SCHOOL OF PUBLIC POLICY
CENTER FOR GLOBAL SUSTAINABILITY

DECARBONIZING CAPTIVE COAL POWER PLANTS IN INDONESIA AND IMPLICATIONS FOR CHINESE STAKEHOLDERS: TRENDS, CHALLENGES AND OPPORTUNITIES

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POLICY INSIGHTS

- Captive coal power plants, accounting for 18% of Indonesia's coal capacity, with over half built since 2016, remain a big challenge for the Indonesia Just Energy Transition Partnership (JETP) targets.

- The growth of captive coal power plants is driven by Indonesia's economic and industrial strategies including critical mineral mining industry, industrial parks, and urbanization/infrastructure investment.

- Decarbonizing these plants is a complex technical and socioeconomic conundrum, facing a trilemma of Indonesia's economic priorities, inadequate power grids, and limited low-carbon alternatives.

- Chinese investors are involved in over 70% of the captive coal power capacity, and their investments are closely linked to broader industrial ventures.

- China, with its vast experience in green development, including areas such as renewable energy, eco-industrial parks, circular economy, energy efficiency and carbon markets, can play a pivotal role in Indonesia's captive coal power decarbonization and supporting the country's transition to a carbon-neutral economy. This transition also opens doors to promising business opportunities for both Chinese and international investors.

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SUMMARY

Captive coal power plants as opposed to supplying electricity to the power grid—currently account for 18% of the coal power installed capacity in Indonesia and are expected to continue a rapid growth trajectory. More than half of them were built from 2016 onwards. The surging demand for captive power plants in Indonesia is driven by three primary forces: (1) the mining industry of mineral ore, including critical minerals for clean energy, and the supply chains, supported by the government's strategy for these industries to be an engine of Indonesia's economic growth; (2) a focus on industrial estates/parks distributed around the country as a policy tool for regionally diverse industrial growth; and (3) urbanization and expanding investment in infrastructure.It is therefore a key question and policy challenge whether the country can effectively halt and decarbonize captive coal power in the context of the government's coal power plant ban and the Indonesia Just Energy Transition Partnership (JETP). Decarbonizing captive coal power plants in Indonesia poses a complex trilemma. The path forward is challenged by the country's national economic strategies, which prioritize energy-intensive industries like mineral mining and their associated supply chains, the limitations of the country's relatively weak and inadequate power grids, as well as the lack of cost-effective low-carbon alternatives. Navigating this trilemma becomes crucial in formulating effective strategies for transitioning away from coal. To ensure alignment between Indonesia's economic strategies and its climate commitments, the country should strengthen its power grid infrastructure and enhance strategies for maximizing clean energy and electricity for industrial parks and captive power needs. Chinese companies play a dominant role in Indonesia's captive coal power investment, and have invested in more than 70% of the existing and planned capacity. This significant involvement is closely linked to China's surging investment in Indonesia's industrial sector more broadly, particularly energy intensive industries. Fourteen Chinese companies, both private and state-owned, are involved in Indonesia's captive coal power plants, with most being iron/steel and mineral mining companies. China's government and industry actors can refocus their efforts on this clean energy strategy for Indonesia. As key stakeholders, Chinese actors should play a more proactive role in accelerating the decarbonization of captive coal power plants in Indonesia. More importantly, both the Chinese government and industry actors have substantial experience and best practices that can be shared with Indonesia to transition towards a sustainable and carbon-neutral economy.

OVERVIEW OF CAPTIVE COAL POWER PLANTS IN INDONESIA

Indonesia has recently increased its commitment to a transition away from coal-fired electricity and has made recent progress toward these goals, attributable to both domestic and foreign investment commitments. Notably, Indonesia announced that it will stop building new coal-fired power plants from 2023. In parallel, China - one of the largest coal-fired power country investors in Indonesia, has also pledged to end the funding of coal-fired power plants overseas, including Indonesia. Indonesia's Just Energy Transition Partnership announced at the G20 summit in 2022 aims to mobilize 20 billion USD to accelerate the retirement of coal-fired power and the deployment of renewable energy. However, uncertainty remains in translating those commitments into long-term coal phase-out actions. Although Presidential Regulation No. 112 of 2022 bans the development of new coal-fired power plants, it exempts the construction of coal power plants that were already in PLN's (the state-owned monopoly of Indonesia's power sector) 2021-2030 Business Plan before the regulation's implementation, as well as those coal-fired power projects listed as National Strategic Projects (Hamzah & Partners, 2022; Roesad, 2023).

Among the uncertainties, captive coal plants in Indonesia[1] deserve particular attention due to their growing prominence. Different from conventional power plants, which are connected to the power grid, captive coal plants serve as the localized power suppliers of individual or clusters of industrial facilities, and can be most useful for developing industrial

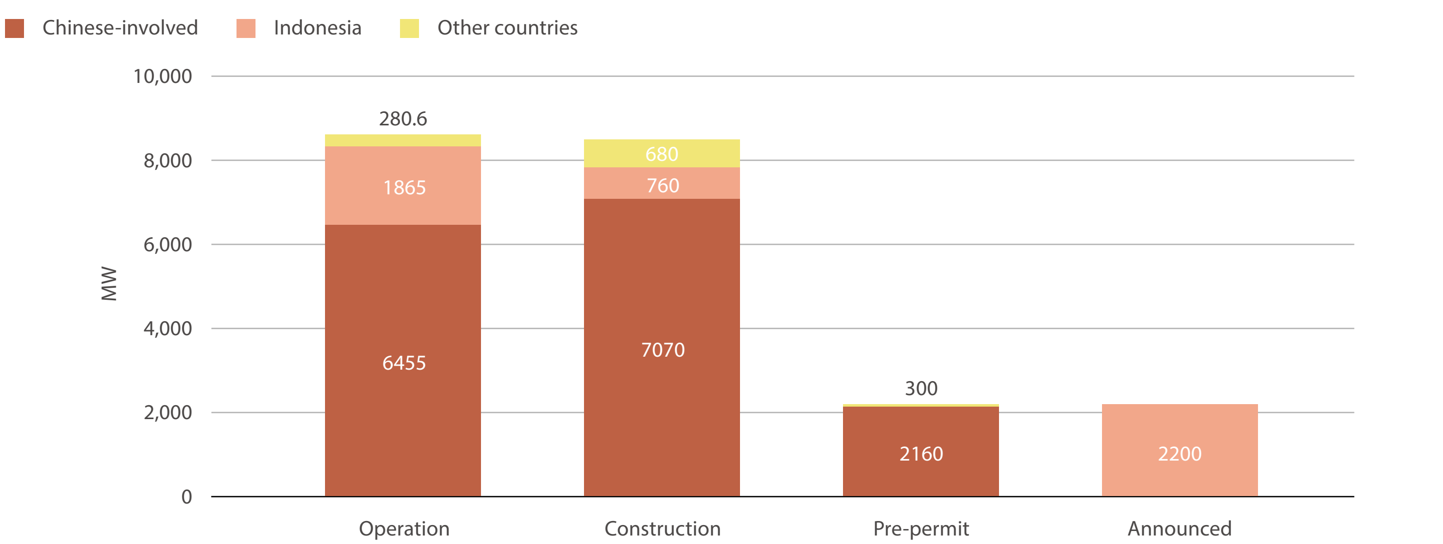
[1] The term captive coal plants here refer to both the plants with *Ijin Usaha Penyediaan Tenaga Listrik untuk Kepentingan Sendiri* (IUPTLS) which is permit for operating power plants for own use, and the private power utility (PPU) ones, where they have permits and business area license to generate and sell electricity in specific area

areas that are both challenging and costly to connect to the grid. Captive power plants enable industry actors to have a reliable power source that meets their specific needs and requirements, thereby improving their operations. Currently, captive coal plants account for 18% of the installed capacity of coal-fired power in Indonesia, reaching 8.6 GW. Moreover, there are an additional 12.9 GW of captive coal power plants that are either under construction, awaiting permits, or have been announced (Global Energy Monitor, January 2023) (Figure 1). The majority of captive coal power plants in Indonesia are wholly or jointly owned by foreign companies, mostly Chinese companies, in conjunction with firms from the United States, Japan, Australia, India, and Malaysia. Captive coal power plants that are wholly owned by Indonesian companies account for a significantly smaller share.

The Presidential Regulation No. 112/2022 also exempts captive power plants for industrial parks (Hamzah & Partners, 2022; Roesad, 2023). This creates a policy conundrum in the context of Indonesia's Just Energy Transition Partnerships (JETP) - caught between the commitment of an accelerated energy transition and the urgent needs for economic development. Therefore, captive power plants will add more uncertainties to the coal retirement process if insufficiently addressed and will substantially comprise the climate comments of both Indonesia and China.

However, the issue of captive coal plants is much more than simply a government ban or ceasing Chinese investment, since it is heavily embedded in the socioeconomic development of Indonesia and the decarbonization process domestically and internationally. Indonesia is currently one of the world's fastest growing economies, fueled by the country's surging industrialization and urbanization. Indonesia's Master Plan of National Industry Development (RIPIN) 2015 –2035 highlights multiple strategies that will require intensive and reliable power supply to support the country's national economic agenda, including developing upstream and intermediate industries associated with natural resources, industrial estates and small/medium industry centers, and infrastructure. Notably, Indonesia already mines around half of the world's nickel supply – a critical element in nearly all emerging low-carbon technologies including EVs, battery storage, geothermal, hydrogen as well as other non-fossil fuel energies (Nickel Institute, 2021). Meanwhile, captive power plants, which can better meet the need for reliable power supply in many industrial sites, are considered an important complement to conventional power plants (PwC, 2016). Therefore, the energy transition of captive power ties directly to the development needs of Indonesia, as well as the global mineral supply chains for clean technologies (Sovacool et al., 2020).

Figure 1. Captive coal power capacity in Indonesia (MW), broken out by the stage of projects and the country/region origin of investment



Data source: Global Energy Monitor, January 2023. Owner country information was manually collected by authors

Key questions need to be addressed prior to crafting the coal phase-out strategies for Indonesia's captive power plants: (1) What are the needs for captive power to serve the electricity requirements of diverse types of industrial facilities? (2) What are the challenges of captive power plants? (3) What is the role of Chinese investors and what can be done to address these challenges given the prominent role of Chinese stakeholders in Indonesia's economy?

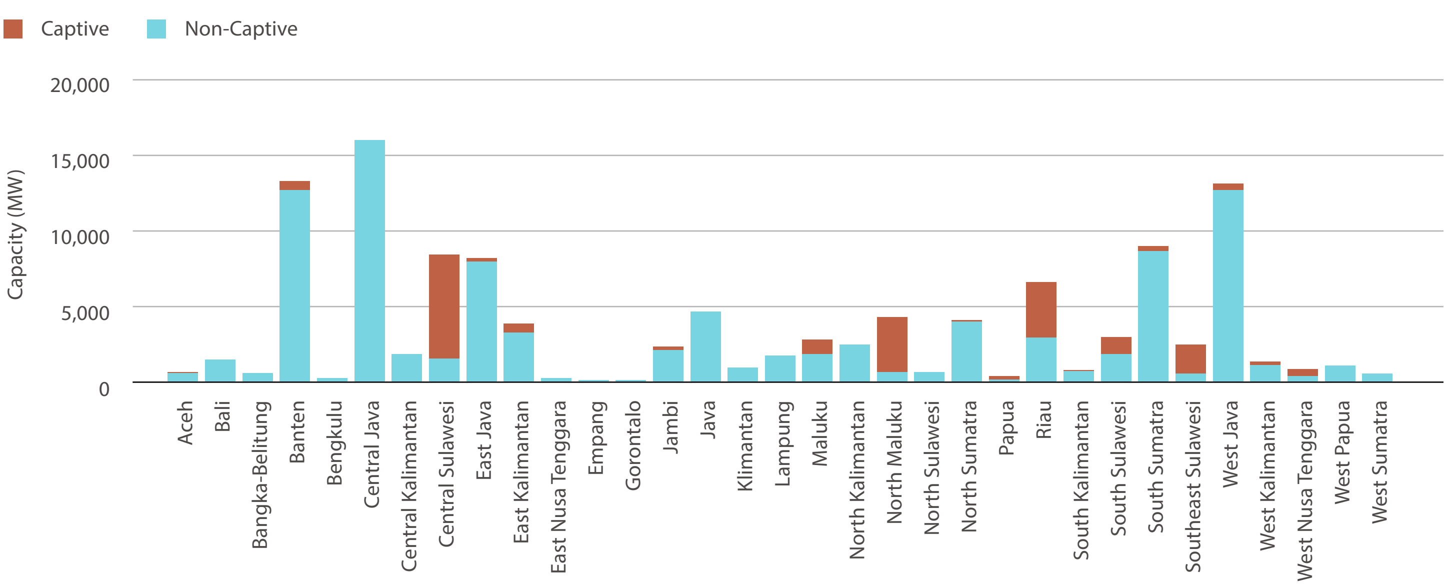
WHAT ARE THE NEEDS FOR CAPTIVE POWER PLANTS?

