Clean at Home, Dirty Abroad: China's Role in Southeast Asia's Subcritical Coal Expansion

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May 2019

EAI Working Paper

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Introduction

Chinese companies and development banks are playing an increasingly impactful role in global infrastructure development. Domestically, China is reaching the point where economic growth rates are slowing and Chinese firms can often find better infrastructure investment opportunities abroad than they can at home. Through the Belt and Road Initiative, Beijing is providing a mix of diplomatic and financial aid to help Chinese firms find those opportunities in nations ranging from Southeast Asia to Africa to Europe. The types of technologies and projects China brings to those nations will have an outsized impact on the global economy for decades to come.

Chinese firms are particularly active in energy infrastructure. China is the world's biggest energy consumer, and it is undergoing a massive domestic transition toward cleaner energy sources (Hart, Bassett, and Johnson 2017). Chinese firms are global leaders across multiple renewable energy sectors—particularly wind and solar—as well as in next-generation clean coal technologies. If China leverages its domestic energy innovations to help other nations avoid installing low-efficiency, pollution-intensive coal, that will enable recipient nations to avoid the high economic, social, environmental, and climate costs associated with those projects. At a global level, if China pushes the next wave of energy infrastructure expansion toward more sustainable technologies, that will help the planet avoid some of the most disastrous impacts from global climate change.

Unfortunately, this is not the approach China is taking today. Instead of helping developing nations acquire, install, and operate innovative cleaner energy technologies, China is driving a massive build-out of high-emission subcritical coal plants. Instead of pulling other developing nations up to help them achieve China's own domestic standards, China is treating many nations as a dumping ground, offloading outdated coal generation technologies that are too inefficient and pollution-intensive to use at home.

Chinese officials and development experts often argue that China is providing the cheapest alternatives because that is what lower-income nations want. That approach is short-sighted. It fails to account for the mid- and longer-term costs associated with sub-standard projects. Indonesia's experience should serve as a warning for Beijing. After purchasing a first wave of sub-critical coal plants from China, Indonesia is now looking to other nations to support future energy infrastructure expansion.[1] If China does not change its approach, negative impacts from the first wave of Belt and Road energy investments could outweigh the positive impacts. That could be particularly consequential in Southeast Asia, which is one of the fastest-growing energy consuming regions in the world and a key focus for China's Belt and Road Initiative. This paper will describe China's current approach

[1] Autor interviews, Jakarta, Indonesia, April 2017.

to energy development in Southeast Asia and the downside risks associated with that approach.

China's Approach to Coal-Fired Power Development

Coal-fired power plants use the heat from coal combustion to generate electric power. The process varies depending on the type of generation technology used.[2] In general, higher heat rates improve plant efficiency—the amount of power produced per unit of coal—and reduce emissions. There are three categories of coal-fired power generation technologies: subcritical, supercritical, and ultra-supercritical. Subcritical plants are conventional plants. They burn coal at lower heat rates and produce the most air pollution and carbon emissions per unit of electricity. Supercritical plants use higher heat rates to increase plant efficiency and reduce emissions. Ultra-supercritical plants use newer technologies to produce the highest heat rates and achieve the best efficiency and emission performance ratings.

Domestically, China is transitioning its coal-fired power fleet from older, high-polluting subcritical coal-fired power units to newer and cleaner supercritical and ultra-supercritical units (Hart, Bassett, and Johnson 2017). Chinese regulators are using a mix of efficiency standards, emission regulations, and mandatory subcritical plant retirements to drive this shift. The regulatory measures are impressive. By 2020, all existing Chinese coal-fired power units must meet an efficiency standard of 310 gce per kilowatt-hour. To put that in comparison with the U.S. coal fleet: no existing U.S. coal-fired power unit is performing at those efficiency levels today (Hart, Bassett, and Johnson 2017).

