8 The role of China in energy transition in Indonesia

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1 Introduction

Indonesia started to produce large-scale electricity from steam coal power plants in the mid-1980s. The government has facilitated the development of steam coal power plants by introducing several policies. In 2006, by Presidential Regulation No. 71, Indonesia started to develop a mega project of steam coal power plants, or the first fast-track (FTP-1) program. By November 2018, about 9,647 MW of steam coal power plants were completed, and 280 MW is still under construction (PLN, 2019a). In 2010, the government launched the second fast-track program (FTP-2). In FTP-1, the new capacity was based on the coal power plant, but in FTP-2, the 17,458 MW new power plant consisted of steam coal (10,520 MW), geothermal (4,855 MW), gas (280 MW), and hydropower (1,803 MW). However, by November 2018, about 755 MW of new capacity was operated commercially. Thus, both FTP-1 and FTP-2 will increase the new steam coal power plant to about 20,447 MW. In 2016, the government launched the 35,000 MW project which will be finished in 2028. Coal power plants will contribute about 20,000 MW of the total project.¹ Thus, the three mega projects will further expand the role of coal in the power generating system.

Foreign countries have made significant contributions to developing power plants in Indonesia. By the end of 2015, about 17,300 MW of newly installed power capacity was constructed under the independent power producer (IPP) and engineering, procurement, and construction (EPC) schemes.² China is a latecomer to the greenfield coal project, and the first project was constructed in Indonesia by Shenhua Group in 2011, with a capacity of 400 MW (Li, 2019). However, China can move faster than many other countries. Now, China's share of the 17,300 MW is about 46%, with Japan at 30%, while 24% was jointly contributed by South Korea, Turkey, the United States, Malaysia, and Indonesia (Shalati and Simanjuntak, 2019).

Cooperation between Indonesia and China in construction power plants has triggered major changes in terms of business schemes, technology, maintenance, and operation. For example, Java 7 steam coal plant was developed under the IPP model, with a capacity of $2 \times 1,000$ MW. This project is a

part of the 35,000 MW program. It was implemented by the joint company of Shenhua Guohua and PJB (one of PLN's subsidiary companies). About 70% of stock is owned by China and the rest by Indonesia. This plant uses ultra-supercritical technology, in contrast to FTP-1, which is dominated by subcritical technology. For maintenance and operation, the project involves Guohua Taidian Ltd, PJB Ltd, and Taishan Power Generation Company.

Furthermore, China is aware that Indonesia has a great potential for renewable energy, such as hydropower, geothermal, bioenergy, solar photo-voltaics (PV), wind, and ocean wave. Under the first generation of the IPP scheme, China started the development of the hydropower plants Asahan 3 and PLTA Poso. In the case of the Poso hydropower plant in Central Sulawesi, Poso Energy Ltd, part of the Kalla Group business, operated the project under the IPP scheme, but the turbine was imported from China.³ Chinese companies developed some of the large-scale hydropower plants in East Kalimantan and Sulawesi.⁴ In the meantime, China has substantially increased exports of PV components to Indonesia (Chapters 7 and 8 in this book). Considering the position of China, which has been actively involved in developing both coal and renewable energy generation, the energy transition to low-carbon development must not be slack.

Against this backdrop, this paper aims to investigate the role of China in forming the energy transition in Indonesia from the perspective of investment in coal-based and renewable energy power supplies.

2 Framework and method

The analysis in this chapter follows theoretical frameworks of energy security. Energy security is defined as the uninterrupted availability of energy sources at an affordable price (IEA, 2020a). IEA (2020a) defined energy security in the long and short terms. The long-term perspective on energy security refers to investment that aims to achieve economic and environmental development, while the-short term perspective of energy security focuses on the ability of energy systems to respond to any shocks from both the demand and supply side. Then, Sovacool (2011) divided energy security into five dimensions, namely, regulations and governance, availability, technology development and efficiency, environmental sustainability, and affordability.

The World Energy Council (WEC) produces the Energy Sustainability Index. The index covers two major elements, such as energy performance and contextual performance. Energy performance consists of energy security, energy equity, and environmental sustainability, while on the contextual performance, this includes political strength, societal strength, and economic strength. For the transition to low-carbon intensive sources of electricity, it is necessary to develop a higher degree of flexibility in dealing with intermittency of renewable energy (IEA, 2020b). By pursuing energy securities, countries can achieve number 7 of the Sustainable Development

Goals (SDGs), which states that countries should ‘ensure access to affordable, reliable, sustainable, and modern energy for all’.⁵

Because energy security is a multidimensional subject (Peimani, 2011), this section focuses on three dimensions of energy security in which Indonesia is relatively successful and less successful. First, from 2010 to 2018, Indonesia provided electricity to an extra 10 million people who had not previously had access to electricity (SEforAll, 2020).⁶ This indicates the biggest improvement in the world, after India, Bangladesh, and Afghanistan. Availability and affordability are key factors that open up opportunities for better access to electricity.

Second, Indonesia received a red card for low-carbon electricity generation and CO₂ emissions per capita in 2010–2020 (WEC, 2020). This implies that Indonesia lacks behind in terms of innovation capability toward green energy. Finally, the future performance of the electricity sector depends on how regulation and governance can create business opportunities and economic stability for energy investment (Sambodo, 2016). This area represents elements of political commitment, regulation, and governance. Considering several important elements of energy security in Indonesia, this chapter focuses on accessibility and affordability, sustainability, and governance, and discusses the above three dimensions in relation to energy cooperation with China.

Expert interviews were conducted to confirm and develop robust arguments. The experts covered the perspectives of PLN, private business, and community associations in the energy sector. Secondary data was collected from various sources, such as the Ministry of Energy and Mineral Resources of the Republic of Indonesia, PLN, and data subscribed from BPS. Additionally, information was sourced from major newspapers.