Energy-intensive industries, such as construction, mining, and manufacturing, are major drivers of Indonesia's economic growth, respectively accounting for 10.44%, 8.98% and 19.25% of the country's GDP in 2021 (Statista, 2022).The PLN's 2021-2030 RUPTL ("Electricity Business Plan"), which is the ten-year electricity expansion plan of Indonesia, forecasted an average annual power demand growth rate of 4.9%. However, Indonesia has historically faced an electricity supply crisis despite the country's abundant energy resources. This is due to both geographical barriers (i.e., the country is composed of more than 17,000 islands) and underinvestment in power infrastructure (Hartono et al., 2020). The rapid growth in demand for electric power has outpaced capacity increases and been constrained by the country's power grid reliability and distribution issues. Electricity blackouts remain common across Sumatra, Kalimantan, Sulawesi, and areas of Eastern Indonesia (PwC, 2018).

In addition, there is a significant imbalance in the distribution of power demand and supply across Indonesia. This disparity primarily exists between the developed regions, largely situated in the western part of the country, such as Java, Bali, and Sumatra, and the underdeveloped regions, mostly in the eastern part of the country, such as Papua and Maluku. Approximately 89% of the electricity is consumed in Java and Sumatra, while less developed regions only consume 2.3% of the electricity (Sulaeman et al., 2021).

Therefore, captive power plants have been increasingly favored by industry actors in recent years. Among 82 currently operating captive coal plants, 51 of them were built in or after 2016 , accounting for approximately 80% of the captive coal installed capacity. More than half of the captive power capacity was installed after 2016. Captive power plants are found in half of the provinces in Indonesia, but unevenly distributed across these provinces (Figure 2).

Figure 2. Total Coal Power Plant Capacity in Each Province by Captive and Non-Captive Plants as of 2023



Data source: Global Energy Monitor, 2023; Center for Global Sustainability (CGS) in-house data

The Indonesian government has hoped that captive power plants can be a catalyst for Indonesia's industry (PwC, 2016). The demand for captive power plants is expected to continue growing due to three major forces:

The mining industry of climate-saving minerals as an engine of economic growth.

Indonesia is abundant in mineral deposits. The fast growing mineral mining industry, especially for nickel, bauxite, and their downstream industries, has been gradually centered in the country's economy. This has been driven by the need for conventional industrial products, such as stainless steel, but also increasingly by the surging global demand for clean technologies, such as electric vehicles (EVs), wind turbines, and solar PV.

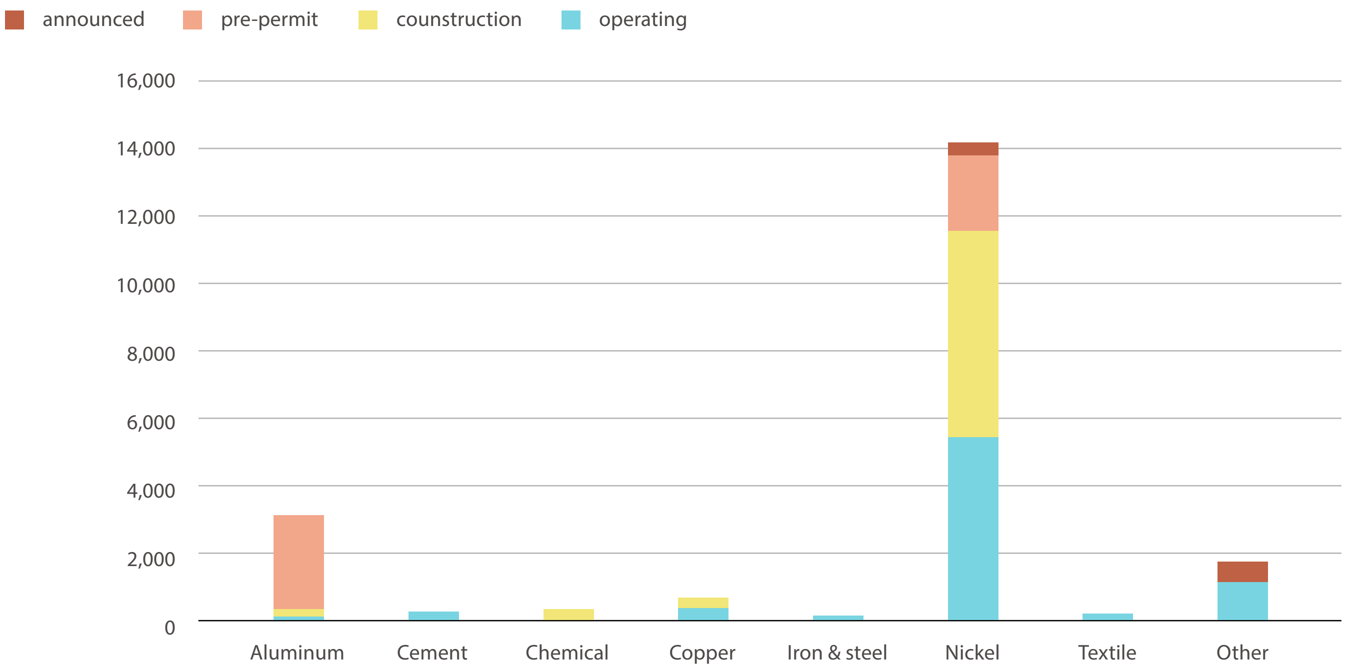
As the world seeks to move rapidly away from fossil fuels, the global demand for nickel continues to grow. Indonesia is the world's largest nickel producer and, recognizing the investment potential of nickel industries, has attempted to maximize the socioeconomic benefits of those resources. Over the last decade, Indonesia's nickel mining production has experienced a major surge, starting from 236 thousand Mt in 2010 and reaching 1,600 thousand Mt in 2022. In particular, the production more than doubled from 2020 to 2022 (Statista, 2023). Additionally, the country is expected to account for half of the global production increase in nickel between 2021 and 2025 (Huber, 2021).

More importantly, the Indonesian government issued a ban on unprocessed mineral ore exports, including of nickel and bauxite, to boost downstream industries such as refining, smelting, and equipment manufacturing, and to add value to local supply chains. So far, mineral mining-related supply chains have created jobs and contributed significantly to Indonesia's GDP (EITI, 2021; Huber, 2021). Encouraged by earlier success in the steel industry, Indonesia is determined to extend and upgrade its nickel-related supply chains and become a major hub for EV and battery manufacturing (Firstpost, 2023; Pandyaswargo et al., 2021).

However, mining activities and its supply chain industries, including metal processing, are among the most energy-intensive industries globally. The mining industry consumes approximately 38%, 15%, and 11% of the total global industrial energy use, electricity use, and the total global energy use, respectively (Igogo et al., 2020; McLellan et al., 2012). Growing pressure for Indonesia to capitalize on its mineral resource wealth will inevitably drive up the demand for cheap and reliable energy supplies, as this is one of the most significant costs in the mining industry, accounting for 15%-40% of total operating costs (Maennling & Toledano, 2018). Consequently, coal has become the predominant power source for the industry. This creates an unwanted challenge for global low-carbon transitions.

Additionally, access to reliable electricity is also critical for the mining industry. Many mines and mineral plants are located in areas that lack access to a stable and adequate power supply, which can be a major challenge for future development of the industry. For example, nickel resources and reserves are abundant across Sulawesi, including the provinces of South Sulawesi, Central Sulawesi, and Southeast Sulawesi, which is home to Indonesia's largest nickel producer. Abundant nickel deposits were also found in North Maluku province on the islands of Obi, Gebe, and Halmathera (Petromindo, 2022). However, these regions generally have relatively low installed power capacities and are served by smaller, more isolated, and less dependable power grids (Asian Development Bank, 2019).This often requires installing captive power plants as an alternative. For example, Figure 7 shows that regions with abundant nickel resources, such as North Maluku and Sulawesi, account for the majority of the country's captive coal plants. This indicates that the demand for captive power plants is strongly associated with Indonesia's mineral mining industry, particularly nickel, which is becoming increasingly central to the country's economic development (Figure 3).

Figure 3. Captive power plants's end-use sectors/industries (MW)



Data source: CGS in-house data

Industrial estates/parks as a policy tool for industrial growth

Industrial parks are areas that have been designated for the promotion of industrial activities by providing necessary infrastructure and facilities. They can attract investment, generate employment opportunities, and increase exports, while also overcoming obstacles to industrialization. Industrial parks can also create an engine with positive spillover effects in the park and onto surrounding areas. As a result of the Joko Widodo administration's strong focus on industrial development since 2014, industrial parks have been expected to play a vital role in clustering such developments and become a crucial driver of the country's industrial growth, as emphasized by Indonesia's Master Plan of National Industry Development (RIPIN) 2015-2035 (Global Business Guide, 2016; Oxford Business Group, 2017). The government issued a new regulation in 2015, which revised the previous Government Regulation No.24/2009 on industrial zones, and sought to incentivize investment in developing industrial parks across the country (Library of Congress, 2016). The new regulation requires that all manufacturing activities must take place within designated industrial parks/estates, indicating the central position industrial parks hold in shaping future industrial activities in Indonesia (Oxford Business Group, 2017). Additionally, this regulation serves as a legal basis for more detailed ministerial regulations, in order to offer more incentives to both industrial estate developers and business tenants.

The number of industrial parks has grown significantly since then. There was a 51% increase from 2015 leading up to 2020 (Indonesia Window, 2020). By February 2023, 156 industrial parks had been developed throughout Indonesia based on our in-house data. Many of the existing or planned industrial parks were built for the mineral mining industry and its supply chain.

Similar to the case with the mining industry, captive power plants can serve as an important complement to on-grid power supply for industrial parks as they are able to provide high quality and reliable electricity. This is particularly true when the conventional centralized power system is weak.

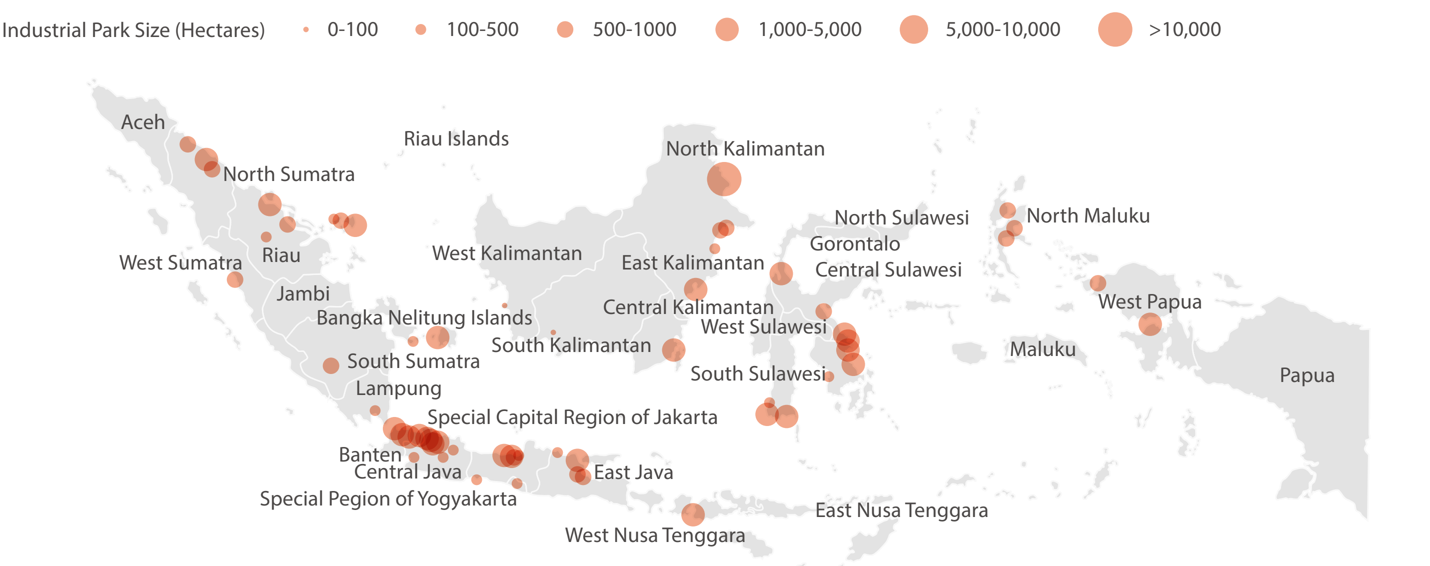
There have already been a notable number of cases where industrial parks located in eastern and northern Indonesia had power grids that were inadequate (Figure 4).

However, given the government's strong determination for investment in less developed regions, there is great potential for an increasing number of industrial parks to be developed in the regions that currently lack sufficient power supply. In order to accelerate industrial development across the entire territory of Indonesia, ten Industrial Development Areas were established in 2015. Seven of them were in the eastern part of Indonesia (i.e., Kalimantan, Sulawesi, Papua, Bali and Nusa Tenggara), which is generally less developed (except for Bali): two are in Sumatra and one area is in Java (Tumiran et al., 2021). Additionally, the new government regulation designates four industrial zones according to the development level of those regions: (1) developed industrial estates in Java; (2) developing estates in southern Sulawesi, eastern Kalimantan, parts of northern Sumatra, and southern Sumatra; (3) potential estates in northern Sulawesi, western Kalimantan, Bali, and Nusa Tenggara; (4) Papua and West Papua. Greater incentives have been provided to encourage investment in industrial parks in less developed areas (Library of Congress, 2016).

