

GLOBAL CHINA INITIATIVE

Understanding China's Global Power



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SUMMARY

The Global China Initiative at Boston University's Global Development Policy Center (GDP Center) introduces a new interactive dataset that tracks Chinese overseas finance in the electric power sector. Based on data compiled from GDP Center projects, the China's Global Power (CGP) interactive database tracks and displays the capacity, technology, local and national location, and projected carbon emissions of power plants financed through China's two global policy banks and foreign direct investment (Gallagher et al, 2018; Li et al, 2020; Chen et al, 2020).

Between 2000 and 2018, the CGP database exhibits that Chinese companies and policy banks have invested in 777 power plants overseas at 186.5GW of generation capacity across 83 countries in the world. Of this, 106.2GW is already online, with the remainder planned into the future.

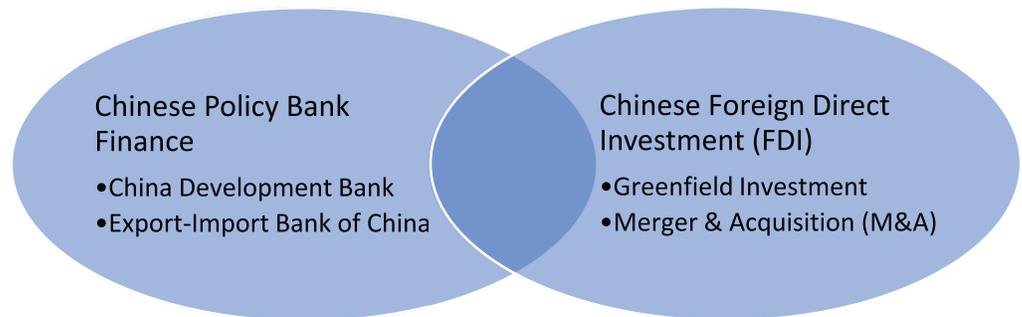
Forty percent of China's overseas power plant capacity is in the form of coal-fired power plants; 27 percent is hydroelectric and other renewable energy only accounted for 11 percent of the total capacity. The CGP shows that China's fossil fuel power plants are currently leading to approximately 314 million tons (Mt) of CO₂ emissions per year, which is about 3.5 percent of the annual CO₂ emission from the global power sector outside of China. Assuming no retirement by 2030, cumulative CO₂ emission from 2018 onward from these fossil fuel power plants will reach approximately 5.9 Gigaton (Gt), which would consume 1.3 percent of the global carbon budget for a 66 percent chance of limiting global warming to 1.5 degrees Celsius (Rogelj, J. et al., 2018), according to the Intergovernmental Panel on Climate Change (IPCC) Special Report.¹ Li, Ma, and Gallagher (2020) outline the methodology deployed to produce these data and discuss frequently asked questions about how the database can be used. This short policy brief outlines the major trends that are revealed from the data to date.

¹ Blended metric (BT) with additional Earth system feedback. For other estimates of the remaining carbon budget see Rogelj, J., Forster, P.M., Kriegler, E. et al. Estimating and tracking the remaining carbon budget for stringent climate targets. *Nature* 571, 335–342 (2019). <https://doi.org/10.1038/s41586-019-1368-z>.

1. Scope of the China's Global Power Database

The China's Global Power Database covers project information for power plants with the *participation* of Chinese Foreign Direct Investment (FDI) and/or policy banks (China Development Bank and Exim Bank of China) overseas. It should be clear that these data do not include Chinese commercial financing or investment funds.

Figure 1: Scope of China's Global Power Database



Whereas the associated scholarly papers with these data provide estimates of the dollar amount of Chinese overseas power plants, this dataset and interactive only focuses on plant capacity as full estimates of financing remain elusive.

Among Chinese investors in the global power sector, both state-owned and private companies are active players. We record 63 Chinese companies that have participated in FDI in the global power sector, with state-owned enterprises (SOEs) taking the lead. Some FDI projects are loan-financed, and some are not. There are also cases where they perform equity investment alongside Chinese or other sources of debt finance. Our database includes projects with more than 10 percent Chinese ownership. For projects with available ownership information, the average ownership percentage of Chinese investors is roughly 79 percent.

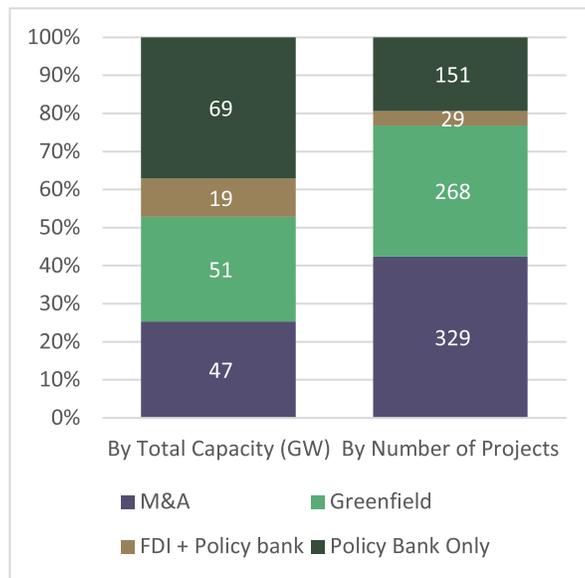
2. Patterns of Chinese power generation investment and finance overseas

According to our database, Chinese companies and banks have made investments that support 186.5GW of generation capacity across 777 power plants overseas, reaching 83 countries in the world. Of this, 106.2GW is already online, which accounts for close to two percent of the world's total capacity outside China (IEA, 2019a). An additional 80.3GW is under construction/planning, which is about 1 percent of additional capacity needed by 2030 according to the Stated Policies by country governments of the world (*Ibid.*, 2019).