3 A brief review of the power sector development since the Yudhoyono presidency

The development of steam coal power plants has been a government priority since 2006, especially under FTP-1, with support from the Presidential Decree No. 17/2006. The decree aimed to increase the capacity of the steam coal power plan by 80 units, with an additional capacity of 10,000 MW. The regulation also stated the location and number of new units for each province. Then, in 2010, the government extended the program with the implementation of FTP-2 with the Presidential Decree No. 4/2010. The new decree stated that the government hand the assignment to PLN for the development of generating power by utilizing renewables, coal, and gas, with a total capacity of 10,053 MW by 2014. The share of renewable energy in FTP-2 was about 51.5% and consisted of hydropower (1,204 MW) and geothermal (3,977 MW). In sum, FTP-1 promoted only coal power, while FTP-2 provided more space for renewable energy.

In May 2015, the government launched the 35,000 MW program. This was the third accelerated program following the two fast-track programs and will be completed by 2029. The government expected that, by 2020, the construction of new power plants will have reached 8,823 MW, or the highest level of new capacity for the whole project phase.⁷ By 2019, the government said that 96%, or 33,856 MW, was under contract and that 19% (6,811 MW) was in operation. Some projects from FTP-2 and regular programs, amounting to 11,872 MW, were carried over under the 35,000 MW program (Sebayang, 2015).

Several ambitious programs are necessary to boost electricity consumption. Installed capacity increased by 38.5 GW from 2004 to 2018 (Table 8.1). The National Electricity General Plans (Rencana Umum Ketenagalistrikan Nasional-RUKN) 2019–2038 stated that the share of new and renewable energy in the power sector needed to reach 23% by 2025. Indonesia produced more electricity, from wider sources of renewable energy, in 2018 than in 2004 (Table 8.1). Considering the target of renewable energy is 39,653 MW by 2025, the annual growth of renewable energy needs to reach about 22% (using the exponential growth model). This target is high on impossible, but one that must be pursued. Growth of installed capacity from renewable resources was lower than fossil fuel, and the share of renewable energy slightly decreased from 2004 to 2018 (Table 8.1). Weak institutional architecture, resistance from PLN to adopt premium feed-in tariffs, land access, complicated approval processes, and long negotiation processes, have all

Table 8.1 Installed capacity (in MW) of power plants in Indonesia

<i>Type</i>	<i>2004</i>	<i>2018</i>	<i>Change 2018-04</i>	<i>Renewable energy target by 2025*</i>
Hydro	3,200	5,370	2,170	17,986.7
Geothermal	820	1,948	1,128	7,241.5
Wind		143	143	1,800
Micro-hydro		105	105	3,000
Mini-hydro		268	268	
Solar		53	53	6,500
Waste		16	16	3,124
Biogas		109	109	
Biomass		1,759	1,759	
Steam coal	9,750	31,578	21,828	
Gas	2,803	5,348	2,546	
Combine cycle	6,846	11,220	4,374	
Diesel	2,994	4,631	1,637	
Gas engine	12	2,358	2,346	
Total	26,424	64,904	38,480	
Share of renewable	0.152	0.151	(0.0016)	

Note: renewable include on grid and off-grid; * based on general planning of national energy (RUEN).

Source: ESDM (2015) and ESDM (2019).

blocked wider deployment (Burke et al., 2019). Since the difficulty in weaning dependency on coal and unsupportive renewable energy has made the Ministry of Energy and Mineral Resources pessimistic about reaching their target, the government has proposed to extend the 23% target of new and renewable energy to 2030.⁸

However, extension of the target on renewable energy may affect the Indonesian government's commitment to reduce greenhouse gas emissions from the energy sector. Indonesia has submitted its Nationally Determined Contribution (NDC) and the government aims to reduce greenhouse gas emissions by 29% under unconditional condition (relying on national strength) and 41% with conditional condition (international cooperation) by 2030. In 2010, the level of CO₂ emissions from the energy sector was the second largest after the forestry sector. However, in 2030, the energy sector will be the largest emitter (Table 8.2). This implies that emissions reduction from the energy sector will have significant impact in terms of the national target. Thus, by considering the existing energy system, energy transformation to low carbon can be promoted by energy efficiency in steam coal power plants or fuel switching.

Coal is showing an increasingly significant role in the electricity generation system and utilization of gas may help Indonesia to reduce carbon dioxide emissions. From 2019 to 2028, the government plan to add 56,394 MW of new capacity, among which 27,063 MW or 48% will be steam coal power (Table 8.3). In 2019, the share of fossil fuels is 59 GW or 85% of total installed capacity. Based on the PLN's business plan, the share of steam coal plants will slightly increase from 46.9% to 47.4% in the same period. Although gas has an important role to play in the transition to low-carbon emissions, its contribution is likely to decline. At the current level of gas consumption, natural gas will run

Table 8.2 Indonesian nationally determined contribution (NDC) by sector

No	Sector	GHG emission level 2010	GHG emission level 2030			GHG emission reduction				Annual average growth BAU (2010–2030)	Average growth 2000–2012
		MtonCO ₂ e	(Mton CO ₂ e)			(Mton CO ₂ e)		% of total BaU			
			BaU	CM1	CM2	CM1	CM2	CM1	CM2		
1	Energy*	453	1,669	1,355	1,271	314	398	11	14	6.7	4.5
2	Waste	88	296	285	270	11	26	0.38	1	6.3	4
3	IPPU	36	70	67	66	3	3	0.1	0.11	3.4	0.1
4	Agriculture	111	120	110	116	9	4	0.32	0.13	0.4	1.3
5	Forestry**	647	714	217	64	497	650	17.2	23	0.5	2.7
	Total	1,334	2,869	2,034	1,787	834	1,081	29	38	3.9	3.2

Note: * include fugitive emissions; ** include peat fire; BaU (not considering climate change mitigation); CM1 (considering emissions target by sector); CM2 (with conditional, more ambitious and considering emissions target by sector).

Source: Ministry of Environment and Forestry, Republic of Indonesia (2017).