Urbanization and expanding investment in infrastructure

Indonesia has undergone substantial urbanization over the past half century, despite the fact that this trend has slowed down since the 1990s (Roberts, 2019; The World Bank, 2016). Currently, more than half of the population in Indonesia reside in urban areas, and it is projected that by the year 2045, nearly 75% of the population will live in cities and towns (Roberts, 2019). Despite the significant increase in urbanization, Indonesia has been unable to fully realize its vision for economic and human development. The need for a more rapid urbanization and industrialization has brought challenges such as inadequate infrastructure, including for roads and buildings, especially in the eastern Indonesia region such as Kalimantan and Sulawesi, as infrastructure in Indonesia has been significantly underinvested for decades (Salim & Negara, 2018). To tackle the infrastructure challenges has been the foundation of the Joko Widodo administration (Global Business Guide, 2015). The government has paid more attention to infrastructure development as the country is estimated to have a 1.5 trillion USD gap in infrastructure assets. To bridge this gap, the government targeted approximately 415 billion USD in additional investments in

Figure 4. Industrial Parks in Indonesia by area



Data source: CGS in-house data

transport, water, energy, and other key sectors from 2015 to 2019 (Roberts, 2019).

Notably, Indonesia has been planning on or executed large infrastructure-related projects that could significantly drive up the demand for energy-intensive raw materials such as cement and steel. It is expected that the development of these industries will largely depend on captive power plants if the power grids of the country remain inadequate in the near future. For example, Indonesia has begun to construct its new capital city, Nusantara, which is expected to replace Jakarta as the country's political hub by the end of 2024. This contributes to expectations for cement demand to rise by 33% over the next two decades (Global Cement, 2022). In addition, given that the new city is being built in Indonesia's coal-mining heartland of East Kalimantan province, it is likely that coal will be the primary energy source without interventions. Consequently, national coal consumption is anticipated to increase by 9% (Global Cement, 2022; Goh, 2022). Similarly, the demand for steel is also expected to surge, which will also drive the growth of captive coal plants. For example, Indonesia's largest private steel company is planning to spend more than $66.8 million to increase its production due to construction demand related to the new capital city (Shibata, 2022).

Moreover, the National Medium-Term Development Plan for 2020-2024 has set various infrastructure targets (Table 1). The road and bridge infrastructure development targets include 2,500 km of new and/or operational toll roads, 3,000 km of new national roads. Specifically, the Ministry of Public Works and Public Housing (PUPR) has set an ambitious target to double the length of toll roads in Indonesia, increasing from 2,386 km in 2021 to 5,103 km by 2024 (Kurniawan, 2021). In addition, the Indonesian government has been developing the "Sea Toll Program" since 2015, which aims to improve transportation and connectivity of the country which has over 17,000 islands and calls for infrastructure buildup. The program will lead to an increase in domestic energy consumption, including for diesel oil, fuel oil, and electricity (Caryana, 2017).

Table 1. Infrastructure targets of Indonesia for 2020-2024

Objectives or Indicators	Baseline (2019)	Target (2024)
b. Length of newly built and/or operational toll roads (in km)	1,461	2,500
c. Length of newly built roads (in km)	3,387	3,000
d. Percentage of roads in good condition at the national/provincial/regency/city level (%)	92/68/57	97/75/65
e. Length of newly built rail network (cumulative) (in km)	6,164	7,451
f. Railroad conditions according to the Track Quality Index (TQI) categories 1 and 2 (%)	81.5	94.0
g. Connected shipping routes/loops (%)	23	27
h. Number of main ports that meet standards	1	7
i. Number of subsidized sea toll routes	14	25
j. Number of newly built ports for water transport	24	36
k. Number of newly built airports	15	21

Objectives or Indicators	Baseline (2019)	Target (2024)
I. Number of air transport routes	35	43
I. Number of air transport routes	35	43
Increasing mass public transportation services in 6 (six) metropolitan cities		
a. Number of metropolitan cities with built and developed urban mass transit systems	1	6
b. Number of cities with multi-level transport systems	3	6
Increased access to and supply of equitable, reliable, and efficient energy and electricity		
a. Number of gas network connections that connect to households (cumulative)	537,936	4,000,000
b. Total oil refinery capacity (cumulative) (in barrel per calendar day/BPCD)	1,151,000	1,276,000
c. National electricity demand (consumption) per capita (in kWh)	1,077	1,400
d. Electrification ratio (%)	98.86	~100
Increasing development and utilization of ICT infrastructure, as well as contribution of the information and communication sector in economic growth.		
a. Fixed broadband network coverage (% of total districts)	35.71	60
b. Mobile broadband network coverage (% of total districts)	87.4	95
c. Population served by digital broadcasting (%)	52.28	80
d. Facilitating new start-up unicorns (unit)	5	8

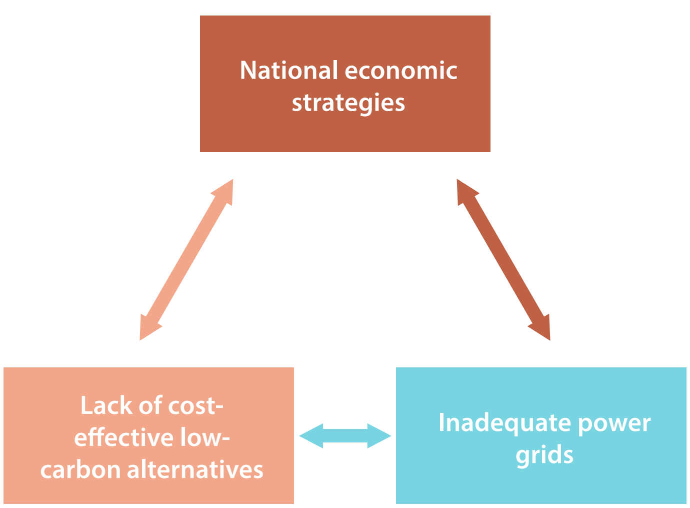
Source: The National Medium-Term Development Plan for 2020-2024

WHAT ARE THE CHALLENGES AND OPPORTUNITIES OF CAPTIVE POWER PLANTS?

Captive power plants in Indonesia face multiple challenges in terms of the context of needed energy transitions, and also with respect to their role as economic infrastructure. Indonesia faces two major challenges in phasing out captive coal plants. First of all, there is a surging demand for captive power plants to accommodate the economic growth model proposed by the Indonesian government, as the country's power grid infrastructure is still underdeveloped. Second, low-carbon alternatives for captive coal plants can, depending on their location, face challenges in cost-effectiveness, competing land-use priorities, the availability of suitable clean energy sources and reliability. Specifically, renewable energy development in Indonesia has significantly lagged behind its Southeast Asian peers, such as the Philippines (Guild, 2019), despite ambitious government renewable energy targets (RET) to reach 23% of the primary energy mix by 2025 (MRET) and 31% by 2050, up from 14% in 2021. Analysis shows that renewable energy is now more cost-competitive than fossil fuels in Indonesia. The low-end cost of renewable energy has decreased by more than 30% compared to that in 2019. Particularly, the levelized cost of electricity (LCOE) for solar power reaches 4.09-10.06 in 2022, down from 5.84 - 12.34 USD/KWh. However, due to the Indonesian government's heavy subsidies for fossil fuel, renewable energy adoption in Indonesia remains low (IESR, 2023; IESR, 2019; Lee et al., 2020).

In a nutshell, the challenges of captive coal plants lie between the national economic strategies of Indonesia (e.g. the mineral mining industry and industrial parks as drivers of economic development), inadequate power grids across the country, and a lack of cost-effective and reliable low-carbon alternatives for captive coal power plants (Figure 5). Both the mineral mining industry and the plan to develop industrial parks across the country are Indonesia's national strategies for economic development and industrialization. As previously mentioned, these economic activities are energy-intensive and have a high standard for reliable power supplies. This inevitably leads to either a surging demand for much stronger power distribution and transmission infrastructures invested by PLN or captive power plants that can meet the needs of energy-intensive industrial activities.

Figure 5. The trilemma of captive coal plant phaseout in Indonesia



However, despite the growing demand, investing in captive coal power plants in Indonesia remains unclear for three major reasons. Firstly, the demand for low carbon power sources from current and potential tenants is uncertain. Secondly, investors may have concerns about investing in captive power plants in industrial parks as there are many uncertainties regarding their long-term prospects. Industrial parks may face uncertainties as their operations often largely depend on the business performance of their tenants. This is particularly true for the non-ore processing industrial parks, mainly in Java. These uncertainties create risks for power developers due to the unstable demand for power as they may face decreased revenues if some firms go bankrupt. This lack of stability in demand makes investment in captive power plants less attractive to developers. In this case, industrial park owners usually have a long-term contract with the utility to supply their power requirements and build gas power plants with the capacity that can be expanded quickly.

Thirdly, the financing of captive coal power plants in Indonesia is increasingly challenging as banks and other financial institutions perceive them to be high-risk investments. For coal power plants specifically, currently over 200 globally significant financial institutions have established coal exclusion policies, which drive up the financing cost of new coal power (Trivedi & Srivastava, 2023). This perception creates a hurdle for power developers seeking to secure funding for the construction and operation of these plants. The higher risk associated with captive coal power plants often leads lenders to impose stringent requirements such as higher interest rates and additional collateral. As a result, the financing of captive coal power plants remains a hurdle to their expansion in Indonesia.

In summary, the challenges of captive coal plants in Indonesia cannot be viewed solely as a technical issue. Instead, it is a complex development challenge that requires an inclusive consideration of technological options, socioeconomic reforms, as well as market and financial mechanisms.

Existing technological alternatives for captive coal power plants

Technologically, decarbonizing captive power plants requires low-carbon energy alternatives with the potential to replace captive coal power plants. While captive renewable power plants require more effective renewable policies, improved market mechanisms, and more robust and innovative financial tools to lower the deployment costs in Indonesia and incentivize energy investors, other low-carbon alternatives, such as gas-fired power plants or co-firing, could potentially be more immediate options (Table 2). Technologies such as carbon capture, utilization and storage (CCUS) and hydrogen have been actively discussed and explored in recent years. However, these technologies are still in early development and have not yet been commercialized.

In addition, there are broader options and opportunities that can also help lower the carbon footprints of those energy-intensive economic activities. Those include approaches such as improving energy efficiency in energy-intensive industries, promoting eco-industrial parks,

Table 2. Potential energy technologies for decarbonizing captive coal power plants in Indonesia

Energy alternatives	Current status in Indonesia
Captive gas-fired power plants	As Indonesia has abundant natural gas resources, gas power can be used as captive power plants to provide reliable power supplies for enterprises or industrial parks. Gas-fired power generation made up 15% of the Indonesian energy mix in 2022 (IEA, 2023). The advantage of gas-fired power plants lies in their relatively low emissions and high efficiency. These characteristics make gas-fired power plants a more environmentally friendly and cost-effective choice compared to captive coal power plants. However, the high construction cost of captive gas-fired power plants in Indonesia, combined with the high price of gas, results in high electricity prices.
Powership	A powership is a mobile power generation equipment that can navigate autonomously on waterways such as seas or rivers and uses natural gas as fuel to generate electricity. Powerships are usually equipped with a natural gas engine and a generator set, which has a certain degree of flexibility and can quickly supply power. They are usually used in situations where a temporary power supply or rapid response is required, such as in offshore drilling platforms, on ships, and for emergency repairs. The maintenance and management of natural gas power generation ships are relatively simple, which can reduce operating costs. However, the construction, lease and purchase costs are relatively high, requiring a large amount of capital and resources.
Coal-to-gas	Coal-to-gas generally refers to the process of converting coal into synthetic gas (syngas) through gasification technology. The syngas can then be further processed into various products, which can be used as fuel for power generation, transportation, and other industrial purposes. The coal-to-gas technology is seen as a way to utilize Indonesia's abundant coal resources and diversify the country's energy mix, while also reducing greenhouse gas emissions and improving energy efficiency. However, the coal-to-gas process can be expensive and technically challenging.
Co-firing	Co-firing refers to the practice of using a combination of different fuels, typically coal and biomass, to generate electricity in power plants. The use of biomass in co-firing can reduce greenhouse gas emissions and increase the sustainability of the power generation process. In Indonesia, co-firing is seen as a way to utilize the existing coal power facilities with lower carbon emissions. However, using a large amount of biomass to reduce CO_2 emissions from coal-fired power stations is challenging due to technical and financial issues related to obtaining high-quality material. Additionally the effects on carbon emissions reduction are likely to be limited.
Renewables and energy storage	Renewable energies such as solar, hydropower, geothermal, and wind, combined with energy storage technologies, are an ideal option to replace captive coal power in light of climate goals. In 2015, there were 600 MW of renewable energy projects sited on or serving mine sites globally. By the end of 2019, nearly 5 GW of renewable energy projects were installed or planned for mine sites around the world (Igogo et al., 2020). However, the costs of such an option are still high as it requires massive installed capacity in order to meet the needs of energy-intensive operations. In addition, Indonesia's solar energy cost is the highest among ASEAN members at 165 USD/MWh. The lack of domestic industries producing the necessary components makes renewable energy less cost-effective in the country. Meanwhile, Indonesia's MOI Reg. No. 5/2017 specifically sets out the minimum local content of solar modules at 40% (Tampubolon et al., 2019). Consequently, Indonesia's attractiveness to investors in the renewable energy sector has been negatively affected (Kanugrahan et al., 2022).

and implementing the circular economy concept in the industrial sector. Indonesia has already embarked on some of those strategies to decarbonize its industrial sector. In addition to implementing feasible technological solutions to address captive coal power phaseout in the near term, power sector decarbonization in Indonesia requires long-term, broader institutional transformation. This includes reforms in the power sector to incorporate more robust market mechanisms, as well as improved financial access to stimulate the development of renewable energy and the necessary supporting power grids.