China's domestic coal transition is making the nation a world leader in supercritical and ultra-supercritical coal-fired power technologies. If China leverages its growing international role to bring those technologies to other nations, that could help other nations avoid building out more pollution- and carbon-intensive coal plants. China is particularly active in developing nations that are unable to meet the high project standards required to obtain financing from the World Bank and other western-led development banks (IMF 2018). Many of those lower-income nations are currently experiencing the rapid growth rates associated with early-stage economic development and, in order to fuel that growth, rapid energy infrastructure expansion. The generation technologies these nations choose will have an outsized impact on their local environmental conditions and the global climate for decades to come. China is well-placed to push that expansion in a sustainable direction.

Unfortunately, Beijing is thus far taking a different approach. When Chinese banks and firms go abroad, they tend to follow a bifurcated strategy: they bring cutting-edge energy technologies to developed markets and cheap, outdated technologies to developing markets. In the energy sector, that strategy risks saddling developing regions with severe local environmental pollution and skyrocketing carbon emissions. As Beijing tightens China's domestic coal-fired power standards, Chinese firms can no longer build subcritical plants at home so many of them are sending those technologies abroad. In some cases Chinese firms are actually dismantling outdated coal-fired power plants and exporting them to developing nations.[3] At a global level, if China continues to export outdated energy technologies that will make it harder to slow and reduce global climate change.

Beijing does not provide transparent data on either the size or impact of its international development

[2] Duke Energy, "How electricity works: energy from coal," available at https://www.duke-energy.com/energy- education/how-energy-works/electricity-from-coal (last accessed April 2017).
[3] Author interviews, Jakarta, April 2017.

activities. Researchers seeking to map China's international development footprint must gather that data through a combination of open sources and commercial databases.[4] Boston University's Global Economic Governance Initiative tracked China Development Bank and China Export-Import Bank financing from 2001 and 2016 and discovered that those two banks supported over 50 coal-fired power plants in other nations during that 15-year period, of which 58 percent used subcritical technologies (Gallagher 2016). Over the next three decades, this group of 50 coal-fired power plants is projected to emit over 17 thousand metric tons of carbon dioxide, which is more than the combined U.S. and Chinese annual carbon emissions today (Hart, Ogden, and Gallagher 2016).

Chinese leaders have resisted signing on to multilateral agreements and standards that would limit the types of coal-fired power technologies China's state-owned policy banks could fund in other nations. Chinese leaders and development experts often argue that imposing sustainability standards on cross-border energy infrastructure projects increases project costs, sometimes beyond what the recipient nation can afford. They argue that, for some developing nations, subcritical coal-fired power technology is the only financially-viable option and if China does not support those projects with financing, technology components, and construction expertise, the recipient nation would be more likely to face critical power-supply bottlenecks that would drag down economic growth. Those arguments tend to overlook or downplay the costs these projects accrue over time, including environmental costs, climate costs, and long-term operational costs (i.e., since sub-critical plants are less efficient, they consume more coal and are thus more expensive to run). Those costs are likely to be particularly consequential in Southeast Asia.

Southeast Asia's Energy Expansion

Southeast Asia is one of the fastest-growing energy consumption regions in the world and is launching a major energy infrastructure boom.[5] The region's per capita energy use is still relatively low, at 0.13 tons of oil equivalent as of 2013. That consumption rate is expected to more than double by 2035 as economic development expands energy access and consumption ability across the region (ASEAN Center for Energy 2015). Population is also projected to grow rapidly and that will further drive electricity consumption growth. Between 2015 and 2040, the region's overall energy demand is projected to grow 80 percent and power consumption is projected to triple.[6] By 2025, the region is expected to add around $1.5 trillion in new energy infrastructure to supply its growing demand. Energy technology choices made during this massive infrastructure expansion will have an outsized impact on the region's energy efficiency, sustainability, and climate emissions for decades to come.

As of 2013, the ASEAN region generates 821 TWh of electricity, of which natural gas accounts for 44 percent, coal 31.5 percent, and oil 4.16 percent (ASEAN Center for Energy 2015). Although natural gas dominates in installed capacity, the region is rapidly shifting toward coal, and coal already outpaces natural gas in new-builds. By 2035, coal is projected to account for around 55 percent of the region's electricity generation (accounting for 30 percent of total global coal growth through 2035). By 2040, the region will likely consume as

[4] For example, see: Axel Dreher, Andreas Fuchs, Bradley Parks, Austin M. Strange, Michael J. Tierney, "Aid, China, and Growth: Evidence from a New Global Development Finance Dataset," AIDDATA Working Paper 46, October 2017, https://www.aiddata.org/publications/aid-china-and-growth-evidence-from-a-new-global-development-finance-dataset.