Table 8.3 Installed capacity of power plants in Indonesia by source and future direction

Source	In MW			In percentage*	
	Existing capacity 2019	Added capacity 2019–2028	Estimate capacity in 2028	Share of installed capacity in 2019	Estimate share of installed capacity in 2028
Fossil based	59,377	39,680	99,057	85.2	78.6
Coal	32,677	27,063	59,740	46.9	47.4
Gas	21,920	12,416	34,336	31.5	27.2
Oil	4,780	201	4,981	6.9	4.0
New and renewable	10,302	16,714	27,016	14.8	21.4
Geothermal	2,131	4,607	6,738	3.1	5.3
Hydro	5,976	6,060	12,036	8.6	9.5
Solar	146	3,483	3,629	0.2	2.9
Other new and renewable	2,049	2,564	4,613	2.9	3.7
Total	69,679	56,394	126,073	100.0	100.0

Note: * Calculated by the authors based on the data.

Source: ESDM (2020) and PLN (2019b).

out in less than 18 years.⁹ The contribution of gas tends to decrease. Further, utilization of gas depends on infrastructure. In 2006, Rekayasa Industry Ltd won the contract for the pipe gas network development of about 255 km between Cirebon in West Java and Semarang, Central Java. The project is valued at around US\$ 269 million. However, in October 2020, the company backed out of the deal, due to the uncertainty of gas supply. In addition, the Electricity Procurement Plant (Rencana Usaha Penyediaan Tenaga Listrik-RUPTL) also indicated that with a risk of gas supply, then coal and oil will need to substitute any deficit of the gas supply (PLN, 2019a).

Due in part to COVID-19, there was an excess power of 16,675 MW and electricity consumption declined from 243 TWh to 222 TWh in 2020.¹⁰ The excess power occurred in Java-Bali (10,849 MW), Sumatera (3,308 MW), Sulawesi (1,146 MW), Kalimantan (874 MW), and Papua (498 MW). This implies that by 2020, the reserve margin was about 30% and was higher than the target (25%). Because of COVID-19, the government plans to cut power supply from the 35,000 MW project by 15.5 GW, and which will commence at RUPTL from 2020 to 2031.

4 Findings

4.1 Availability and affordability

Due to the economic crisis of 1997/1998, Indonesia started with a low basis of energy access (Sambodo, 2016). This pushed the government to pursue more ambitious programs in order to expand and improve energy access

by conducting energy cooperation. On 24 March 2002, President Megawati Soekarnoputri visited China. This brought new projects for steam coal, such as Labuhan Angin, Tapanuli Tengah, and Sumatera Utara.¹¹ Labuhan Angin was a joint project between PLN Ltd and the China National Machinery & Equipment Corp. (CMEC) with a capacity of 2×115 MW. This project was under the EPC scheme and was financed by loans from China and PLN's internal funding. The total investment was about US\$ 208.6 million and 232.39 billion rupiahs. Project design and construction were conducted by CMEC. The project was signed on 6 October 2003 and the contract was effective on 15 March 2005. The first and second unit of the project were completed on delivery (COD) in 2009. President Megawati's visit to China was also linked with other projects, such as the steam coal Pangkalan Susu Loan China 2×200 MW, steam coal Parit Baru Loan China 2×50 MW, and steam coal Jenepono Loan China 2×100 MW. Thus, the 'political lobby' from Megawati was effective in attracting more loans from China into the power sector.

In 2005, both Indonesia and China signed the strategic partnership. The partnership aims to enhance cooperation in trade, investment, and maritime matters. The Indonesian Minister of Mines and Energy, Purnomo Yusgiantoro, indicated China's interest in cooperating in the energy sector. Before the government issued the Presidential Regulation Number 71 Year 2006 (FTP-1), in April 2006, several government officials, such as Vice President, Yusuf Kalla, and the Director of PLN, Eddie Widiono, visited China.¹² This visit aimed to investigate the readiness and ability of Chinese companies to develop steam coal power plants in Indonesia. They then invited Chinese companies to participate in an open tender for FTP-1. At that time, PLN also signed the Memorandum of Understanding (MoU) with five electric companies in China, such as Dongfang Electric Corporation, Harbin Electric Corporation, Shanghai Electric Power Co. Ltd, Huandian, and Chenda.¹³

With the implementation of FTP-1, PLN became the project owner and conducted the open tender or direct bidder. The project's development adopted the engineering, procurement, and construction (EPC) scheme. Chinese companies have capabilities to develop large-scale steam coal power plants, and also for small-scale power plants, such as the 50 MW that was abandoned in China. Many contractors came with technology from China, and many non-Chinese bidders withdrew from the bidding process because they could not compete with low prices offered from China. For example, the average price of 10 GW was about US\$ 800/kW, while for non-Chinese products, it was above US\$ 1,300/kW.¹⁴ Thus, almost all FPT-1 projects were completed by technology from China, especially on subcritical and supercritical unit (Sambodo, 2012). For the capacity of 100 MW or above, the main contractors were from China, but they needed to cooperate with Indonesian contractors. Then, for capacity below 100 MW, the main contractors were from Indonesia, but electrical and mechanical equipment was supplied by China.

Between 2005 and 2015, Chinese contractors developed 33 coal power projects under EPC (Hervé-Mignucci and Wang, 2015). The total value for the 33 projects was US\$ 16,754 million and 40% of the total value consisted of loans from China. The total projects that had been operated were 20, with total capacity 10,070 MW and a total value of US\$ 10,683 million (Hervé-Mignucci and Wang, 2015). In most of the FTP-1 projects, the equity was owned by PLN and the debt was provided by China. Almost 80% of FTP-1 projects were allocated in Java (Sambodo, 2012). In addition, nine out of ten projects of FTP-1 in Java were built by EPC contractors from China, with a total capacity of 7,490 MW (Tampubolon, Arinaldo, and Adiatma, 2018). Steam coal capacity in Java was about 16,330 MW in 2016; thus, 46% of coal capacity in Java was related to EPC projects from China.¹⁵ Because most of FTP-1 projects were located in Java, the share of electricity production of coal from PLN power plants in Java was about 88% in 2018. Generally speaking, the operation of power generation followed the long-run marginal cost principle; thus, the most efficient power plant (mostly non-Chinese) went into operation first, followed by the less efficient ones.¹⁶ This applied to Java's system, before 2019, where about 30% of ex-FTP-1 projects contributed to the Java-Bali System.¹⁷

Steam coal power plants had the lowest percentage change in average cost, because coal had the lowest standard deviation of generating cost. In addition, average elasticity of coal as well as hydropower and geothermal is positive, meaning that energy transition moves toward these two sources. Because the average change in price of geothermal was relatively higher than coal, increasing electricity production from coal was higher than geothermal. Growing coal power generation stabilized generating costs in 2009–2019 (Table 8.4).