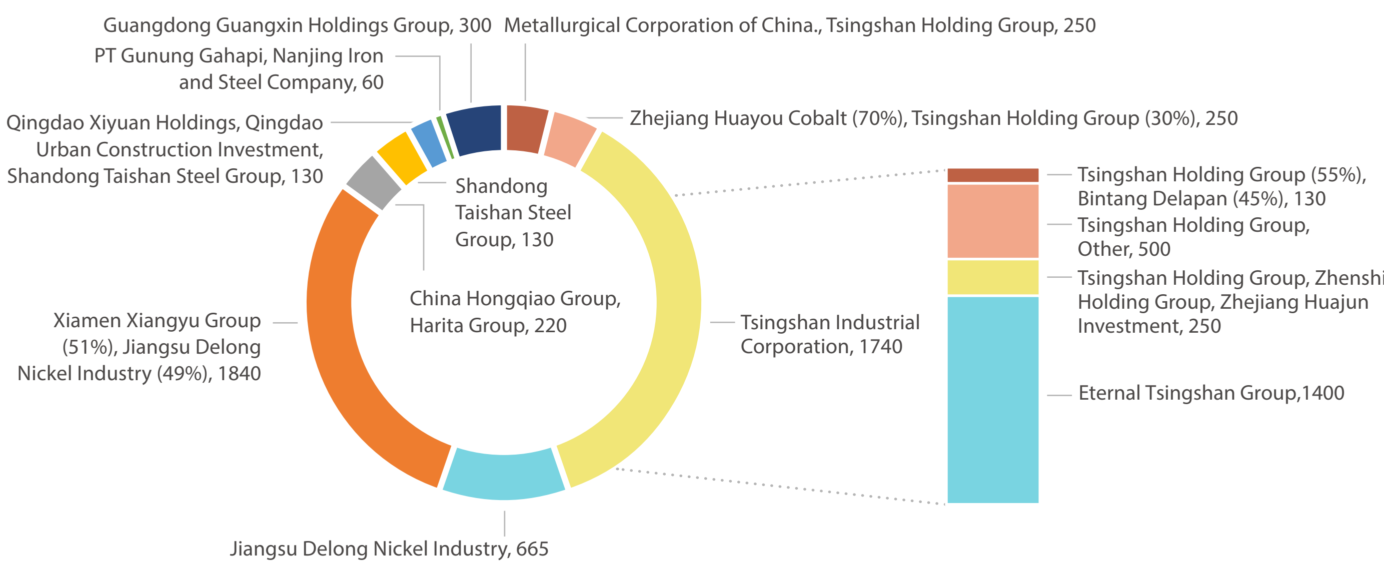
THE PARTICULAR ROLE OF CHINESE STAKEHOLDERS IN ADDRESSING THE CHANGES OF CAPTIVE COAL POWER PLANTS IN INDONESIA

China is currently the largest source of investment for captive coal plants in Indonesia. Chinese investors, either with complete or shared ownership, account for more than 70% of both installed and planned captive coal power capacities in Indonesia. The planned capacities include those that are under construction, have been pre-permitted, or have been announced. China's investment in captive coal plants already outnumbers its investment in Indonesia's conventional coal plants (Cui et al., 2023).

Fourteen Chinese companies, both private and state-owned, are involved in Indonesia's captive coal power plants, with most being private-owned iron/steel and mineral mining companies (See Appendix 1). Among them, Tsingshan Industrial Corporation (or the Tsingshan Industrial Board of Directors) along with its pillar subsidiaries (Tsingshan Holding Group, Eternal Tsingshan Group and Dingxin Group) take up the largest share in terms of both operating and planned plants. It is currently involved in approximately 40% of the current installed capacity owned by Chinese investors. This corporation started in the stainless steel business and is now one of the world's largest nickel producers. Jiangsu Delong Nickel Industry is the second largest Chinese investor in Indonesia's captive coal power (Figure 6). In addition, Ningbo Lygend, which is also a major Chinese nickel producer, holds the largest capacity of pre-permitted captive coal power plants in Indonesia (Figure 7). Specific attention should be paid to decarbonize captive power plants that are in early phases of planning and therefore easier to adjust.

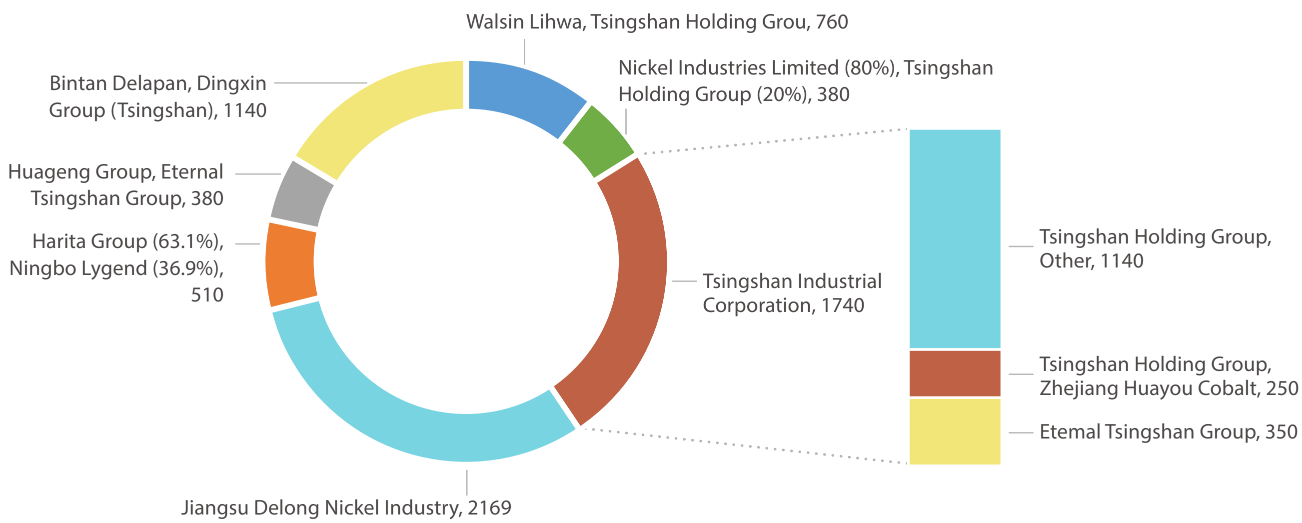
Figure 6. Chinese companies' investment share in Indonesia's captive coal power plants (capacity by company, MW)

(a) Operating



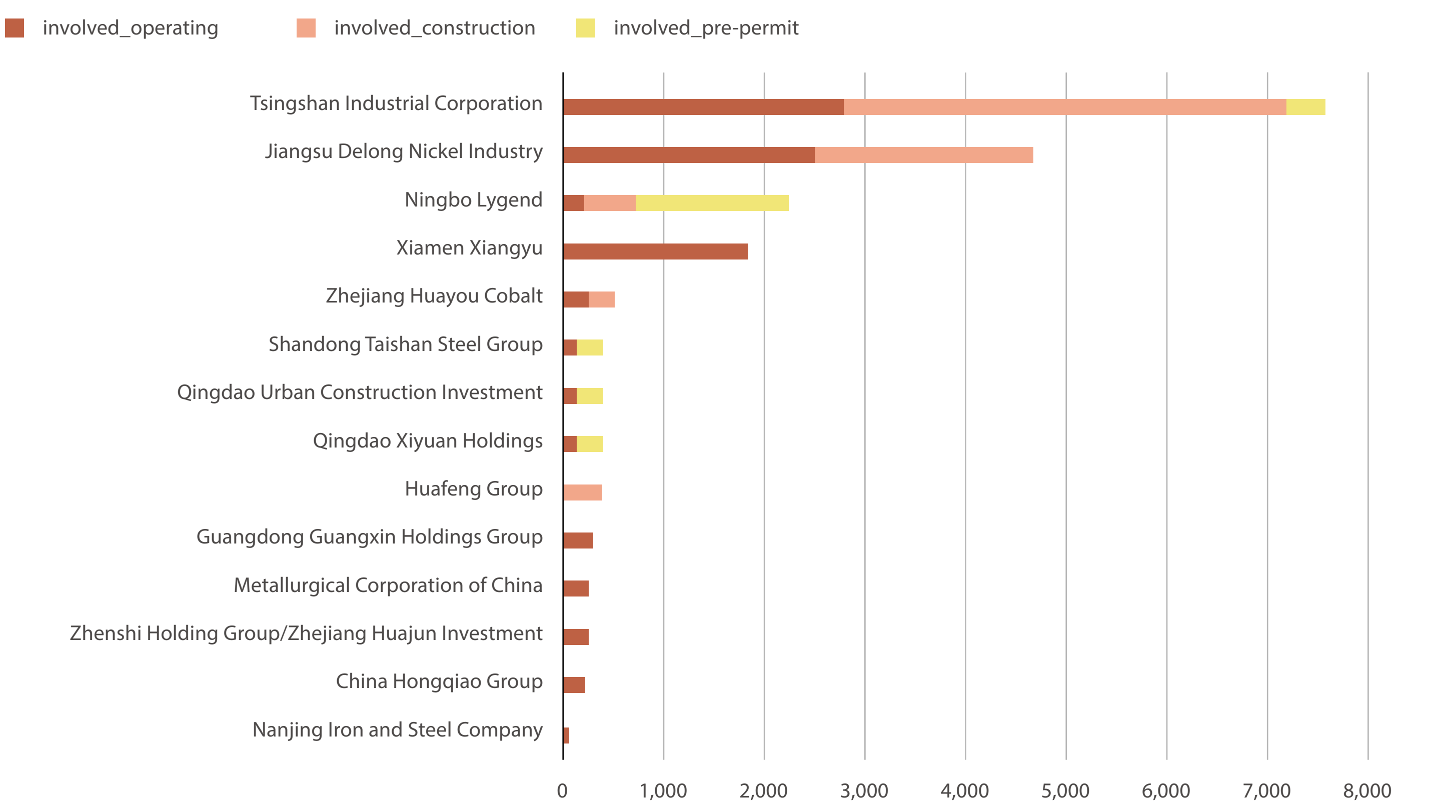
Data source: Global Energy Monitor,January 2023.

(b) Under construction



Data source: Global Energy Monitor,January 2023.

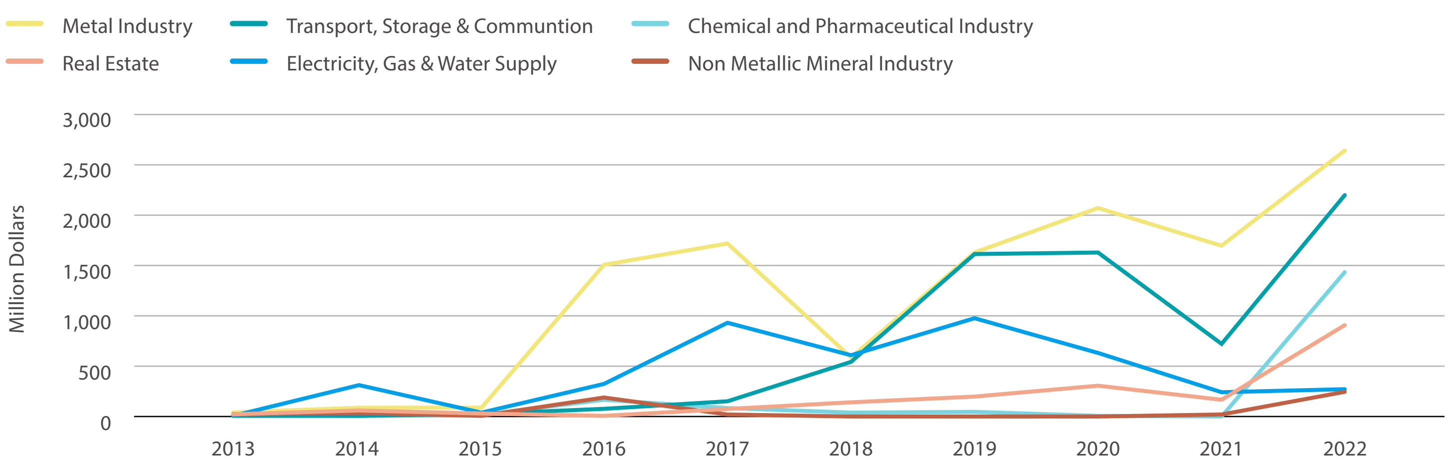
Figure 7. The participation of Chinese investors in captive coal power capacity (MW) by development phases. Any capacity that includes shared ownership is considered involvement by Chinese investors



Source: Global Energy Monitor, January 2023.