Chinese FDI and policy banks have supported similar amounts of power generation capacity overseas. However, by number of projects, 81 percent of the projects are supported by FDI, 23 percent involve debt investment from Chinese policy banks, with a four percent overlap. This shows that policy banks have been investing in much larger projects by capacity than FDI. (Figure 2)



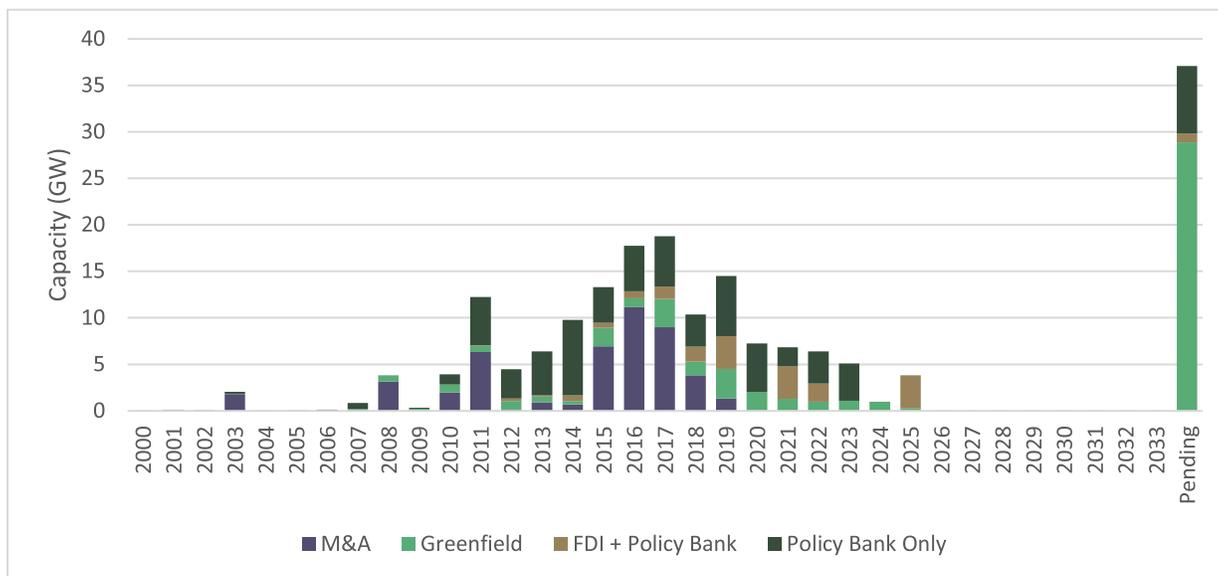
Figure 2: Deal Types of Overseas Power Plants with Chinese Investment and Finance



Source: China's Global Power Data, Boston University Global Development Policy Center

Mapping the commission years of these projects over time, Figure 3 shows that the commissioning of power generation with Chinese investment started climbing around 2008, peaked in 2017, and is still growing, although at a slowing speed. Since the year of commission in the database does not reflect the transaction dates, except for mergers and acquisitions (M&A) projects, and most greenfield investments are still under planning, most greenfield commission years are shown as pending. While transactions of M&A activities have been slowing down since 2016, policy bank-financed projects and greenfield investment projects are still steadily coming online.

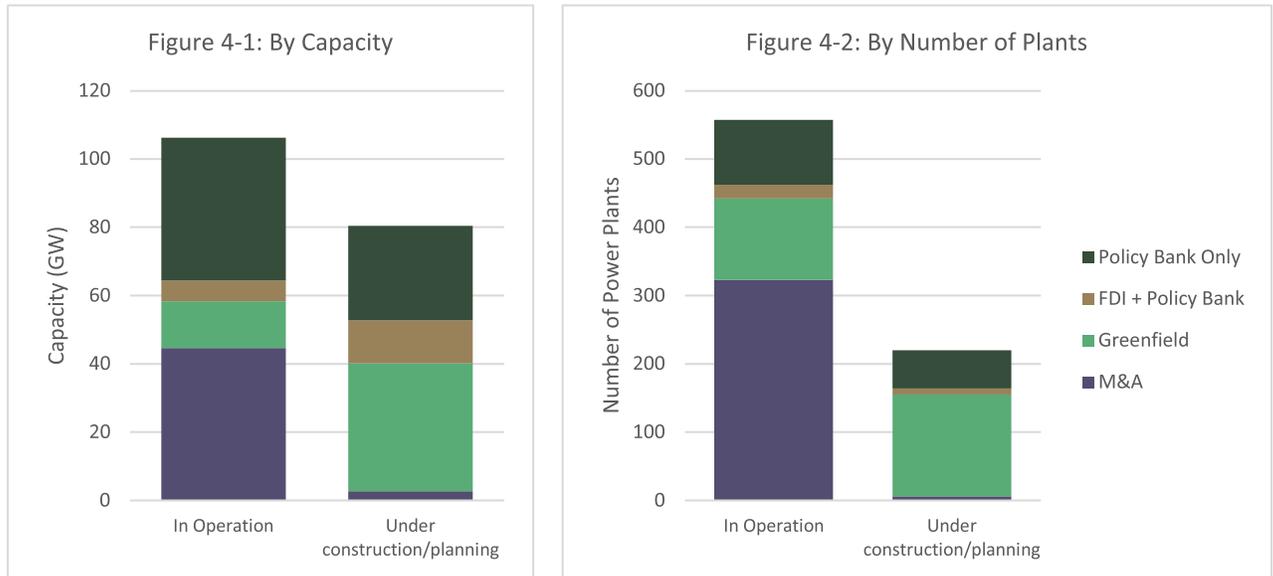
Figure 3: Deal Types of Overseas Power Plants with Chinese Investment and Finance Over Time



Source: China's Global Power Data, Boston University Global Development Policy Center

As shown more clearly in Figure 4, the majority of the currently operating power generation capacity with Chinese investment is supported by policy bank finance (45 percent) or acquired by M&A (42 percent). Nineteen percent of the currently operating capacity involves greenfield investment, with 6 percent involving both policy bank and greenfield FDI (Figure 4-1). However, calculating by the number of power plants, only 21 percent of the operating power plants with Chinese investment involve policy banks, and FDI projects take up a much bigger portion (Figure 4-2), since policy bank project sizes are typically larger than FDI. Meanwhile, there is almost three times the amount of the current operating greenfield investment capacity that is still under construction or under planning. On average they are going to be larger projects than the ones that have already come online, but still smaller than policy bank-financed projects that are under construction/planning.