Table 8.4 Comparison elasticity, standard deviation, and average of price for different type of power plant 2009–2019

Type of power plant	Average elasticity*	Standard deviation of generating cost**	Average price***	Average change in price (%)****
Coal	0.792	113.9	670	3.21
Hydro power	6.089	141.8	241	18.79
Geothermal	0.113	1,708.5	3,298	25.68
Diesel	−0.537	2,472.6	3,486	19.35
Gas	−0.270	591.4	1,099	21.63
Steam gas	−0.742	204.6	1,080	6.95

Note: *The ratio percentage change in electricity production with respect to percentage change in generating cost for respective type of power plant. **Standard deviation of statistical model for period 2009 and 2019 for each respective type of power plant. ***Standard average statistical calculation. ****Calculated by averaging the annual change for the whole period.

Source: PLN (2014, 2019b) and ESDM (2020).

After FTP-1 was launched, PLN substantially increased the number of steam coal power plants. Accordingly, its power generation increased from 47,764 GWh in 2006 to 122,826 GWh in 2019. The increase enabled PLN to supply electricity to 40 million new customers, contributing to an increase in electrification ratio (Table 8.5). Coupled with price stability, these increases bring economic benefits to PLN.

However, it has increased coal consumption from 19 million tons to 67 million tons in the same period (PLN, 2014; PLN, 2019b). Based on PLN's RUPTL 2015–2024, CO₂ emissions will increase from 201 million tons (in 2015) to about 383 million tons (in 2024) and 333 million tons, or 87%, of total emissions will come from coal firing (PLN, 2015). Then, based on the current planning or the RUPTL 2019–2029, CO₂ emissions in 2024 will be about 305.6 million tons and the share of emissions from coal will contribute 88.3% of total emissions (PLN, 2019a). Thus, there has been a reduction in the carbon emissions target, but carbon emissions from coal plants still show a slight increase.

Then, there is the generation cost, which is much higher than the price of electricity sold. As a result, the government needs to provide more electricity subsidies. It is interesting to note the decreasing ratio of electricity production to the number of customers. This indicates two causes. First, the growth in the number of customers is much faster than the level of electricity production. Second, because electricity production per customer hit a peak in 2014 and then declined (Table 8.5), there has been a slowdown in investment growth in the electricity sector.

People realized from FTP-1 projects that operation and maintenance cost from China is more expensive, because it requires increased labor due to the level of automatization, and that the availability factor or level of capacity utilization was relatively low compared to Japan's technology.¹⁸ Also, low quality material was a problem with steam coal power plants from China.¹⁹ Of course, this condition is not ideal, but it is effective to reduce the pressure from increasing generating costs due to the use of fuel oil. As Mori (2020) said, the amount of electricity subsidy increased substantially from 2009 to

Table 8.5 Selected indicators of PLN's performance in 2006–2019

<i>Year</i>	<i>Number of PLN steam coal power plant</i>	<i>Number of PLN customer</i>	<i>Price of electricity sold (Rp/ kWh)</i>	<i>Generating cost (Rp/ kWh)</i>	<i>Subsidy (kWh)</i>	<i>Electricity production (Gwh)</i>	<i>Electricity production (KWh)/ number of customer*</i>	<i>Electrification ratio (%)</i>
2006	43	35,751,224	628	-	-	133,108	3,723.18	63
2009	49	40,117,685	670	768	98	156,797	3,908.43	66
2014	86	57,493,234	940	1,297	357	228,555	3,975.34	84
2019	133	75,705,614	1,130	3,000	1,870	278,941	3,684.55	98.9

Note: The author's calculation from the data.

Source: PLN (2009, 2019b).

2019, and the government gained by reducing total energy subsidy through the switch from oil to coal for power generation.

4.2 Sustainability

Steam coal power plants have contributed a great deal in terms of expanding the national power capacity, promoting price certainty, and increasing the electrification ratio. Furthermore, China has attempted to improve the performance of steam coal power plants by using or licensing boiler, turbine, and generator technology from Japan, the United States, and Europe.²⁰ Similarly, China has improved significantly its maintenance operator skills and they have a high degree of adaptation in repairs.²¹ In addition, steam coal power plants from China can fulfill the existing requirements from the Ministry of Environment and Forestry.²² For example, steam coal Indramayu 3×300 MW in West Java is a consortium project between China (SINOMACH and CNEEC) and Indonesia (Penta Adi Samudera Ltd). In early 2020, this project obtained the 'Green Proper Award'. The Green Proper Award is an appreciation given to firms who manage the environment by government request (the Ministry of Environment). However, China needs to improve assembly capacity and there are many problems on balance of plant (BoP) that causes poor performance of generators, spare parts, quality of works, and generator efficiency.²³

China has a great interest in developing steam coal power plants. There are three renewable energy sectors in which China has shown its contribution to Indonesia, such as geothermal, hydropower, and solar PV. China attempted to develop geothermal projects, such as those in Ulumbu, Manggarai, and East Nusa Tenggara. There are four units of geothermal in Ulumbu (4×2.5 MW). Units 3 and 4 have operated since 2012, and the plants were imported from China, and were financed by the Indonesian government budget of 2009. Units 1 and 2 were in operation from 2014 and used technology from the United States, with funding from ADB. Units 1 and 2 used back pressure turbine technology, and units 3 and 4 used condensing unit turbines. Utilization of geothermal energy will reduce oil-based power plants that are more expensive in terms of generating cost. In 2013, PLN reduced the consumption of oil to about IDR 75.5 billion (Handoyo and Mychelisda, 2016).