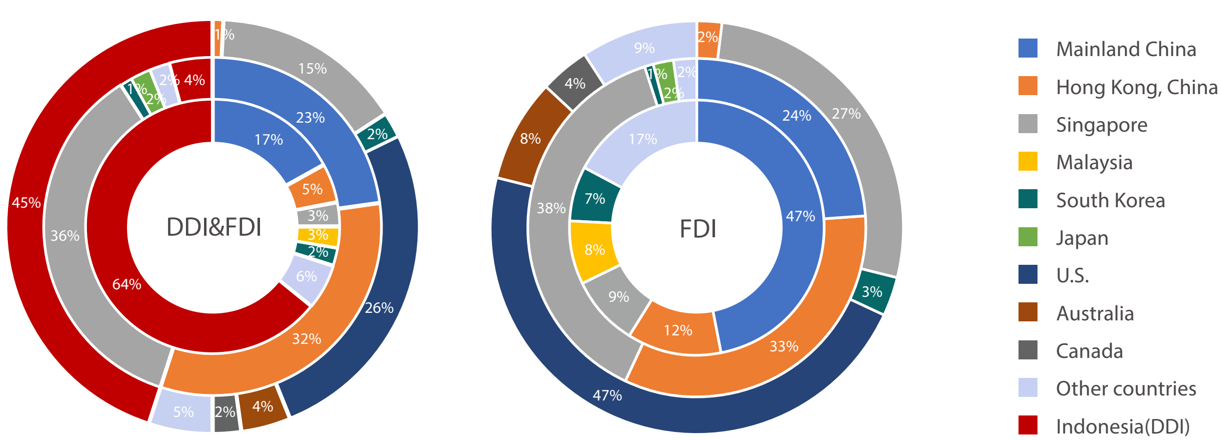
The predominant role of Chinese investment in Indonesia's captive coal power plants is closely linked to China's surging investment in Indonesia's industrial sector more broadly. China, including both the Mainland and Hong Kong, has greatly increased its investment in Indonesia over the past decade, and will continue to play a significant role in the country's economic development, especially in the abovementioned industries with high energy demand (Figure 8). China, with $13.7 billion of investment in 2022, exceeded Singapore and has become the largest FDI source for Indonesia (Indonesia Ministry of Investment, 2023a). More importantly, more than 83% of Chinese investment went into energy-intensive industries by 2022, including metal industry, infrastructure industry, chemical and pharmaceutical industry, non-metallic mineral industry, and the power industry. The growth potential of these sectors is substantial as the metal and mineral industry is leading the way in Indonesia's surge of FDI, which was expected to experience a growth of 44.2% in 2022 compared to 2021 (Sulaeman et al., 2021). Additionally, Chinese investment constitutes more than half of both the FDI in the metal and mineral sector and the combined total of FDI and Domestic Direct Investment (DDI) in this sector (Figure 9).

Figure 8. Chinese investment (mainland China) in Indonesia by sector from 2013 to 2022



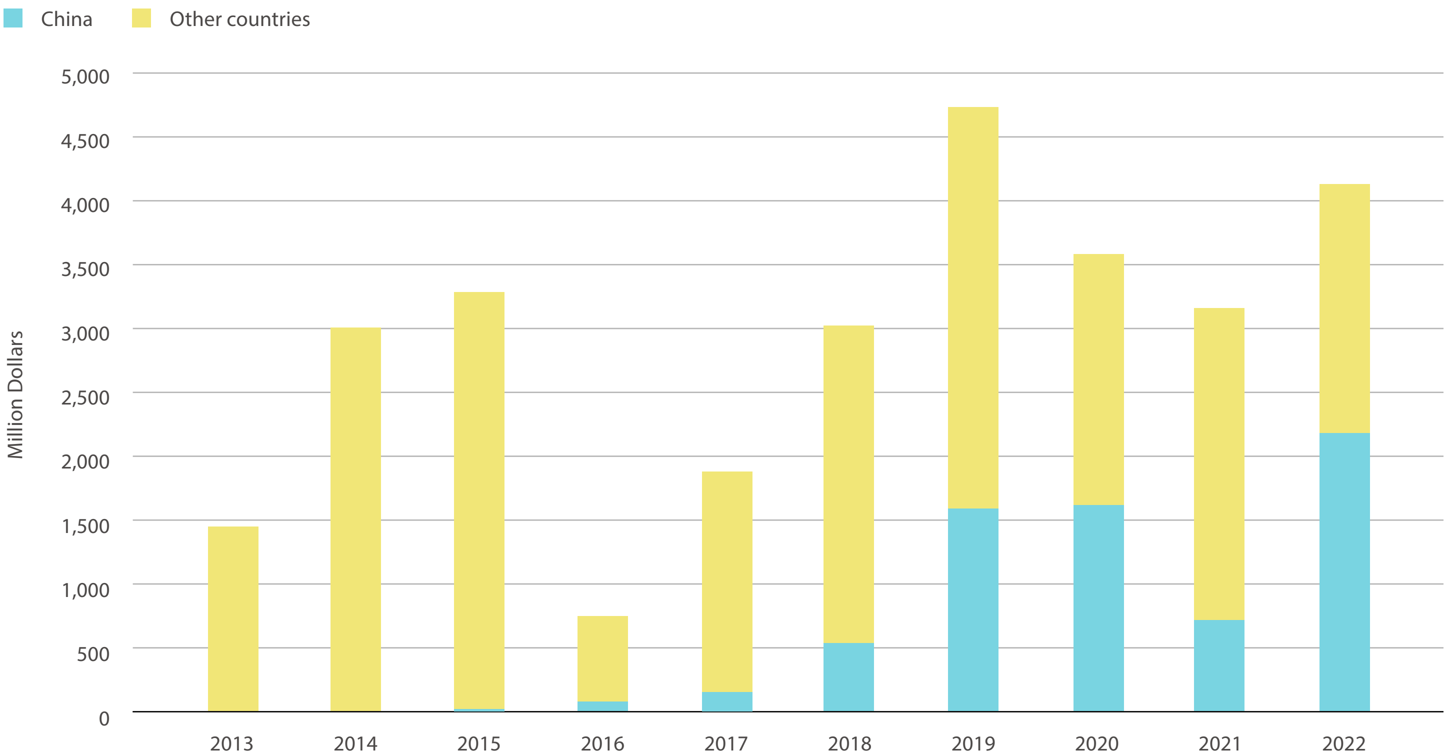
Source: Indonesia Ministry of Investment, 2023b.

Figure 9. Indonesia's top five foreign investors in the nonmetallic mineral Industry (inner ring), metal industry (middle ring), and mining industry (outer ring) in 2022



Source: Indonesia Ministry of Investment, 2023b.

Figure 10. FDI investment in transportation, storage, communications from 2013-2022



Source: Indonesia Ministry of Investment, 2023b.

In addition, Chinese investment has also experienced a significant growth in the infrastructure sector. In 2022, Chinese investment contributed 53% of the FDI in the transportation, storage, and communications sectors (Figure 10).

Feasible technological options and the underlying market mechanisms and institutions are needed to minimize Indonesia's dependence on captive coal power plants. In this context, recent technological experience in China, as well as an interest by China in engaging in and supporting Indonesia's investments in its low-carbon growth trajectory, make China a key potential actor in realizing a rapid reduction in Indonesia's captive coal power. China has been the world's largest wind and solar investor for over a decade, accounting for 35% and 32% of the global total installed capacity, respectively (BP, 2022). By the end of 2018, the total installed capacity of captive power plants across China exceeded 156 GW, accounting for about 8.2% of the country's total installed electricity capacity. More than 97% of the captive power plants were fossil fuel-fired (CEC, 2020). Therefore, China has been actively exploring methods to decarbonize captive coal power plants domestically. Additionally, it has vast experience in these areas and could provide a model for such developments (Li et al., 2019; Lo, 2014; Zeng et al., 2021; Zhao & Qi, 2022). These efforts could potentially inform the decision-making of Chinese investors when developing captive power plants in Indonesia.

Therefore, Chinese participation to support low-carbon growth in Indonesia can provide a helpful complement to the ongoing G7 JETP climate agenda and the more prominent trend of global supply chain decarbonization. Such participation would see Chinese stakeholders as leading international investors. Such strategies would also enable these firms to undertake innovative and profitable business opportunities in clean technologies, and avoid unwanted investment losses and sunk costs. Equally importantly, both the Chinese government and industry actors have knowledge and experience in renewable energy utilization, captive plants and industrial parks, and more that can be shared with Indonesia to transition towards a sustainable and carbon-neutral economy. These steps can be summarized as the "3S's":

- **Stop.** Chinese stakeholders should rule out new coal power investment in any form, including both captive and non-captive power plants, to fulfill China's commitment to end overseas coal power investment. Non-power investors should consider clean energy options if captive power plants are needed. For existing captive coal plants, Chinese stakeholders should proactively identify low-carbon alternatives. (It is worth noting that Chinese banks have already ceased financing captive coal power plants overseas).

- **Shift.** Chinese power investors should divert their investments from coal power to cleaner energy alternatives, such as solar and wind power with energy storage systems, for both captive and non-captive power plants. Private-sector companies, as dominant players in Indonesia's captive coal power plants and the country's key industries, should take immediate actions to decarbonize its supply chains by investing in renewable and other low-carbon power plants. Additionally, state-owned enterprises that dominate the power sector have emerged as major players in renewable energy investment worldwide. In particular, to align with China's Belt and Road Initiative, as well as the "Go Global" strategy for CSOEs, China's power CSOEs should coordinate internally on their overseas investment strategies. Moreover, Chinese investment can shift to green businesses or ones that support the decarbonization process, such as power transmission facilities and low-carbon public transportation.

- **Surpass.** Chinese stakeholders, both from power and non-power industries, should seek out low-carbon and sustainable business models, drawing from China's practices and experiences. They should also set higher environmental and energy efficiency standards that are aligned with industrial standards in China, in order to facilitate the transition towards low-carbon supply chains in Indonesia (including downstream industries associated with mineral mining) and meet the increasing demand for a cleaner global supply chain. For instance, electric motors are fundamental to the operations in steel and mining supply chains, with their efficiency playing a critical role in the overall energy consumption, operational costs, and carbon emissions of these industries. Indonesia implements a relatively lower energy efficiency standard for electric motor equipment compared to China and other industrialized economies. China plays a crucial role as a major exporter of electric motors to Indonesia. Chinese stakeholders should actively phase out the production of low-efficiency motors intended for export to Indonesia, thus assisting in the country's transition towards higher energy efficiency standards (Top10 China, 2019).

Most recently, the Chinese government has issued "the Guidelines for Ecological and Environmental Protection of Foreign Investment Cooperation and Construction Projects" to set higher environmental requirements for Chinese companies' overseas investment. The policy encourages Chinese investors to adopt internationally recognized rules and standards or stricter Chinese standards if host countries or regions do not have relevant standards or have low standard requirements (MEE, 2022).

This report identifies five strategies for decarbonizing captive power plants in Indonesia, which Chinese stakeholders can contribute to:

1. Substituting captive coal power plants with low carbon energy alternatives
2. Developing eco-industrial parks
3. Promoting circular economy in the industrial sector
4. Improving energy effiiciency
5. Facilitating carbon markets

1. Substituting captive coal power plants with low-carbon energy alternatives

Practices in Indonesia

- In 2023, Indonesian nickel company Trimegah Bangun Persada (TBP) is planning to implement a 300 MW photovoltaic project for the nickel iron smelting project on Obi Island. The nickel iron project consists of 8 production lines with an annual nickel production capacity of 780,000 tons and is currently primarily powered by captive coal power plants.
- In 2023, PLN, China Energy Engineering Corporation (CEEC), Huadi Nickel-Alloy Indonesia (PT Huadi), and PT Dayatama Prima Energi, along with PT Anugrah Teknik Industry (industrial park developer) and PT Suryacipta Swadaya (industrial park developer), have signed an MOU to jointly develop a 4,000 MW power project to address the power supply issue for the nickel iron smelting project. The MOU aims to facilitate collaboration between the five companies in resolving the power supply needs of the project.
- In 2021, Tsingshan announced plans to build 2 GW of renewable energy portfolio for their industrial park in Morowali and Weda Bay in 3 to 5 years (Daly & Zhang, 2021).