Figure 4: Deal Types of Overseas Power Plants with Chinese Investment and Finance: In Operation vs. Under construction/planning

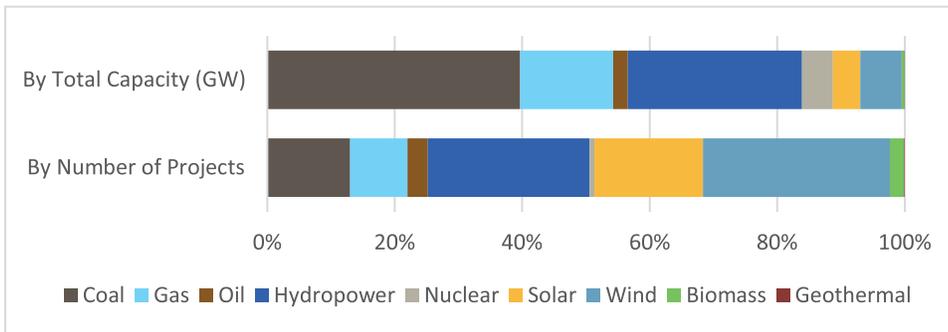


Source: China's Global Power Data, Boston University Global Development Policy Center

In terms of the energy sources of the overseas power plants with Chinese investment and finance, 40 percent of the capacity is coal-fired; 27 percent is hydroelectric; other renewable energy only accounted for 11 percent of the total capacity. On the other hand, wind, hydro, and solar power projects respectively accounted for 29 percent, 25 percent, and 17 percent of the total number of projects (Figure 5). This does not come as a surprise since renewable energy projects are typically much smaller in capacity than coal and gas projects.



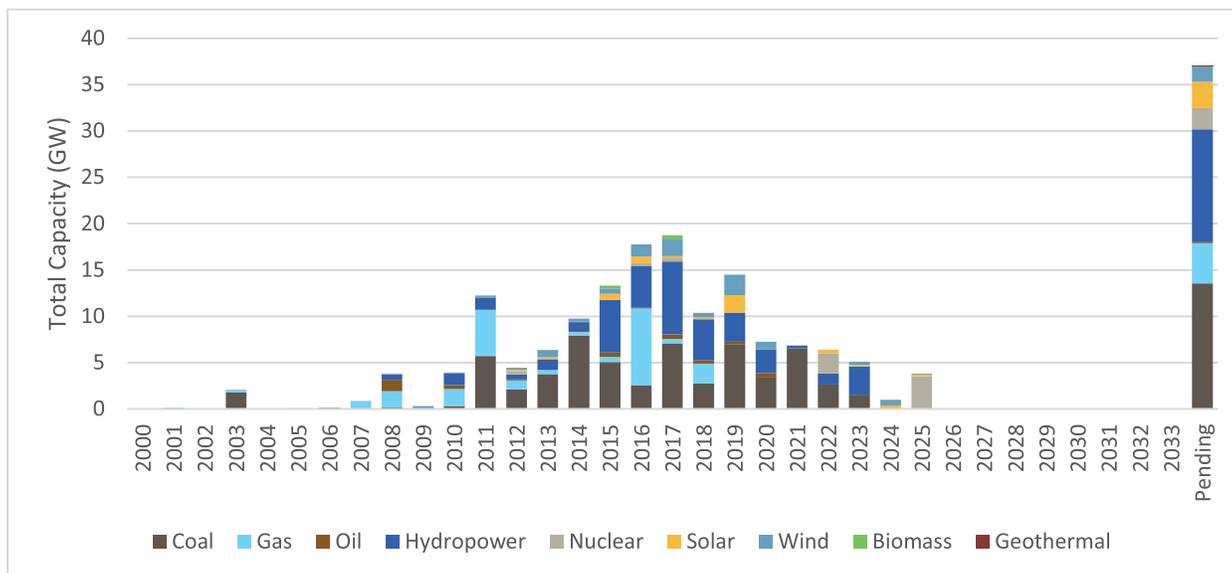
Figure 5: Distribution of Energy Sources of Overseas Power Plants with Chinese Investment and Finance



Source: China's Global Power Data, Boston University Global Development Policy Center

As Figure 6 shows, indeed the annual installation of renewable energy has been generally on the rise over the past decade. Many of these projects are still under development or planning. However, fossil fuel projects are still taking up a significant share of both projects in operation and those under planning.