A report indicates that units 3 and 4 very often have problems and that spare parts for repairs are difficult to obtain (Sambodo et al., 2015). The main problem for units 3 and 4 is the Automatic Voltage Regulator (AVR) and PLN is required to independently produce AVRs in Indonesia.²⁴ After construction was completed, there was no proper takeover process from Chinese engineers to local operators. There were language problems with no manual written in English, which has caused local engineers to have difficulties in fixing electrical and mechanical problems (Sambodo et al., 2015). Because peak load in the Manggarai region was about 9.2 MW, when the two units (3 and 4) failed to operate, it had a substantial impact on power

supply in the region.²⁵ If that is the case, PLN will need to operate diesel power plants that are more expensive.

Another project that China has an interest is hydropower. Currently, investors from China are involved in developing hydropower plants in Batang Toro, Tapanuli Selatan, and Sumatera Utara. The capacity is 4×127.5 MW. The projects were developed by North Sumatera Hydro Energy (NSHE) Ltd in cooperation with China's Sinohydro. The Commercial Operation Date (COD) was expected in 2022. This project is part of a 35,000 MW program. NSHE has the rights for about 1,800 hectares, and the open area is about 370 hectares, and 86 hectares will have permanent damage.²⁶ The Batang Toru project has faced protests by local communities, and by non-government organizations both local and international, because it is the habitat of the Tapanuli orangutan, and also supports other ecosystems. It seems that the project needs to develop more detailed systematic studies to assess and mitigate the environmental impact. Other issues have been raised by the Bank of China and the bank is going to reassess the project.

The Kayan hydropower plant, in North Kalimantan, is another project. Power Construction Corporation of China (PowerChina) has signed a memorandum of understanding (MoU) with Indonesia Kayan Hydropower Energy Ltd (Kayan Hydro Energy/KHE) to jointly build hydropower plants with a total investment of US\$ 17.8 billion on the Kayan River in North Kalimantan, by April 2019. The two firms will develop five hydropower plants with a total electricity generation capacity of 9,000 MW. PowerChina began studying the hydropower resources of the Kayan River in 2008 and completed the development plan for the whole basin of the river, as well as the feasibility study and preliminary design of the first hydropower plant, in 2013. Sinohydro Corporation is PowerChina's subsidiary engaged in hydropower plant construction. Kayan hydropower is expected to operate in 2025.

PLTA Kayan seems to work better than Batang Toru. Land acquisition has been prepared, including socialization and negotiation with the local village. There are two permits in process, such as renewing the permit for the utilization of forest areas and a permit from the dam agency. Feasibility studies, environmental assessments, and detail engineering designs (DED) have been completed by KHE. There are 27 permits that need to be prepared and 25 permits have been completed.²⁷

Indonesia also has great potential for development of solar photovoltaics (PVs). The first, massive solar home system (off-grid based) program was launched in 2011. PLN launched the Solar PV program or Super Extra Energy Saving (SEHEN), and the Ministry of Energy and Mineral Resources had Solar Home System (SHS).²⁸ Basically, the programs are similar in terms of technical aspect, but different in terms of business model. The SEHEN model was designed under the management of PLN, while the SHS model was organized by the community. Indonesia has constructed solar PVs, both for autonomous households and the community (communal system). Both SEHEN and SHS have big roles to play in addressing the lack

of access to electricity in a fast manner. SEHEN succeeded in increasing customers from 3,984 to about 113,715 in East Nusa Tenggara Province in only one year, between March 2012 and February 2013 (Sambodo, 2015). This strategy helped Indonesia to provide electricity to people who live in the outermost, frontline, and disadvantaged regions that are not economically feasible for grid access. Both SHS and SEHEN have increased the number of households from tier-1 of electricity access to tier-2.²⁹ However, program and business sustainability are the major challenges for successful PV development (Sambodo, 2015). Program designs that tend to conflict with each other, such as the off-grid models owned by PLN and the Ministry of Energy and Mineral Resources, are different in terms of the amount of payment, even though the benefits are relatively similar (Sambodo, 2015). Also, solar PV components that are damaged are often difficult to replace, especially for imported components, and maintenance services are not yet available, especially to users who live in remote areas (Sambodo et al., 2016).

LEN Ltd is a state-owned enterprise that produces PVs at one of its business units. LEN Ltd started to produce solar PVs in 1997, and the production capacity has increased from 20 MWp to about 45 MWp in 2018. LEN Ltd also developed IPP and the first IPP was a 5 MWp in Kupang of East Nusa Tenggara (the first largest capacity). LEN Ltd also makes solar modules, solar power street lighting systems, solar trees, hybrid solar, grid-connected solar, centralized solar, and bidirectional inverters. However, LEN Ltd cannot fully support the PV program due to capacity constraints and lack of price competitiveness compared to imported goods. As a result, Indonesia imports key components of PVs from several sources, such as China, Hong Kong, Taiwan, Japan, and the United States.³⁰ The share of PVs in the total imports increased from 0.007% in 2010 to 0.027% in 2018. In particular, imports from China have shown an upward trend, reaching 70% in 2016 (Table 8.6). This indicates that China has become one of the important pillars for the development and utilization of PVs in Indonesia.

Table 8.6 Share of imports of main solar PV components from China (in million US\$)

<i>Year</i>	<i>Total Indonesian imports</i>	<i>Imports of Indonesian PV from the world</i>	<i>Imports of PV from China</i>	<i>Share of PV import to total import (%)</i>	<i>Share of import PV from China (%)</i>
2010	135,663.3	10.2	5.5	0,007	54
2011	177,435.5	13.1	7.8	0,007	60
2012	191,691.0	9.6	6.6	0,005	69
2013	186,628.7	17.5	9.8	0,009	56
2014	178,179.0	16.5	7.6	0,009	46
2015	142,694.8	27.2	15.1	0,019	56
2016	135,652.8	22.7	15.8	0,017	70
2017	156,985.5	33.0	16.2	0,021	49
2018	188,711.2	51.3	34.0	0,027	66

Source: BPS (2018).