China's best practices

- **Replacing captive coal with on-grid renewable power.** China's power grid has been integrating a growing proportion of renewable energy sources. By 2021, the installed capacity of renewable energy in China reached 1.06 gigawatts, accounting for 44.8% of the total installed capacity (NEA, 2022). Certain regions such as Yunnan and Inner Mongolia achieved even higher proportions, reaching 84% and 60% respectively by 2020 (People's Daily, 2022; Yunnan Bureau of Statistics, 2021). The high percentage of renewable power in the electrical grid gives enterprises an opportunity to achieve decarbonization of energy consumption by shifting from captive coal power to on-grid renewable power. The current policy structure emphasizes the need for enterprises with captive coal plants in areas rich in renewable resources such as wind, solar, and hydro power to reduce "self-generated & self-consumed" electricity and increase purchases from the market (NDRC, 2015; RMI, 2022).

  Certain power companies, such as the National Grid Haixi Power Company, are offering lower-priced electricity to businesses and helping them in reducing dependence on captive power (China Power, 2020). In the aluminum industry, it is estimated that the proportion of captive power will fall from 60-70% in 2020 to 20% in 2060. Shandong Weiqiao group, one of the major aluminum companies in China, has started re-allocating some of its production capacity to regions with abundant renewables like Yunnan and utilizing the local low-rate grid power (Huaxia Energy, 2020). Captive power will gradually be replaced by clean grid power over time (Sandström et al., 2022).

- **Replacing captive coal power with captive renewable power plants.** The national and provincial governments have been launching policies to facilitate the transition of captive power plants from coal-based energy sources to renewable alternatives.
  - At the national level, the "Carbon Peak Implementation Plan in the Industrial Field" of 2022 emphasizes that the government should encourage enterprises to use clean energy and develop captive renewable power plants based on the model of "photovoltaics (PV) + energy storage" (MIIT, NDRC, & MEE, 2022).
  - At the provincial level, in 2022, the Inner Mongolia government launched its 14th Five-Year-Plan (FYP) on renewable energy development. The plan mentions the necessity to widely expand the application of renewable energy. It encourages the captive coal power plants operating in the Industrial parks (IPs) to change the coal-base energy supply mode and transfer to construction of wind power and PV facilities, whether in centralized or distributed configurations (Inner Mongolia Energy Bureau, 2022).

2. Developing eco-industrial parks

Eco-industrial parks (EIPs) are integrated industrial zones that aim to minimize waste and pollution, conserve resources, and enhance the economic, social, and environmental performance of industries. EIPs are designed to promote sustainable industrial development by establishing a network of interdependent firms that exchange materials, energy, water, and information.

Practices in Indonesia

In Indonesia, the concept of eco-industrial parks has gained momentum in recent years (UNIDO, 2022). The United Nations Industrial Development Organization (UNIDO) has been supporting the development of EIPs in Indonesia, and recently facilitated the issuance of a ministerial decree to accelerate the process. The Ministry of Indonesia has worked closely with the United Nations Industrial Development Organization (UNIDO) and the State Secretariat for Economic Affairs (SECO) of Switzerland to implement the Global Eco-Industrial Park Programme (GEIPP), which was launched in July 2020 (Antara, 2022).

Currently, there are several EIP pilots that have been established or are currently in development in Indonesia, including:

- Karawang Eco-Industrial Park (KEIP): KEIP is one of the largest EIPs in Indonesia, located in Karawang, West Java. It was established in 2015 with the aim of promoting sustainable industrial development in the region.
- Batamindo Industrial Park (BIP): BIP is located on the island of Batam, Riau Islands Province. It was established in 1990 and has since evolved into an eco-industrial park that focuses on waste management and renewable energy.
- Suryacipta City of Industry (SCI): SCI is an EIP located in Karawang, West Java. It was established in 1994 and has since implemented various green initiatives, such as a centralized wastewater treatment plant, renewable energy production, and green transportation systems.
- Kendal Industrial Park (KIP): KIP is located in Central Java and was established in 2014. It was designed as a green and sustainable industrial park that incorporates green infrastructure, energy-efficient buildings, and waste management systems.

China's best practices

- **Policy framework**

  China's commitment to the development of eco-industrial parks (EIPs) can be traced back to 2000. During this period, the former Environmental Protection Administration, in collaboration with UNEP, proposed an eco-industrial park pilot program (Du et al., 2019). Subsequently, with a series of more detailed management measures for eco-industrial parks, such as "Planning Guidelines for Circular Economy Demonstration Zones (2003)", circular economy, low-carbon and green development gradually became the basic themes for EIPs' development (MEE, 2003). In 2015, the Ministry of Ecology and Environment (MEE) released the "Measures for the Administration of National Eco-industrial Demonstration Parks", further standardizing the management of EIP's development (MEE, 2015). This policy underscores the vital role of EIP in fostering ecological progress in the industrial sector and driving the adoption of green, low-carbon, and circular practices. China lays significant emphasis on EIP development and has built a robust policy structure to support their growth (Tie & Sawyer, 2015).

- **Industrial actions**

  - Embracing circular economy: Circular economy concepts are central to the development of the EIPs in China. By extending the industry chain, by-products and waste from one production activity could be fully utilized by another, which establishes the "producer-consumer-decomposer" cycle and realizes the closed-loop circulation of resources (Wang et al., 2021; Zhao, 2021). Moreover, the adoption of strategies such as waste heat and pressure utilization, graded and quality-based use of water, cascaded material exchange, and other resource management practices substantially enhances overall resource efficiency within EIPs (Zhao, 2021). EIPs also establish sharable infrastructures such as energy infrastructure (Guo et al., 2020) and water infrastructure (Lyu et al., 2022), to ensure the circular flow of production resources and achieve integration among raw materials, product manufacturing and technology innovation (Liang, 2021).

For example, Anning Industrial Park is the main industrial park in the Dianzhong New District of Yunnan. The park focuses on three major industries, iron and steel, petroleum refining and phosphorus chemical industry (Kunming Daily, 2022). The park's strategic emphasis lies in industrial chain extension and circular economy projects. Relying on the basic raw material resources provided by petrochemical refining and chemical industry, the park plans to extend and develop the downstream industrial chains associated with styrene and propylene (Yunnan Industrial Park Association, 2022). In the meantime, the industries in the park share the PV plants, water conservancy infrastructures and wastewater treatment facilities (Kunming Daily, 2022).

- Adopting decarbonization measures: Since 2006, China has introduced and implemented a series of low-carbon policies for eco-industrial parks (Guo et al., 2021). The "Industrial Green Development Plan (2016-2020)" in 2016 placed emphasis on the low-carbon transformation of industrial parks and required EIPs to take the lead in reaching carbon peak and carbon neutrality (NDRC, 2016). Currently, there are a number of useful tools in clean energy, sustainable transportation, and green building that are used to achieve low-carbon and even zero-carbon targets in EIPs (CASVI, 2021).

  - Clean energy: Using clean energy is one of the major pathways to decarbonize industrial parks. Some EIPs have successfully transitioned to utilizing entirely clean power sources and attained zero-carbon status. A notable example is the construction and operation of the world's first zero-carbon industrial park in Ordos, Inner Mongolia, in April 2022 (Everyday Wind Power, 2023). The Ordos Zero-carbon Industrial Park relies exclusively on renewable energy sources, implements a zero-carbon digital operating system, and fosters the development of a green new industrial cluster. By 2023, 80% of generated green electricity (Wind & solar) will be used for the park's operation, while the remaining 20% will be traded on the power grid (Ordos Energy Bureau, 2023). In energy intensive industrial parks, the role of facilitating clean energy is more prominent. For example, Holin Gol electrolytic aluminum industrial park puts significant emphasis on transferring the conventional coal-based energy structure to a greener one through captive PV, coal with carbon capture and storage (CCS), and "renewable+storage" (NRDC, 2022).

  - Sustainable transportation: Developing park sustainable transportation systems is a crucial approach to achieve decarbonization of industrial parks (Zhejiang Department of Economy and Information Technology, 2022). For example, Suzhou Industrial Park has undertaken 156 energy internet projects, including PV, energy storage and distributed generators. Meanwhile, the park installed 1,430 charging piles within the region and formed a "photovoltaic + energy storage + charging piles + distributed natural gas" regional energy structure. This helps the park establish a greener transportation system, decarbonize energy consumption and achieve low-carbon transition (Suzhou Industrial Park Management Committee, 2021b).

  - Green building: EIPs with an additional approach to decarbonize their energy consumption. For example, Qingdao Sino-German Ecopark is promoting the low-carbon transition by constructing a diversified clean energy supply system with green building as one crucial component (Sino-German Park, 2023). The park has built a distributed PV installation with a capacity of up to 16 MW. It pioneered the "Intelligent Green Tower" model, which utilizes solar PV panels as the curtain walls of buildings in the park. The obtained energy is temporarily stored in high-efficiency lithium-ion batteries inside the building to balance the load current within the community (Chndaqi, 2022).

3. Promoting circular economy in the industrial sector

Circular economy (CE) is defined as an economic system that aims to keep resources in use for as long as possible, minimize waste, and maximize the value of resources. In the industrial sector, promoting the circular economy involves adopting practices such as reducing material inputs, designing products for circularity, and recycling and reusing materials.

Practices in Indonesia

Recently, the adoption of CE has been stated in the 2020-2024 National Medium-Term Development Plan in Indonesia (GPQI, 2023). There are several initiatives aim to promote CE in the industrial sector, including:

- The Indonesian Circular Economy Forum (ICEF). ICEF is a non-profit organization that promotes CE in Indonesia. It focuses on raising awareness, developing policy recommendations, and supporting relevant initiatives.
- The Indonesian Plastic Bag Diet Movement (GIDKP): This is a grassroots initiative that aims to reduce the use of plastic bags in Indonesia by promoting reusable bags and educating consumers about the environmental impacts of single-use plastics.
- The Indonesian Ministry of Industry's roadmap for the implementation of the circular economy. The Indonesian government has integrated CE strategies into its 2020-2024 RPJMN and is formulating a larger roadmap. The planned outcome of the integration is to achieve a green economy by 2060.
- The Packaging and Recycling Association for Indonesia Sustainable Environment (PRAISE). PRAISE is an industry association that supports the sustainable management of packaging waste in Indonesia. Its mission is to promote the Extended Stakeholder Responsibility (ESR) model and CE, and to serve as a reference for the government in integrated packaging waste management.
- Green industry programs: The Indonesian Ministry of Industry has encouraged the provision of fiscal incentives for companies implementing green industry programs, in order to promote sustainable development and advance the CE concept in practice.

China's best practices

- **Policy framework**

  China has made remarkable progress in establishing a robust legal framework for the circular economy (CE) (Fan & Fang, 2020). The concept of the CE gained prominence within policy discussions in China starting from 2002 (China Dialogue, 2018). Subsequently, from 2003 to 2009, the State Council and the Environmental Protection Administration initiated a series of policies aimed at elucidating the trajectory for developing a circular economy and implemented several pilot CE programs (The State Council, 2005; Xinhuanet, 2006). In 2009, the "Circular Economy Promotion Law" was promulgated and was amended in 2018 (The National People's Congress, 2018a), marking the formation of a systemic law system for CE development. In 2021, the "14th FYP Circular Economy Development Plan" (NDRC, 2021) further facilitated the CE policy system to become more well-rounded. Moreover, in addition to government-led efforts, China also has other non-governmental incentives to promote the progress of CE like the "China Circular Economy Association Science and Technology Award" (China Association of Circular Economy, 2022). China's policy system concerning CE is becoming increasingly comprehensive over time (Zhu et al., 2018).

- **Industrial actions**

  Guided by policies and regulations, the industrial field has been promoting CE through comprehensive utilization of resources, cleaner production, waste management, and sustainable consumption (Ogunmakinde, 2019; Zhu et al., 2018). For example, Suzhou New District (SND) has been conducting centralized planning and coordinated construction. The sewage treatment plant, sludge disposal plant, kitchen waste treatment plant and power plant were planned together to facilitate the formation of a robust circulation system (Green Partnership of Industrial Parks, 2022). SND also encourages recycling and circulation of metal resources like turning residue from mining into inputs of sulfuric acid and using waste ammonia for processes in paper manufacturing (Mathews & Tan, 2016).

  In the steel industry, CE's role is more prominent (SAMR, 2018). For example, the Caofeidian Industrial Zone in Hebei Province embraces the principles of "reduce-reuse-recycle" and has extended its industrial chain accordingly. They have achieved efficient resource utilization. For instance, iron slag generated from steel production is recycled as feedstock for the recovery of iron elements, while zinc slag is returned to the smelter for re-melting. Additionally, residual heat and high-temperature exhaust gas are captured and utilized for seawater desalination projects. These resource and waste recycling actions create significant synergies within the park. (Economic Daily, 2022).