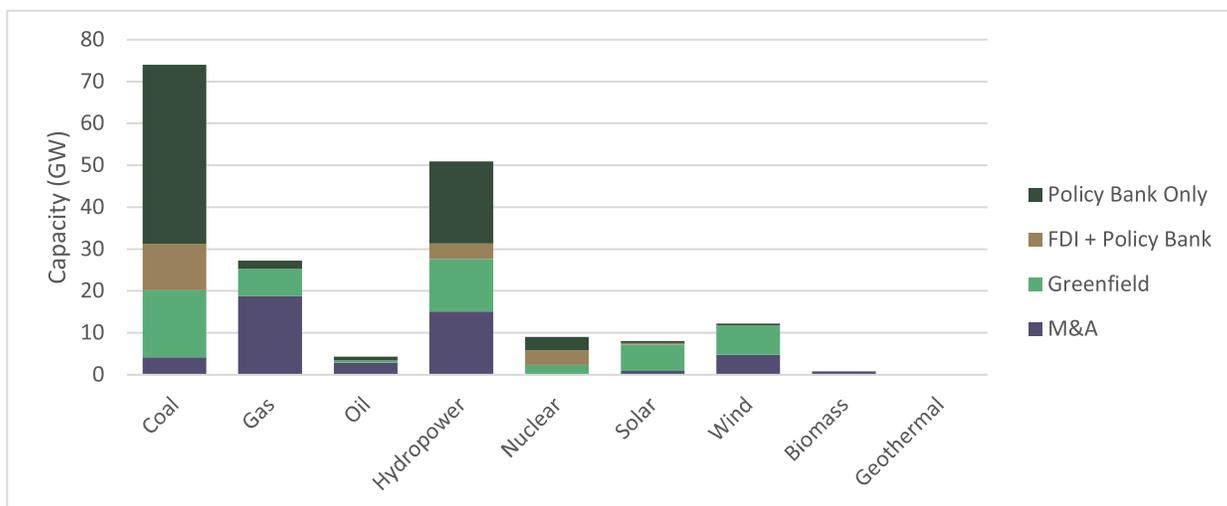
Figure 6: Energy Sources of Overseas Power Plants with Chinese Investment and Finance Over Time



Source: China's Global Power Data, Boston University Global Development Policy Center

As Figure 7 shows, Chinese policy banks contributed to 73 percent of overseas coal power generation capacity with Chinese investment and finance, and almost half of the hydropower plant capacity. Meanwhile, the majority of Chinese overseas investment in gas-fired power plants and renewable power generation projects come in the form of FDI.

Figure 7: Fuel Type Distribution of Each Deal Type of Chinese Overseas Power Generation Investment



Source: China's Global Power Data, Boston University Global Development Policy Center

The Chinese investment also shows starkly different patterns in energy sources between different regions, generally in line with energy resource endowments of these regions.² Coal power investment is highly concentrated in Southeast Asia (40 percent), South Asia (31 percent), and Africa (16 percent). These regions also received significant amounts of hydropower investment,³ but Latin America received the most investment in hydropower (41 percent). Latin America also stands out to be the biggest recipient of other forms of renewable energy, with the largest number of smaller projects. (Figure 8-1) In contrast, the Middle East features only a few large-scale coal, solar, and oil-fired power plants. Chinese investment in Europe and Central Asia, Oceania, North America and East Asia is more focused on natural gas and other non-hydro renewable energy projects, and the scale of installed capacity in these regions is relatively small (Figure 8-2).

Fossil fuel power plants lead to different CO₂ emissions burdens for different regions, affecting countries' abilities to achieve Nationally Determined Contributions under the Paris Agreement, and exacerbate global climate change. With our rough estimates,⁴ fossil fuel power plants with Chinese overseas investment and finance are currently leading to approximately 314 million tons (Mt) of CO₂ emissions per year (Figure 9), which is about 3.5 percent of the annual CO₂ emission from the global power sector outside of China (IEA, 2019a). Assuming all fossil fuel projects that are still under construction or under planning come online by 2030, they will add another 211 Mt to annual CO₂ emissions (Figure 9).

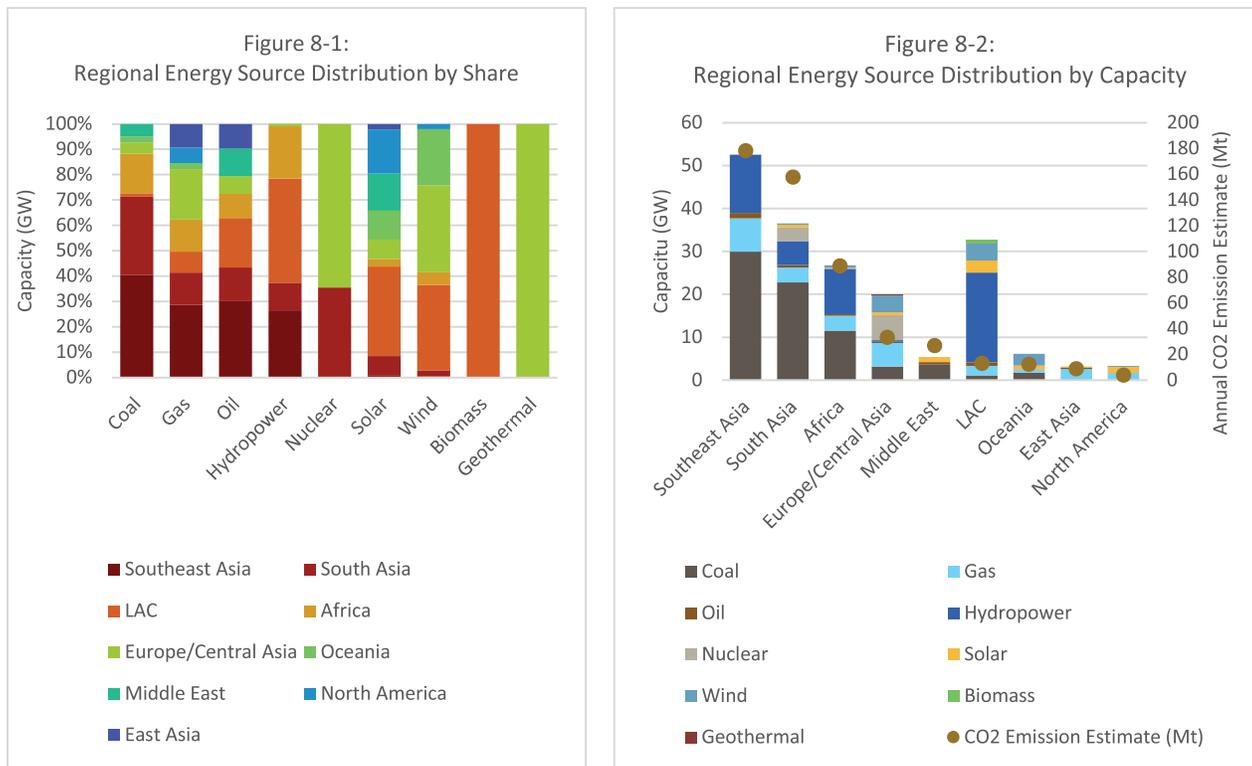
² For geographic endowment of different primary energy sources see World Energy Council, 2016. World energy resources 2016. World Energy Council, London, UK. <https://www.worldenergy.org/assets/images/imported/2016/10/World-Energy-Resources-Full-report-2016.10.03.pdf>