The business strategy between LEN Ltd and Chinese companies shows competition and cooperation. LEN Ltd is aware that promoting investment in solar PVs is challenging. The Chinese policy to avoid cell trading and to promote module trading has affected domestic module production. The Chinese government gives support to the solar panel industry, enabling them to sell solar panels below the market price (Purushothaman, 2019). Then, European Union (EC) imposed anti-dumping duties to Chinese solar panels, and other countries, such as the USA and India, implemented similar duties (Purushothaman, 2019). China suspended its subsidies in the second half of 2018 and the government asked companies to bid at competitive prices.³¹ This situation has had an impact on Indonesia, which already has low technology capability in PV cell production. LEN Ltd can compete to produce modules with China, if China can export cells at the market price. On the other side, LEN Ltd has developed a business partnership with many of China's companies, such as CETC, CNBM, China Light Solar, Hareon Solar, Hollysys, JA Solar, and ZTE, in order to expand the production of solar PVs. By the end of 2019, President Director of LEN Ltd visited China to find a business partner with total investment of about IDR 1 trillion. However, more than a year later, there has been no significant progress on this investment plan, and it seems the Ministry of Energy and Mineral Resources of the Republic of Indonesia plans to issue a letter to speed up this project.³²

4.3 Governance

FTP-1 suffered from long delays due to legal issues (land procurement), construction problems (especially from local companies), frequent changes in project location, and lack of awareness of environmental assessment (Sebayang, 2015). It took almost eight years to complete installation of 8,947 MW or 90% of the target 9,975 MW (Sebayang, 2015), compared with 22 months to cover EPC in business as usual.³³ Long delays of project construction on FTP-1 have negatively impacted on Indonesia, both in terms of financial cost and availability of power supply.

First, it increased the external debt position of Indonesia to China. The total debt increased from US\$ 735 million in 2006 to US\$ 13.66 billion in 2015.³⁴ The FTP-1 projects amounted to US\$ 3,939 million (Shalati and Simanjuntak, 2019).³⁵ This implies that the FTP-1 project contributed 28.8% of Indonesia's total debt to China. Bank of China, Bank of China Limited, China Development Bank, the Export-Import Bank of China, and Barclay Capital were involved in financing the EPC projects in Indonesia (Shalati and Simanjuntak, 2019). China contributed about 61% of total investment of the first FTP project, while the rest came from Indonesia (especially PLN; Shalati and Simanjuntak, 2019). Because of government guarantees, PLN borrowed loans from domestic banks that covered 39% of the total project investment (Shalati and Simanjuntak, 2019).

Second, the delay increased financial problems for PLN and Indonesian taxpayers. Project delays led to extra cost. The Supreme Audit Agency indicated a financial loss in 2016 of IDR 606 billion or US\$ 79 million (Shalati and Simanjuntak, 2019). The Supreme Audit Agency also indicated budget waste due to high project costs of IDR 817 billion or US\$ 8.7 million (Shalati and Sumanjuntak, 2019). Then, there were others cost due to poor decision-making that reached 430 billion rupiahs or US\$ 36 million (Shalati and Simanjuntak, 2019). Thus, the total cost was 1.85 trillion rupiahs or US\$ 124 million. As a result, PLN imposed penalties on the EPC contractors of 705 billion rupiahs or US\$ 102 million (Shalati and Simanjuntak, 2019). However, both Indonesia and China were responsible for the delays, caused by land procurement, environmental concerns, incapability of domestic project contractors, planning and design, lack of best practices, poor quality of project conditions, and delay in project financing. This is why EPC contractors bore a portion of the penalty, and PLN and taxpayers were obliged to burden the rest.

One of the Indonesia-China IPP projects stumbled into a legal case. In the case of coal-mine mouth Riau-I (2×300 MW), PT PJB (Pembangkit Jawa Bali, subsidiary of PLN) appointed PT PLN Batu Bara, BlackGold, PT Samantika Batubara (subsidiary of BlackGold), and China Huadian Engineering, to form a consortium. By January 2018, they signed a letter of intent (LoI) to obtain agreement on power purchase. In July 2018, the Corruption Eradication Commission (KPK) arrested Eni Maulani Saragih. Eni was a member of parliament and KPK also arrested Idrus Marham, who was a Social Affairs Minister. Eni, for receiving a bribe from Johannes Kotjo, who was one of the owners BlackGold. The bribe was related to coal-mine mouth Riau-I.³⁶

The government was also aware that the quality of the projects was below standard. President Joko Widodo, in his speech to 300 entrepreneurs in Beijing (November 2014), mentioned the poor quality of steam coal power plants from China due to problems on both from Chinese and Indonesia sides.³⁷ In his discussion with President Xi Jinping, to measure the problem of the poor quality of steam coal power plants, President Xi Jinping suggested the leaseback solution and President Joko Widodo agreed to this. However, the trade union of PLN refused the proposal and said that the systemic failure of steam coal power plants was a form of fraud from EPC contractors.³⁸ Due to the poor quality of steam coal power plants from China, since 2015, China could not compete for any open EPC tender from PLN. Only OECD countries were able to join the tender, such as the expansion of steam coal Teluk Naga which was completed by Japan.³⁹ However, for IPP projects, China are allowed to join the tender because risks become the responsibility of the developer over the project for about 20–25 years.

