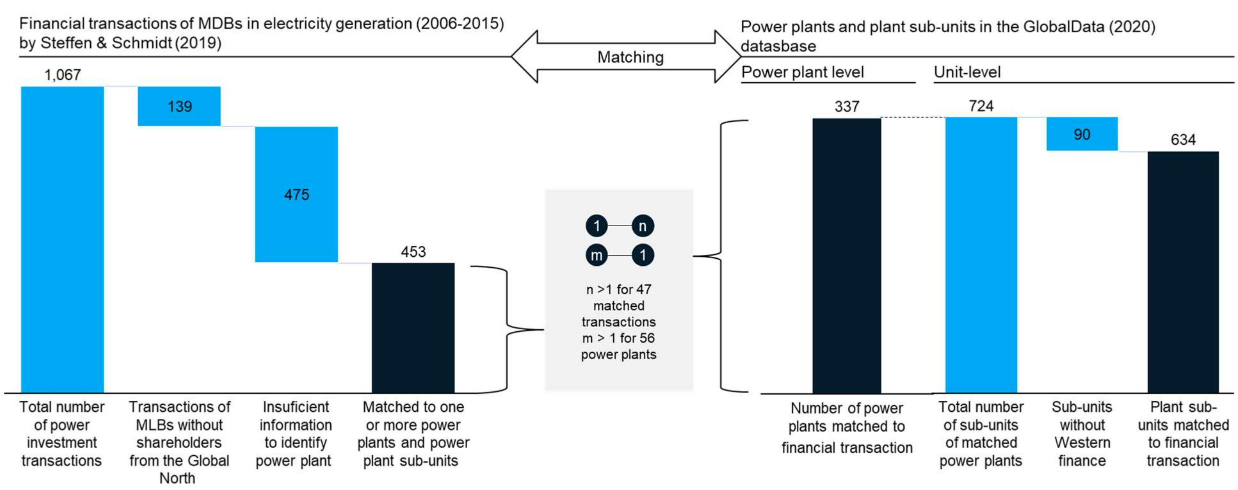


Fig D.7. Summary of dataset linking results between the dataset from Steffen and Schmidt (2020) and GlobalData (2020

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