³ Southeast Asia 26 percent, Africa 21 percent, South Asia 11 percent.

⁴ See China's Global Power Database Methodological Note

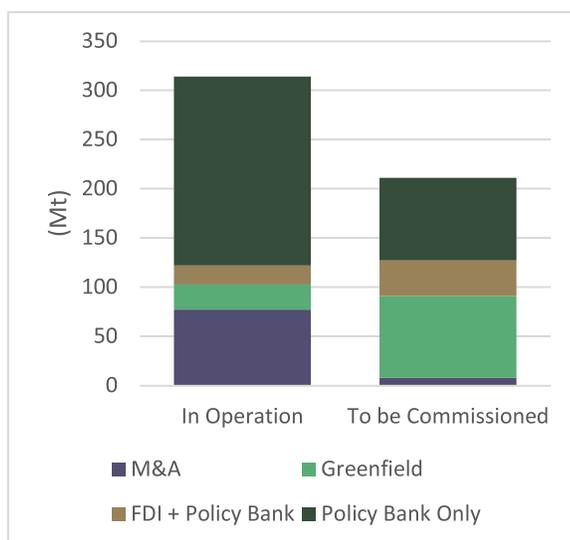


Figure 8: Geographic Distribution of Power Generation of Different Sources with Chinese Investment and Finance Overseas



Source: China's Global Power Data, Boston University Global Development Policy Center

Figure 9: Estimated Annual CO2 Emissions from Overseas Power Plants with Chinese Investment and Finance



Source: China's Global Power Data, Boston University Global Development Policy Center

Among the currently operating power plants, Chinese policy banks have been financing overseas projects that lead to approximately 211 Mt of CO₂ emissions per year, with more potentially to come in the projects under construction or planning. Meanwhile, although Chinese FDI with no policy bank involvement has invested in more clean energy generation than fossil fuel capacities, they also have a large fossil fuel power generation portfolio that are under construction or under planning (Figure 9).

Among the 83 countries that have received Chinese FDI and policy bank finance in the power generation sector, the top 15 recipient countries represent 77 percent of the total capacity that Chinese entities have invested in, and are going to produce 82 percent of the CO₂ emissions by all overseas power plants with Chinese investment (Table 1).

Table 1: Top 15 Countries with the Most Power Generation Capacity with Chinese Investment and Finance

Recipient Countries	Capacity (GW)	Estimated Annual CO ₂ Emissions from Power Generation (Mt)
BRAZIL	23.5	23.5
PAKISTAN	20.3	20.3
INDONESIA	16.1	16.1
VIETNAM	13.2	13.2
SOUTH AFRICA	11.2	11.2
UK	10.1	10.1
INDIA	8.3	8.3
MYANMAR	6.2	6.2
MALAYSIA	6.1	6.1
AUSTRALIA	6.0	6.0
BANGLADESH	5.5	5.5
LAOS	5.0	5.0
NIGERIA	4.8	4.8
UNITED ARAB EMIRATES	3.6	3.6
MEXICO	3.2	3.2
Proportion of Global	77%	82%

Source: China's Global Power Data, Boston University Global Development Policy Center

Brazil and the UK are a few of the top recipient countries where Chinese power generation investment have a low emissions intensity, as the majority of investment they received are renewable or nuclear energy; all Chinese investments in Laos are in hydropower, thus the emissions are low (shown as "-").⁵ In contrast, Chinese power generation investment in India, South Africa, Vietnam, UAE, etc., have particularly high emissions intensities due to the fossil fuel-heavy portfolios in these countries.