Learning the lessons of FTP-1, the government adopted IPP in FTP-2 and the 35,000 MW Program. Although Chinese investors have actively participated in many IPP projects, they do not request government guarantees

for financing and investment, despite the fact that other countries do.⁴⁰ The perspective of the business sector from Indonesia indicates that there is still a lack of transparency and openness in the financial process and sometimes it is hard to implement.⁴¹ Inaccurate actions in calculating risk, and good understanding of the local bureaucratic context, has caused great harm to both the Indonesian and Chinese sides. For example, some projects have caused corruption in collaboration with Indonesian coal oligarchs or mobilized political power to accept joining tenders with poor quality projects. Finally, low technology standards and the lack of maximized utilization of local content and employment have been criticized by Chinese investors.⁴²

5 Discussion

The above analysis reveals that Chinese power investments in Indonesia generate two types of dilemmas. The first is a trade-off between availability, affordability, and sustainability. On the one hand, China has provided affordable technology, more simple procedures, and taken risks for host countries in order to enhance availability.⁴³ Due to the broad range of technology options, Chinese contractors tend to be more flexible in technological choice, taking financial, technical, and other constraints in host countries into account.⁴⁴ Since State-Owned Enterprises (SOEs) account for most of the investments, they face no problem with financial resources, and even in taking more risky projects, as long as host country governments offer credit guarantee.⁴⁵ Furthermore, China can offer more interesting business proposals, with affordable prices and international standards.⁴⁶ Marketing and representative officers from China were more aggressive in delivering business proposals both to government and the business sector in Indonesia.⁴⁷ China also develops large-scale hydropower plants. As a result, Indonesia has increased availability at a lower generation cost than oil power plants.

On the other hand, China reduced its commitment to finance the FTP-1 program from US\$ 3 billion to about US\$ 1.5 billion, due to unclear reasons, and did not listen to claims from the Indonesian government. The resulting delay imposed non-trivial burdens to electric utilities and taxpayers in the host countries, risking the financial sustainability. In addition, China has developed steam coal power plants at a time when OECD member countries raised environmental concerns and reduced financing for steam coal power.⁴⁸

Second, the dilemma is a trade-off between domestic industrial development, availability, and sustainability. The Indonesian government imposed local content requirement for the FTP projects: 70% for below 8 MW; 50% for 8–25 MW; 45% for 25–100 MW; and 40% for larger than 100 MW.⁴⁹ By November 2014, China had committed to developing 70 units of steam coal power plants with total capacity of 10,575 MW and a range of capacity between 7 and 600 MW per unit.⁵⁰ Among them, 91.5% was larger than 100 MW and thus were subject to 40% local content requirements. Most of the

small-scale projects are outside Java, and local developers used technology from China, such as steam coal Embalut, Kalimantan Timur 2×3 MW, Palu Tawaeli 2×17.5 MW, and many small-scale plants below 20 MW in Kalimantan and Sumatera.⁵¹ However, many small-scale coal power plant (less than 50 MW) projects have been delayed and some units canceled (PLN, 2019). Then, for the sake of efficiency, small-scale coal power plants have been constructed with a capacity of at least 50 MW. As a result, local content requirements for steam coal power plants were satisfied at the sacrifice of low efficient coal power plants generating a higher intensity of emissions.⁵²

In contrast, the requirement for hydropower and geothermal did not.⁵³ In addition, the Ministry of Industry Regulation No. 4 5/2017 imposed higher local content requirements for solar PVs, at 60%. However, this was not realistic for two reasons.⁵⁴ Local industry has insufficient capability to supply components, and insufficient product branding or quality, trust or loyalty, and switching costs did not raise the willingness to use local components. Meantime, China shows up as developers of large-scale hydropower projects, and as suppliers of solar PV components, so that Indonesian manufacturers, such as LEN Ltd, can be available for upscaling renewable energy, at the sacrifice of increasing imports and adverse environmental impacts.

6 Conclusions

Rising China has motivated leaders in developing countries to invite China to help them realize ambitious electricity programs, despite lagging behind in its investments in power projects in foreign countries. Against this backdrop, this chapter has focused on accessibility and affordability, sustainability, and governance, and has discussed the above three dimensions in relation to energy cooperation with China. The findings of this chapter can be summarized as follows.

First, Chinese investments in coal power plants enabled Indonesia to switch from an oil-based to a coal-based power supply, enhancing energy availability and affordability. China has offered a variety of technological options suited to economic conditions and natural resources. China has played a significant role in the provision of power supply through bilateral agreements which proactively invite China to invest in coal and renewable energy.

Second, China has strengthened ties with Indonesia in green investment and trade. The Indonesian government has also shown a strong desire to involve more national business actors in these fields while suffering from a trade-off between domestic industrial development and greening energy supply.

Finally, Chinese investments have generated challenges of governance, including huge economic losses due to delays in project implementation, and corruption that has accrued due to local business patterns and weak enforcement of regulations.

China's involvement in the supply of electricity to clean energy is still not optimal. The energy security analysis framework shows that the position of Indonesia has been trapped in high carbon emissions. This is because the government has taken a more compromising stance in pursuing the dimensions of availability and affordability and China can easily grasp the urgent need. Meanwhile, long-term consequences have not received adequate attention from the government.

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Notes

- 1 <https://iesr.or.id/batubara-dominan-pemerintah-diminta-evaluasi-bauran-energi-untuk-program-listrik-35-000-mw> [accessed 5 December 2020].
- 2 Shalati and Simanjuntak (2019).
- 3 Interview with Nasri Sebayang (former Director of Regional Business, PLN), 14 August 2020.
- 4 Interview with Nasri Sebayang (former Director of Regional Business, PLN), 14 August 2020.
- 5 By 2030, countries agree to ensure universal access to affordable, reliable, and modern energy services; to increase substantially the share of renewable energy in the global energy mix; and to double the global rate of improvement in energy efficiency.
- 6 This information was obtained from <https://www.seforall.org/system/files/2020-10/Analysis-SDG7-Progress-2020.pdf> [accessed 7 February 2021].
- 7 <https://www.esdm.go.id/id/berita-unit/direktorat-jenderal-ke-nagalistrikan/tahun-2020-puncak-program-35000-mw> [accessed 5 December 2020].
- 8 <https://katadata.co.id/febrianaiskana/energi/5ee22239ddc05/kementerian-esdm-pesimistis-bauran-energi-ebt-23-tercapai-pada-2025> [accessed 5 December 2020].
- 9 Kompas 15 December 2020.
- 10 Kompas, 14 January 2021.
- 11 Interview with Nasri Sebayang (former Director of Regional Business, PLN), 14 August 2020.
- 12 Ibid.
- 13 <https://majalah.tempo.co/read/laporan-khusus/133356/carilah-listrik-sampai-ke-cina>.
- 14 Interview with Nasri Sebayang (former Director of Regional Business, PLN), 14 August 2020.
- 15 It is based on the following calculation: $7,490: 16,330 = 46\%$.
- 16 Interview with Nasri Sebayang (former Director of Regional Business, PLN), 14 August 2020.
- 17 Ibid.
- 18 Ibid.