4. Improving energy efficiency

Practices in Indonesia

Improving energy efficiency is an important aspect of promoting sustainable development and reducing greenhouse gas emissions. Indonesia has already put significant effort into improving energy efficiency and conservation in recent decades. In addition to the existing policy framework, there are several highlighted initiatives aimed at improving energy efficiency, including:

- National Master Plan for Energy Conservation (RIKEN): This aims to decrease energy intensity by 1% annually until 2025 through targets for energy savings in industry, commercial buildings, and households. The plan includes fiscal incentives, training, and energy audits. A draft version is awaiting approval, and the final version targets 17% in energy savings in several sectors by 2025.
- The Indonesian Clean Energy Development Program (ICED): This is a USAID-funded program aimed at promoting clean energy and improving energy efficiency in Indonesia. ICED II ran through 2015 to 2020 (USAID, 2018).
- The Indonesia Energy Efficiency Society (MASKEEI): This is a non-profit organization that promotes energy efficiency through research, education, and advocacy.
- Government Regulation 70/2009 is the primary industrial energy efficiency policy in Indonesia. This regulation mandates that all companies with an annual energy usage surpassing 6,000 tonnes of oil equivalent (toe) need to appoint an energy manager. They are also required to devise an energy conservation plan, carry out an energy audit, and report their energy consumption to the government (IEA, 2021). Revised by Government Regulation No. 33/2023, energy producers exceeding 6000 toe are required to devise an energy conservation plan, while those below 6000 toe are encouraged to do so. Industrial energy users surpassing 4000 toe must devise an energy conservation plan and implement energy efficiency measures, while those below 4000 toe are not required, but are encouraged, to conduct energy management.

China's best practices

- **Policy framework**

  China has a long policy history in promoting and facilitating energy efficiency. The concept of improving energy efficiency and energy conservation was introduced as early as the 1978 Constitution, which highlighted the importance of energy efficiency (Zhang & Shen, 2016). The promulgation of the "Energy Saving Law" in 1997 marked a significant milestone, solidifying energy conservation as a national strategy (The National People's Congress, 2018b). From 2000 to 2008, more detailed energy saving regulations were progressively implemented across various sectors including building, transportation and energy (Central Government of China, 2000; MOHURD, 2005; MOT, 2021), further refining the energy efficiency policy structure.

  After COP 15 in Copenhagen, energy efficiency was more closely linked to climate-related concerns. In 2016, the "Measures for the Administration of Industrial Energy Conservation" highlighted the major unit of energy consumption, industry sector, and underlined the necessity of promoting energy efficiency and low-carbon development in this sector (MIIT, 2016). In 2021, the National Development and Reform Commission (NDRC) and other relevant administrations together released the "Benchmarks of Energy Efficiency in Key Areas of High Energy-consuming Industries" and launched "Industrial Energy Efficiency Improvement Action Plan" in 2022 to further promote energy efficiency improvement in the industrial field (MIIT, NDRC, MOF, et al., 2022; NDRC et al., 2021).

  China also implemented a series of energy-saving programs, including "Top 1000 Energy-consuming Enterprises Programme" and "Ten Key Energy Conservation Projects", establishing a robust and comprehensive policy framework to enhance energy efficiency (NDRC, 2011b, 2011a).

- **Industrial actions**

  China has been actively improving energy efficiency by supporting some key industries including the steel, textile and metal industry, laying emphasis on upgrading energy-consuming equipment (motors, transformers, and boilers) and facilitating IPs' energy efficiency improvement (MIIT, 2022). China's industrial parks play a crucial role in systematically advancing energy-saving initiatives across various aspects including the energy system, industrial structure, transportation and logistics, and public buildings throughout the entire process (School of Environment Tsinghua University, 2023; Suzhou Industrial Park Management Committee, 2021a). Some EIPs actively embrace renewable energy, carry out smart energy exploration, and build digital and intelligent energy management platforms (Sun, 2020).

  For example, Shandong Wanhua Yantai Industrial Park established a smart energy management system. This system enables the real-time control of the power distribution within the park, monitoring of the load of key equipment, analysis of the energy consumption of each device under different operating modes, and identification of the correlation between energy consumption and process conditions, equipment operating modes, and operating parameters (Xinhuanet, 2021). In the meantime, the park actively harnessed solar power from offshore PV stations and agricultural PV complementary power stations. The park also focuses on capturing waste heat for subsequent reuse, further enhancing its overall energy efficiency (Wanhua Chemical Group, 2023).

5. Facilitating carbon markets

Practices in Indonesia

Indonesia has just launched its first phase of mandatory carbon trading for coal power plants in February. It covers 99 on-grid power plants with a total capacity of 33.6 GW (Reuters, 2023). However, the first phase only includes larger coal on-grid power plants with a capacity of at least 100MW. Smaller and captive coal power plants may be included in the following phases.

China's best practices

China's national carbon market initiated the inclusion of captive coal plants with the introduction of the "National Carbon Emissions Trading Market Construction Plan (Power Generation Industry)" in 2017 (NDRC, 2017). This plan specifically identified that captive power plants with an annual emission of 26,000 tons of carbon dioxide equivalent or more should be treated as key emission units in the carbon market.

During the first year of the national carbon market in 2021, the majority of captive power plants performed well (China Energy News, 2022). Notably, the captive power plants of 15 subsidiaries under Sinopec completed their carbon quota clearance in December, 2021(China Securities Journal, 2022). Captive power plants under China Energy Investment all achieved 100% compliance ahead of schedule (China Energy Group, 2023). Taiyuan Iron and Steel Group not only fulfilled the compliance requirements on time, but also maintained surplus carbon quotas in its subsidiary company, Taiyuan Stainless Steel (Csteelnews, 2022).

POLICY RECOMMENDATIONS

Indonesia should consolidate its economic and industrial development strategies with its climate commitments. The government should take a more holistic approach to incorporate the country's national economic and industrial strategies considering the climate commitments under the JETP's targets. Current strategies focus heavily on energy-intensive activities that have a high requirement for reliable power generation and transmission, while there is a lack of strong power grid infrastructure across the country as well as insufficient cost-effective climate-friendly alternatives for captive coal plants. Additionally, Indonesian government should demand all captive power plants add renewable energy power mix to their power plant portfolios to meet the national renewable energy target, as stipulated in Government Regulation No. 70/2014, and Presidential Regulation No. 22/2017, and align with the emission target in the Nationally Determined Contribution (NDC).

PLN and the Indonesian government should focus on improving power grid infrastructure and renewable energy policies to reduce the demand for captive coal power plants and support the integration of renewable energy sources. This includes investing in smart grids and energy storage systems to handle the intermittency of renewables. Policy reforms that provide incentives for renewable energy adoption can help attract investment in this sector. In addition, the Indonesian government should allow the private sector to invest or co-invest in transmission infrastructure, with PLN. .Meanwhile, the diversification of the energy mix, setting clear renewable energy targets, and capacity building are crucial to reducing reliance on captive coal plants. Through these initiatives, they can support industrialization while encouraging a transition to cleaner energy sources.

The Indonesian government should enhance financial access and explore various financing tools for Indonesia's renewable energy development. Currently, investment shortfalls exist in Indonesia due to perceived risks of renewable power projects. By creating a supportive regulatory environment, reducing investment risks, and fostering knowledge within local financial institutions, Indonesia can attract the capital necessary for its transition towards a sustainable energy sector. Collaboration with multilateral agencies for low-interest loans or grants could further bolster this development.

Domestic and international investors should seek clean business opportunities through proactive transitions towards low-carbon supply chains. To address captive power plant challenges, both power and non-power investors (such as mineral mining investors) should be involved and incentivized. Chinese investors in the power sector should better utilize their experiences in renewable energy investment and explore other cost-effective power investment options in Indonesia. In the context of the increasing demand for a cleaner global supply chain, non-power investors should proactively help with the supply chain transitions to avoid stranded assets and sunk costs. Keystone industry actors in Indonesia's captive coal power plants and the associated industry supply chains, particularly Tsingshan Industry Corporation, Jiangsu Delong Nickel Industry, and Ningbo Lygend should proactively seek renewable power solutions as a key part of their efforts to decarbonize their supply chains in accordance with global climate change goals. In addition, as major investors of industrial estates of Indonesia, Chinese industrial estate developers should explore integrating renewable energy sources to meet the power demands within their industrial parks.

China should offer its experiences and best practices to help with Indonesia's low-carbon transition. Chinese stakeholders, including the government and business communities, should contribute to Indonesia's sustainable development efforts by presenting their best practices in areas such as renewable energy, eco-industrial parks, circular economy, and energy efficiency. Intergovernmental collaboration and business opportunities in these areas can be further explored to advance green growth.

APPENDICES

Appendix 1. Major Chinese investors in captive coal power plants and company information.

Chinese investor	Company portfolio	Ownership	Capacity involved* (including operating, under construction and pre-permit)
Tsingshan Industrial Corporation	One of the world's largest nickel producers; The corporation Includes Tsingshan Holding Group, Eternal Tsingshan Group, Dingxin Group	Private	7560 MW
Jiangsu Delong Nickel Industry	Nickel supply chains	Private	4665 MW
Ningbo Lygend	Nickel supply chains	Private	2240 MW
Xiamen Xiangyu	Supply chain, real estate	State-owned	1840 MW
Zhejiang Huayou Cobalt	Cobalt supply chain	Private	500 MW
Guangdong Guangxin Holding Group	New materials, biological medicines and food as well as digital creative and converged services	State-owned	300 MW
Zhenshi Holding Group (Including Zhejiang Huajun Investment)	Special steel, nickel iron manufacturing, mineral resources, wind-powered base materials	Private	250 MW
China Hongqiao Group	One of the world's largest aluminum producers	Private	220 MW
Qingdao Xiyuan Holdings	Equipments, metal	Private	390 MW
Qingdao Urban Construction Investment	Construction, real estate	State-owned	390 MW
Shandong Taishan Steel Group	Iron and steel	Private	390 MW
Huafeng Group	Material	Private	380 MW
Nanjing Iron and Steel Company	Iron and steel	State-owned	60 MW
Metallurgical Corporation of China	Iron and steel	State-owned	250 MW

* The involved capacity numbers include any capacity that includes shared ownership is considered involvement by Chinese investors. It is important to note that this involvement is ***not mutually exclusive***, meaning that one project may have participation from multiple Chinese investors.

Appendix 2. List of Captive Coal Plants in Indonesia (Global Energy Monitor, January 2023. Owner country information was manually collected by authors)

Operating (Chinese-involved, joint ownership included)

Plant	Owner (parent)	Owner country	Capacity (MW)	Year
Delong Nickel Phase I power station	Jiangsu Delong Nickel Industry Co	China	30	2018
Delong Nickel Phase I power station	Jiangsu Delong Nickel Industry Co	China	30	2018
Delong Nickel Phase I power station	Jiangsu Delong Nickel Industry Co	China	50	2019
Delong Nickel Phase I power station	Jiangsu Delong Nickel Industry Co	China	50	2019
Delong Nickel Phase I power station	Jiangsu Delong Nickel Industry Co	China	60	2019
Delong Nickel Phase I power station	Jiangsu Delong Nickel Industry Co	China	60	2019
Delong Nickel Phase I power station	Jiangsu Delong Nickel Industry Co	China	125	2018
Delong Nickel Phase I power station	Jiangsu Delong Nickel Industry Co	China	125	2018
Delong Nickel Phase II power station	Xiamen Xiangyu Group (51%), Jiangsu Delong Nickel Industry Co (49%)	China	135	2020
Delong Nickel Phase II power station	Xiamen Xiangyu Group (51%), Jiangsu Delong Nickel Industry Co (49%)	China	135	2020
Delong Nickel Phase II power station	Xiamen Xiangyu Group (51%), Jiangsu Delong Nickel Industry Co (49%)	China	135	2020
Delong Nickel Phase II power station	Xiamen Xiangyu Group (51%), Jiangsu Delong Nickel Industry Co (49%)	China	135	2021
Delong Nickel Phase II power station	Xiamen Xiangyu Group (51%), Jiangsu Delong Nickel Industry Co (49%)	China	135	2021
Delong Nickel Phase II power station	Xiamen Xiangyu Group (51%), Jiangsu Delong Nickel Industry Co (49%)	China	135	2021
Delong Nickel Phase II power station	Xiamen Xiangyu Group (51%), Jiangsu Delong Nickel Industry Co (49%)	China	135	2021