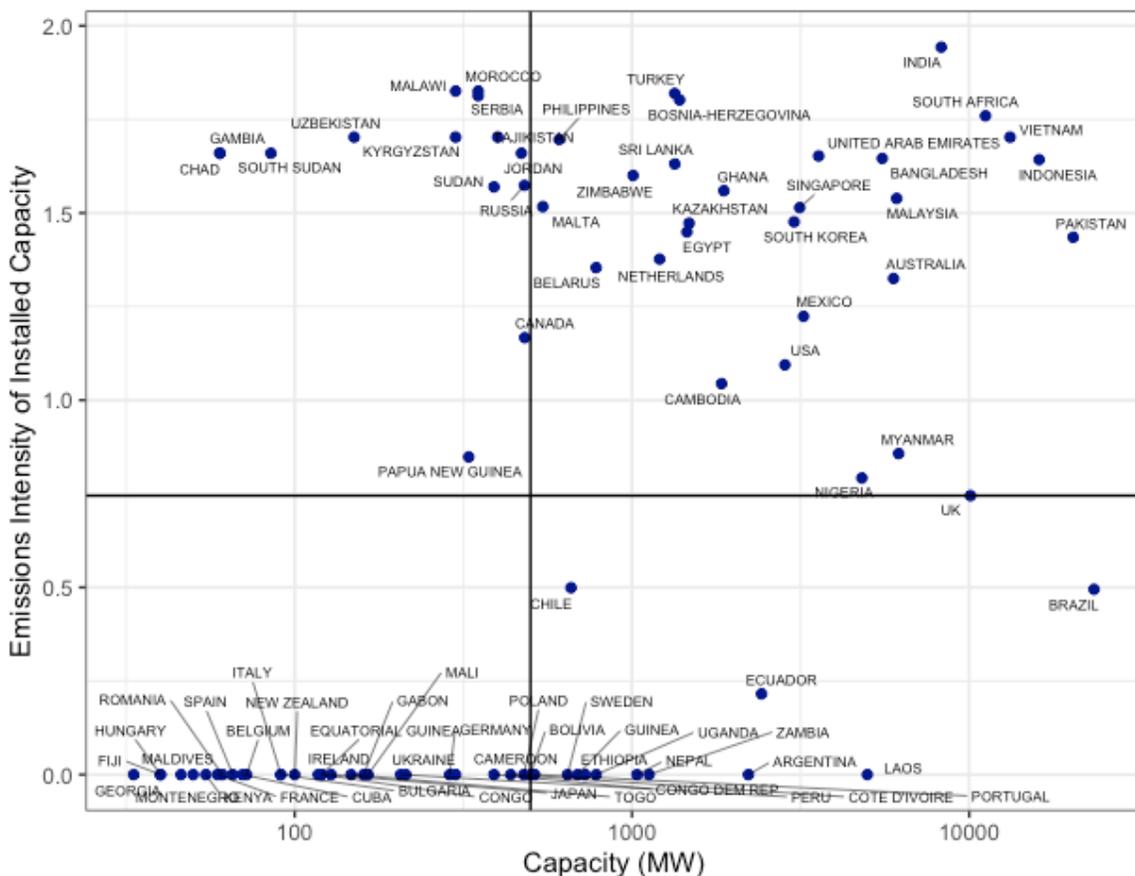
⁵ It should be recognized that although hydropower generation does not lead to carbon dioxide emissions, hydropower plant reservoirs might lead to net emissions if they submerge vegetations that are natural carbon sinks. Our rough estimate did not include this factor.



On the other hand, there are also countries that receive less investment, but the energy sources are relatively low emissions. Figure 10 & Table 2 group Chinese investment and finance in the overseas power sector in the 83 countries by the total capacity in each country and the estimated emissions intensity of these capacities. All countries listed in Quadrant III in Figure 10 and Table 2 have an emissions estimate of zero – all projects with Chinese investment and finance in these countries are renewable, even though the capacities are small.

While energy resource endowments, recipient country market space, and regulations seem to be the main factors that attract Chinese investment and finance in RE (Kong & Gallagher, 2019), there are many countries with high renewable energy potential that have not received Chinese capital in this sector. There is still space for country governments and international development institutions to incubate developing markets and prioritize sustainable options, and attract renewable energy investment in the deal type according to public financial situations.

Figure 10: Power Generation Capacity and Emissions Intensity of Chinese Investment and Finance in Different Countries



Note: Emissions intensity here is intensity on capacity. Numbers are logged and treated.

Quadrants are divided by medians of capacities and emissions intensities of all projects in the database.

Source: China's Global Power Data, Boston University Global Development Policy Center

Table 2: Patterns of Chinese Investment Finance in Power Generation Across Countries (Figure 10)

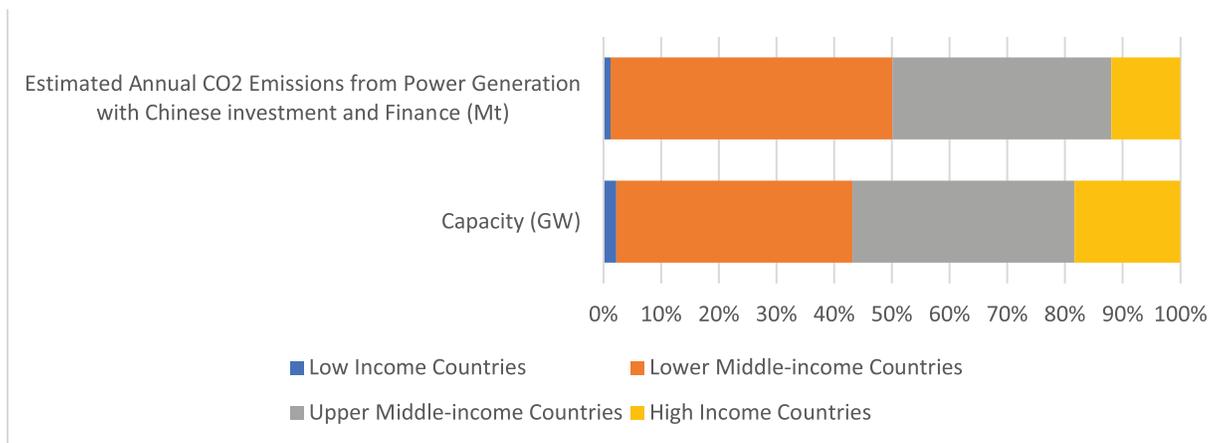
	Less Investment		More Investment	
Less Renewable Energy	Gambia		Pakistan	USA
	Chad		Indonesia	Ghana
	South Sudan		Vietnam	Cambodia
	Uzbekistan		South Africa	Kazakhstan
	Malawi		India	Egypt
	Kyrgyzstan		Myanmar	Bosnia-Herzegovina
	Papua New Guinea		Malaysia	Sri Lanka
	Morocco		Australia	Turkey
	Serbia		Bangladesh	Netherlands
	Sudan		Nigeria	Zimbabwe
	Tajikistan		United Arab Emirates	Belarus
	Jordan		Mexico	Philippines
	Russia		Singapore	Malta
	Canada		South Korea	
More Renewable Energy	Georgia	Ireland	Brazil	
	Fiji	Equatorial Guinea	UK	
	Hungary	Congo	Laos	
	Montenegro	Japan	Ecuador	
	Maldives	Togo	Argentina	
	Kenya	Gabon	Zambia	
	France	Mali	Nepal	
	Romania	Peru	Uganda	
	Spain	Ukraine	Ethiopia	
	Cuba	Germany	Guinea	
	Belgium	Cameroon	Chile	
	Bulgaria	Congo Dem Rep	Sweden	
	Italy	Cote D'Ivoire	Portugal	
	New Zealand	Poland		
		Bolivia		