- 19 Interview with Zainal Arifin, Division of Engineering and Procurement Planning – PLN, 14 August 2020.
- 20 Interview with Nasri Sebayang (former Director of Regional Business, PLN), 14 August 2020.
- 21 Interview with Adrian Lembong, Director of Energy Technology, ADARO, 14 August 2020.
- 22 Ibid.
- 23 Interview with Nasri Sebayang (former Director of Regional Business, PLN), 14 August 2020.
- 24 AVR helps to regulate, adding, and stabilizing power voltage.
- 25 <https://www.floresa.co/2016/10/05/operator-ulumbu-mesin-made-in-china-jadi-biang-pemadaman-bergilir-di-manggarai/>.
- 26 <https://www.mongabay.co.id/2020/03/06/nasib-orangutan-tapanuli-dengan-kehadiran-proyek-plta-batang-toru/> [accessed 6 July 2020].
- 27 <https://www.antaranews.com/berita/1633246/lima-investor-berencana-bangun-plta-kayan-di-kaltara>.
- 28 For detailed discussion, please refer to Sambodo (2015), <http://efi.ui.ac.id/index.php/efi/article/view/505/530>.
- 29 According to ESMAP, there are six tiers of electricity access (0 to 5). Tier 1 is a cut point for non-energy poverty condition. Under Tier 1, minimum hours available per day is 4 hours; minimum power is 50 W, and minimum daily power capacity is 200 Wh.
- 30 HS 854140200, photocells, including photodiodes/photo-transistors; HS 854140290, Oth photocells, including photodiodes and phototransistors; HS 854140210, photovoltaic cells, not assembled; HS 854140220, photovoltaic cells, assembled in modules or made up into panels; HS 85414021, photovoltaic cells, not assembled; HS 85414022, photovoltaic cells, assembled in modules or made up into panels; HS 85414029, Oth photocells, including photodiodes & phototransistors.
- 31 Ibid.
- 32 Information was obtained from discussion with one of PT. LEN's staff by WhatsApp chat, 6 March 2021.
- 33 <https://media.neliti.com/media/publications/202361-analisis-percepatan-pekerjaan-fondasi-da.pdf> [accessed 5 December 2020].
- 34 Data from the External Debt Statistic of Indonesia, Ministry of Finance, February 2021. We assumed that by 2015, all loans that are related to FTP-I had been given.
- 35 This number is derived from Shalati and Simanjuntak (2019), Table 10.
- 36 <https://www.cnnindonesia.com/ekonomi/20180719123945-85-315366/proyek-pltu-mulut-tambang-antara-efisiensi-dan-penyimpangan> [accessed 5 November 2020].
- 37 <https://finance.detik.com/energi/d-2743804/jokowi-sindir-kualitas-pltu-buatan-tiongkok-proyeknya-mana-saja> [accessed 5 November 2020].
- 38 <https://www.dunia-energi.com/pltu-6-ribu-mw-buatan-china-mangkrak-bpk-diminta-audit-pln/> [accessed 5 November 2020].
- 39 Interview with Nasri Sebayang (former Director of Regional Business, PLN), 14 August 2020.
- 40 Interview with Nasri Sebayang (former Director of Regional Business, PLN), 14 August 2020.
- 41 Ibid.
- 42 Interview with Nasri Sebayang (former Director of Regional Business, PLN), 14 August 2020.
- 43 Interview with Adrian Lembong, Director of Energy Technology, ADARO, 14 August 2020.

- 44 Interview with Yudi Hidayat, Power Generation Technology & Renewable Energy Research PT. Indonesia Power, 14 August 2020.
- 45 Interview with Paul Butarbutar, Regional Director South Pole Group, 14 August 2020.
- 46 Interview with Zainal Arifin, Division of Engineering and Procurement Planning – PLN, 14 August 2020.
- 47 Ibid.
- 48 Interview with Yudi Hidayat, Power Generation Technology & Renewable Energy Research, Indonesia Power, 14–16 August 2020.
- 49 <https://www.kemenperin.go.id/artikel/499/Pembangunan-PLTU-Batubara-Harus-Memaksimalkan-Produksi-DN> [accessed 5 November 2020].
- 50 <https://finance.detik.com/energi/d-2743804/jokowi-sindir-kualitas-pltu-buatan-tiongkok-proyeknya-mana-saja> [accessed 5 November 2020].
- 51 Interview with Nasri Sebayang (former Director of Regional Business, PLN), 14 August 2020.
- 52 <https://katadata.co.id/arnold/berita/5e9a5576a6e61/selama-2018-hanya-pltu-yang-penuhi-target-penggunaan-produk-lokal> [accessed 5 November 2020].
- 53 <https://katadata.co.id/arnold/berita/5e9a5576a6e61/selama-2018-hanya-pltu-yang-penuhi-target-penggunaan-produk-lokal> [accessed 5 November 2020].
- 54 <https://katadata.co.id/febrianaiskana/energi/5e9a50d693216/kirim-surat-ke-darmin-asosiasi-minta-empat-regulasi-ebt-direvisi>.

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