Plant	Owner (parent)	Owner country	Capacity (MW)	Year
Delong Nickel Phase II power station	Xiamen Xiangyu Group (51%), Jiangsu Delong Nickel Industry Co (49%)	China	135	2021
Delong Nickel Phase II power station	Xiamen Xiangyu Group (51%), Jiangsu Delong Nickel Industry Co (49%)	China	380	2022
Delong Nickel Phase II power station	Xiamen Xiangyu Group (51%), Jiangsu Delong Nickel Industry Co (49%)	China	380	2021
Delong Nickel Phase III power station	Jiangsu Delong Nickel Industry Co	China	135	2021
Ketapang Smelter power station	China Hongqiao Group, Harita Group	China	30	2016
Ketapang Smelter power station	China Hongqiao Group, Harita Group	China	80	2021
Ketapang Smelter power station	China Hongqiao Group, Harita Group	China	80	2021
Ketapang Smelter power station	China Hongqiao Group, Harita Group	China	30	2021
Medan Steel Mill Power Plant	PT Gunung Gahapi, Nanjing Iron and Steel Company	China	30	2017
Medan Steel Mill Power Plant	PT Gunung Gahapi, Nanjing Iron and Steel Company	China	30	2017
PT Halmahera Persada Lygend Nickel Smelter power station	Harita Group (63.1%), Ningbo Lygend (36.9%)	China	30	2020
PT Halmahera Persada Lygend Nickel Smelter power station	Harita Group (63.1%), Ningbo Lygend (36.9%)	China	30	2021
PT Halmahera Persada Lygend Nickel Smelter power station	Harita Group (63.1%), Ningbo Lygend (36.9%)	China	150	2022
Qingdao Zhongsheng captive power station	Qingdao Xiyuan Holdings Co., Ltd., Qingdao Urban Construction Investment (Group) Co., Ltd., Shandong Taishan Steel Group Co., Ltd.	China	65	2022
Qingdao Zhongsheng captive power station	Qingdao Xiyuan Holdings Co., Ltd., Qingdao Urban Construction Investment (Group) Co., Ltd., Shandong Taishan Steel Group Co., Ltd.	China	65	2022

Plant	Owner (parent)	Owner country	Capacity (MW)	Year
Sulawesi Mining power station	Tsingshan Holding Group (55%), Bintang Delapan (45%)	China	65	2015
Sulawesi Mining power station	Tsingshan Holding Group (55%), Bintang Delapan (45%)	China	65	2015
Sulawesi Mining power station	Guangdong Guangxin Holdings Group	China	150	2016
Sulawesi Mining power station	Guangdong Guangxin Holdings Group	China	150	2020
Sulawesi Mining power station	Eternal Tsingshan Group	China	350	2017
Sulawesi Mining power station	Eternal Tsingshan Group	China	350	2017
Sulawesi Mining power station	Eternal Tsingshan Group	China	350	2019
Sulawesi Mining power station	Eternal Tsingshan Group	China	350	2019
Sulawesi Mining power station	Eternal Tsingshan Group	China	250	2020
Weda Bay power station	Tsingshan Holding Group, Other	China	250	2020
Weda Bay power station	Tsingshan Holding Group, Zhenshi Holding Group, Zhejiang Huajun Investment Co., Ltd.	China	250	2020
Weda Bay power station	Tsingshan Holding Group, Other	China	250	2021
Weda Bay power station	Metallurgical Corporation of China Ltd., Tsingshan Holding Group	China	250	2021
Weda Bay power station	Zhejiang Huayou Cobalt Co. (70%), Tsingshan Holding Group (30%)	China	250	2022

Operating (other)

Plant	Owner (parent)	Owner country	Capacity (MW)	Year
Amamapare Port power station	PT Puncakjaya Power	Indonesia	65	1998
Amamapare Port power station	PT Puncakjaya Power	Indonesia	65	1998
Amamapare Port power station	PT Puncakjaya Power	Indonesia	65	1999
Batu Hijau power station	Newmont Mining Corporation	US	31	1999
Batu Hijau power station	Newmont Mining Corporation	US	31	1999
Batu Hijau power station	Newmont Mining Corporation	US	31	1999
Batu Hijau power station	Newmont Mining Corporation	US	31	1999
Cemindo Gemilang power station	PT Cemindo Gemilang	Indonesia	60	2016
DSS Serang power station	PT Dian Swastatika Sentosa Tbk	Indonesia	35	NA
DSS Serang power station	PT Dian Swastatika Sentosa Tbk	Indonesia	35	NA
DSS Serang power station	PT Dian Swastatika Sentosa Tbk	Indonesia	35	NA
DSS Serang power station	PT Dian Swastatika Sentosa Tbk	Indonesia	70	NA
Indo Bharat Rayon power station	Aditya Birla Group	India	36.6	2008
Kalimantan Cement Works power station	Pt Indocement	Indonesia	55	1998
MSP Pulau Obi power station	Harita Group	Indonesia	38	2016
MSP Pulau Obi power station	Harita Group	Indonesia	38	2016
MSP Pulau Obi power station	Harita Group	Indonesia	38	2016
Nanshan Industrial Park power station	Global Aluminium International (72.7%), Press Metal Aluminium Holdings Berhad (25%), PT. MahkotaKarya Utama (2.3%)	India, Malaysia, Indonesia	30	2021

Plant	Owner (parent)	Owner country	Capacity (MW)	Year
Nanshan Industrial Park power station	Global Aluminium International (72.7%), Press Metal Aluminium Holdings Berhad (25%), PT. MahkotaKarya Utama (2.3%)	India, Malaysia, Indonesia	30	2021
Nanshan Industrial Park power station	Global Aluminium International (72.7%), Press Metal Aluminium Holdings Berhad (25%), PT. MahkotaKarya Utama (2.3%)	India, Malaysia, Indonesia	30	2022
Nanshan Industrial Park power station	Global Aluminium International (72.7%), Press Metal Aluminium Holdings Berhad (25%), PT. MahkotaKarya Utama (2.3%)	India, Malaysia, Indonesia	30	2022
Perawang Mill power station	Sinar Mas Group	Indonesia	35	2009
Perawang Mill power station	Sinar Mas Group	Indonesia	90	2000
Perawang Mill power station	Sinar Mas Group	Indonesia	90	2000
Perawang Mill power station	Sinar Mas Group	Indonesia	90	2000
Perawang Mill power station	Sinar Mas Group	Indonesia	150	2014
Perawang Mill power station	Sinar Mas Group	Indonesia	150	2014
Perawang Mill power station	Sinar Mas Group	Indonesia	150	2014
Sinar Mas Jambi Lontar power station	Sinar Mas Group	Indonesia	37	1994
Sinar Mas Jambi Lontar power station	Sinar Mas Group	Indonesia	37	1994
Sinar Mas Jambi Lontar power station	Sinar Mas Group	Indonesia	37	1994
Sinar Mas Jambi Lontar power station	Sinar Mas Group	Indonesia	100	2017
Tjiwa Kimia Paper Mill power station	Asia Pulp & Paper	Indonesia	35	1992

Plant	Owner (parent)	Owner country	Capacity (MW)	Year
Tjiwa Kimia Paper Mill power station	Asia Pulp & Paper	Indonesia	35	1993
Tjiwa Kimia Paper Mill power station	Asia Pulp & Paper	Indonesia	70	1996
Tjiwa Kimia Paper Mill power station	Asia Pulp & Paper	Indonesia	90	2015
Tonasa Cement Plant power station	PT Semen Indonesia	Indonesia	35	2013
Tonasa Cement Plant power station	PT Semen Indonesia	Indonesia	35	2013

Under construction (Chinese-involved, joint ownership included)

Plant	Owner (parent)	Owner country	Capacity (MW)	Year
Delong Nickel Phase III power station	Jiangsu Delong Nickel Industry Co	China	135	2022
Delong Nickel Phase III power station	Jiangsu Delong Nickel Industry Co	China	135	2022
Delong Nickel Phase III power station	Jiangsu Delong Nickel Industry Co	China	135	2022
Delong Nickel Phase III power station	Jiangsu Delong Nickel Industry Co	China	135	2022
Delong Nickel Phase III power station	Jiangsu Delong Nickel Industry Co	China	135	2022
Delong Nickel Phase III power station	Jiangsu Delong Nickel Industry Co	China	135	2022
Delong Nickel Phase III power station	Jiangsu Delong Nickel Industry Co	China	150	NA
Delong Nickel Phase III power station	Jiangsu Delong Nickel Industry Co	China	300	NA
Delong Nickel Phase III power station	Jiangsu Delong Nickel Industry Co	China	300	NA
Delong Nickel Phase III power station	Jiangsu Delong Nickel Industry Co	China	300	NA

Plant	Owner (parent)	Owner country	Capacity (MW)	Year
Delong Nickel Phase III power station	Jiangsu Delong Nickel Industry Co	China	300	NA
PT Halmahera Persada Lygend Nickel Smelter power station	Harita Group (63.1%), Ningbo Lygend (36.9%)	Indonesia,China	60	NA
PT Halmahera Persada Lygend Nickel Smelter power station	Harita Group (63.1%), Ningbo Lygend (36.9%)	Indonesia,China	150	NA
PT Halmahera Persada Lygend Nickel Smelter power station	Harita Group (63.1%), Ningbo Lygend (36.9%)	Indonesia,China	150	NA
PT Halmahera Persada Lygend Nickel Smelter power station	Harita Group (63.1%), Ningbo Lygend (36.9%)	Indonesia,China	150	NA
Sulawesi Labota power station	Eternal Tsingshan Group	China	350	
NA	Harita Group	Indonesia	38	2016
Sulawesi Labota power station	Huafeng Group, Eternal Tsingshan Group	China	380	NA
Sulawesi Labota power station	Bintang Delapan, Dingxin Group	Indonesia,China	380	NA
Sulawesi Labota power station	Bintang Delapan, Dingxin Group	Indonesia,China	380	NA
Sulawesi Labota power station	Bintang Delapan, Dingxin Group	Indonesia,China	380	NA
Weda Bay power station	Tsingshan Holding Group, Other	China	380	NA
Weda Bay power station	Tsingshan Holding Group, Other	China	380	NA
Weda Bay power station	Tsingshan Holding Group, Other	China	380	NA
Weda Bay power station	Tsingshan Holding Group, Zhejiang Huayou Cobalt Co.	China	250	NA
Weda Bay power station	Walsin Lihwa, Tsingshan Holding Group	Taiwan,mainland China	380	NA
Weda Bay power station	Walsin Lihwa, Tsingshan Holding Group	Taiwan,mainland China	380	NA
Weda Bay power station	Nickel Industries Limited (80%), Tsingshan Holding Group (20%)	Taiwan,mainland China	380	2022

Under construction (other)

Plant	Owner (parent)	Owner country	Capacity (MW)	Year
Asahimas Chemical power station	AGC Inc. (52.5%), Ableman Finance (18%), Rodamas (18%), Mitsubishi Corporation Energy Solutions (11.5%)	Japan, Indonesia, other	150	2022
Asahimas Chemical power station	AGC Inc. (52.5%), Ableman Finance (18%), Rodamas (18%), Mitsubishi Corporation Energy Solutions (11.5%)	Japan, Indonesia, other	150	2022
Nanshan Industrial Park power station	Global Aluminium International (72.7%), Press Metal Aluminium Holdings Berhad (25%), PT. MahkotaKarya Utama (2.3%)	Japan, Indonesia, other	30	2021
Sulawesi Labota power station	Indonesia Wanjia Ferro Nickel Co., Ltd.	Indonesia	380	NA
Sulawesi Labota power station	Indonesia Zhaohui Ferro Nickel Co., Ltd.	Indonesia	380	NA

Under construction (other)

Plant	Owner (parent)	Owner country	Capacity (MW)	Year
Nanshan Industrial Park power station	Global Aluminium International (72.7%), Press Metal Aluminium Holdings Berhad (25%), PT. MahkotaKarya Utama (2.3%)	India, Malaysia, Indonesia	30	2021
PT Halmahera Persada Lygend Nickel Smelter power station	Harita Group (63.1%), Ningbo Lygend (36.9%)	Indonesia, China	380	NA
PT Halmahera Persada Lygend Nickel Smelter power station	Harita Group (63.1%), Ningbo Lygend (36.9%)	Indonesia, China	380	NA
PT Halmahera Persada Lygend Nickel Smelter power station	Harita Group (63.1%), Ningbo Lygend (36.9%)	Indonesia, China	380	NA
PT Halmahera Persada Lygend Nickel Smelter power station	Harita Group (63.1%), Ningbo Lygend (36.9%)	Indonesia, China	380	NA
Qingdao Zhongsheng captive power station	Qingdao Xiyuan Holdings Co., Ltd., Qingdao Urban Construction Investment (Group) Co., Ltd., Shandong Taishan Steel Group Co., Ltd.	China	65	NA

Plant	Owner (parent)	Owner country	Capacity (MW)	Year
Qingdao Zhongsheng captive power station	Qingdao Xiyuan Holdings Co., Ltd., Qingdao Urban Construction Investment (Group) Co., Ltd., Shandong Taishan Steel Group Co., Ltd.	China	65	NA
Qingdao Zhongsheng captive power station	Qingdao Xiyuan Holdings Co., Ltd., Qingdao Urban Construction Investment (Group) Co., Ltd., Shandong Taishan Steel Group Co., Ltd.	China	65	NA
Qingdao Zhongsheng captive power station	Qingdao Xiyuan Holdings Co., Ltd., Qingdao Urban Construction Investment (Group) Co., Ltd., Shandong Taishan Steel Group Co., Ltd.	China	65	NA
Sulawesi Labota power station	Bintang Delapan, Dingxin Group	Indonesia, China	380	NA

Announced

Plant	Owner (parent)	Owner country	Capacity (MW)	Year
Adaro Aluminum Smelter power station	Adaro	Indonesia	2200	2025

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