Source: China's Global Power Data, Boston University Global Development Policy Center



As can be seen from Figure 11, the majority of Chinese power generation investment overseas went to middle income countries; 43 percent went to Lower-middle (LMC) and low-income countries (LIC). According to IEA (2019b), nearly 90 percent of energy investment in 2018 was concentrated in high- (HIC) and upper-middle income countries and regions (UMC). These areas also tend to benefit from relatively well-developed financial systems. Lower-middle and low-income countries accounted for less than 15 percent of energy investment in 2018 despite containing well over 40 percent of the world's population (IEA, 2019b). From this perspective, Chinese investment in lower-middle and low-income countries is crucial for meeting the fast-growing needs of these countries. Meanwhile, these investments need to be clean to meet sustainable development goals – as Figure 11 shows, Chinese power generation Investment in lower-middle income countries is more emissions intensive than in the rest of the world; the portfolios in high-income and low-income countries are both cleaner.

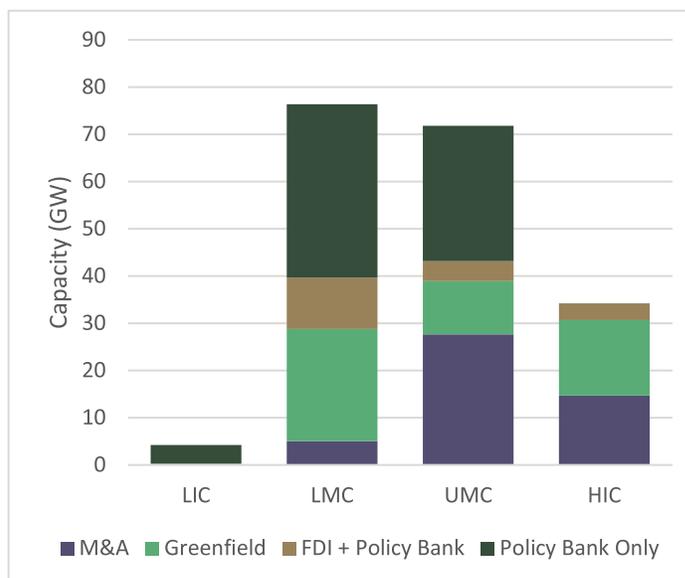
Figure 11: Power Generation Capacity and Emissions Estimates in Different Income Group Countries



Source: China's Global Power Data, Boston University Global Development Policy Center; World Bank Country and Lending Groups, 2020

As shown in Figure 12, Chinese policy banks are key drivers of Chinese investment in lower income country groups. Almost all Chinese power generation investment in LICs is carried out by Chinese policy banks. They also supported 62 percent of the capacity invested in LMCs and 46 percent in UMCs. Their participation in investment in HICs is relatively little, most of which is alongside green-field FDI.

Figure 12: Deal Types of Chinese Overseas Power Generation Investment and Finance in Different Income Country Groups



Source: China's Global Power Data, Boston University Global Development Policy Center; World Bank Country and Lending Groups, 2020

Among the 63 Chinese companies that have participated in FDI in the power generation sector, the top ten companies have contributed to 77 percent of the total capacity, and are leading to about 69 percent of the total CO₂ emissions from these power plants. Except for Canadian Solar, which is one of China's biggest solar PV companies, nine out of the top ten investing companies are state-owned enterprises, and are also among the biggest power companies in China.

Table 3: Top Ten Chinese Companies Investing in Power Generation Overseas

Chinese Investing Companies	Capacity (GW)	Estimated Annual CO ₂ Emissions from Power Generation (Mt)
China General Nuclear Power Group	19.7	37.5
China Three Gorges Corporation	16.7	3.4
China Huaneng Group	14.4	45.3
State Power Investment Corporation	9.2	23.7
PowerChina	7.9	15.3
State Grid Corporation of China	7.4	2.5
China Huadian Corporation	5.3	22.9
Shenhua Group	3.4	15.6
China Datang	3.2	6.6
Canadian Solar	3.2	-
Proportion of Total Chinese FDI in Power Generation	19.7	37.5

Source: China's Global Power Data, Boston University Global Development Policy Center

Besides Canadian Solar, which has been investing solely in solar power, all other top ten companies are investing in multiple energy sources. Companies such as China Three Gorges and Shenhua, which have specific technology focuses, do have FDI portfolios more concentrated on their sectors of expertise.⁶ But all these companies hold at least some investment in renewable power generation, and the trend is growing over recent years.

Meanwhile, 34 of the 63 companies, holding 12 percent of the total FDI capacity, are investing purely in renewable energy (including hydropower). Over half of them are private companies. This shows that even though investing in small volumes, a more diverse range of Chinese companies are investing in renewable energy overseas. Both private firms and SOEs are wading into more renewable energy, many still in early stages. Whether these renewable energy investments will expand and win more market space will likely depend on economic performances of these early stage investment projects.

3. Outlook and Recommendations

Even at the global investment level of 2019, the amount and composition of power generation investment is still far behind the annual investment needed to hold the increase in the global average temperature to well below two degrees Celsius above pre-industrial levels, including in China, United States, and the EU (IEA, 2020). In the current context of the global pandemic, IEA predicts that overall power investment around the world is set to decline in 2020 by an estimated ten percent. Regions that rely heavily on public funding, such as India, Africa, and Southeast Asia, where both supply shortage and Chinese investment are high, are also likely to see deep cuts in spending. Enabling environments for investment in most of these countries carry a number of risks that can challenge project bankability. In Latin America, investment expectations have also been deteriorating. In the two largest markets in Latin America, Brazil is postponing all transmission investment and renewable auctions and Mexico is slowing down the connection of renewables.

Although levels of China's FDI and overseas contracting and engineering of the first eight months of 2020 has been encouragingly stable (MOFCOM, 2020), the global power sector investors are faced with unprecedentedly challenging times. Nevertheless, the power sector could be a significant driving force for sustainable economic recovery. Policy support from China, the recipient countries, as well as multilateral institutions will all be crucial.

Under the Paris Agreement, the world's currently stated policy is to reduce annual CO₂ emissions by 41 Mt by 2030, which leaves the world far short of shared sustainability goals. Full alignment with the Paris agreement requires the world to reduce 5,358 Mt of CO₂ by 2030 (IEA, 2019a). Any continued support for fossil fuel projects will be undermining the future of sustainable development. Chinese policy makers should continue to support renewable energy not only through policy banks' overseas finance. Through promoting R&D investment, international cooperation, and fair market competition, the Chinese government has a key role to play creating space for growth for private enterprises, and also drive for the transformation of Chinese industrial capacity.

As the cost-competitiveness of renewable energy continues to improve, and as more governments increase their environmental standards and sustainable development policies, fossil fuel projects face significant risk of becoming stranded. The Chinese policy banks could introduce climate targets, emission standards/shadow carbon price, and eventually match the environmental standards of multilateral development banks to phase out financing for coal power projects. For both Chinese policy banks and power sector investors, there is potential to cooperate with international development finance institutions on renewables for favorable financial resources and risk management under the economic circumstances of today.

⁶ In these two cases, China Three Gorges primarily invests in hydropower, and Shenhua primarily invests in coal power generation.

For countries in need of power generation capacity, careful calibration of energy plans and resilience would be needed. Policy support for renewable energy and market regulations appear to be boosters for any renewable energy investment. Countries could resort to different deal types of investment according to the market structure and public budget circumstances, and appeal to multilateral development institutions for financial support.

REFERENCES

Chen, X., Gallagher, K.P. and Mauzerall, D.L., 2020. Chinese overseas development financing of electric power generation: A comparative analysis. *One Earth*, Available at <https://www.bu.edu/gdp/2020/10/08/chinese-overseas-development-financing-of-electric-power-generation-a-comparative-analysis/>.

Gallagher, K.P., Kamal, R., Jin, J., Chen, Y. and Ma, X., 2018. Energizing development finance? The benefits and risks of China's development finance in the global energy sector. *Energy Policy*, 122, pp.313-321.

IEA, 2019a. *World Energy Outlook 2019*, OECD Publishing, Paris, <https://doi-org.ezproxy.bu.edu/10.1787/caf32f3b-en>.

IEA, 2019b. *World Energy Investment 2019*, IEA, Paris <https://www.iea.org/reports/world-energy-investment-2019>.

IEA, 2020, *World Energy Investment 2020*, IEA, Paris, <https://doi-org.ezproxy.bu.edu/10.1787/6f552938-en>.

Kong, B. and Gallagher, K.P., 2020. Chinese development finance for solar and wind power abroad. GCI WORKING PAPER 009 • 01/2020. https://www.bu.edu/gdp/files/2020/02/WP9-Kong-Bo-inc_abstract-1.pdf.

Li, Z., Gallagher, K.P. and Mauzerall, D.L., 2020. China's global power: Estimating Chinese foreign direct investment in the electric power sector. *Energy Policy*, 136, p.111056.

Li, Z., Ma, X., and Gallagher, K.P., 2020. China's Global Power Database Methodological Note. <https://www.bu.edu/gdp/2020/10/19/chinas-global-power-database-methodology-note/>.

Ma, X., Gallagher, K.P., Guo, Y., 2020. China's Global Energy Finance (CGEF) 2019. *GCI Policy Brief 004, February 2020*. <https://www.bu.edu/gdp/2020/02/13/chinas-global-energy-finance-cgef-2019/>.

MOFCOM, 2020. Press Release September 17, 2020. <http://www.mofcom.gov.cn/article/ae/ah/>.

Rogelj, J. et al., 2018. In Global Warming of 1.5 °C: an IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty (eds Greg Flato, Jan Fuglestedt, Rachid Mrabet, & Roberto Schaeffer) Ch. 2, (2018).

Rogelj, J., Forster, P.M., Kriegler, E. et al., 2019. Estimating and tracking the remaining carbon budget for stringent climate targets. *Nature* 571, 335–342. <https://doi.org/10.1038/s41586-019-1368-z>.

The World Bank, 2020. World Bank Country and Lending Groups. Available at <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>.





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The Global China Initiative (GCI) is a research initiative at Boston University's Global Development Policy Center. The GDP Center is a University wide center in partnership with the Frederick S. Pardee School for Global Studies. The Center's mission is to advance policy-oriented research for financial stability, human wellbeing, and environmental sustainability.

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