[5] Southeast Asia is defined here as the region composed of the members of the Association of Southeast Asian Nations (ASEAN), which include Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam.

[6] IEA and ERIA, Southeast Asia Energy Outlook (World Energy Outlook Special Report), September 2013, http://www.iea.org/publications/freepublications/publication/SoutheastAsiaEnergyOutlook_WEO2013SpecialReport.pdf

much coal as India today. As a result, the region's energy-related carbon dioxide emissions are projected to double by 2035.[7]

Renewable energy is also growing – as of 2013, installed renewable energy generation capacity totaled 45.7 GW and accounted for around 21 percent of total electricity generation. All ASEAN nations have renewable energy targets and policies, but coal still enjoys substantial policy support, partly because the region is rich in coal resources and partly because coal production interests heavily influence energy policy in many ASEAN nations.

The IEA estimates that Southeast Asia will require over $1.5 trillion in energy supply infrastructure investments through 2025 to meet rising demand. Foreign direct investment played a large role in the region's previous infrastructure expansions and is likely to play a large role in the next round as well.[8] From 2013 to 2035, ASEAN economic growth is expected to average around 6.1 percent annually, and ASEAN coal and natural gas use is expected to grow by 7.0 percent and 5.5 percent, respectively. For outbound investors in nations facing much slower growth rates, those growth projections make Southeast Asia an increasingly attractive investment destination.

Chinese companies are particularly active in the region. Unfortunately, in the coal sector, most of the Chinese projects are bringing subcritical coal, saddling recipient nations with longer-term efficiency and environmental costs that could become a drag on local economic growth as well as a disaster for the global climate.

China's Role in Southeast Asia's Sub-Critical Coal Expansion

The Southeast Asian region can be divided into three tiers based on individual nations' development level and investment climate.

1. Higher income: Singapore ($57,714 GDP per capita in 2017), Malaysia ($9,944 GDP per capita) and Brunei ($28,290 GDP per capita) are the most developed nations in the region; they offer lower political risk as well as lower investment returns.[9]
2. Mid-tier: Thailand ($6,593 GDP per capita in 2017), the Philippines ($2,998 GDP per capita) and Indonesia ($3,846 GDP per capita) occupy the middle tier; their rapid growth rates make infrastructure investments very attractive, but political risks (including an inability to meet some global regulatory standards) can deter some investors.
3. Lower-income: The "CLMV" nations—Cambodia ($1,384 GDP per capita), the Lao People's Democratic Republic ($2,457 GDP per capita), Myanmar ($1,298 GDP per capita) and Vietnam ($2,343 GDP per capita)—offer fast-rising growth rates along with mixed political risks.

[7] By 2035, the region's carbon emissions are projected to reach 2.3 Gt. IEA and ERIA, Southeast Asia Energy Outlook (World Energy Outlook Special Report), September 2013, http://www.iea.org/publications/freepublications/publication/SoutheastAsiaEnergyOutlook_WEO2013SpecialReport.pdf

[8] "ASEAN Investment Report 2016: Foreign Direct Investment and MSME Linkages," the ASEAN Secretariat and the United Nations Conference on Trade and Development, September 2016, http://asean.org/storage/2016/09/ASEAN-Investment-Report-2016.pdf.

[9] All 2017 GDP per capita data from the World Bank, available at: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=TH.

Chinese companies are engaged in energy infrastructure development across all three income tiers. That engagement takes multiple forms including project finance, providing technology components, and construction services. Chinese companies are primarily bringing and building sub-critical coal technology, regardless of the host nation's income level.

Below, Table 1 tallies the number of coal-fired power units Chinese companies are supporting across all three Southeast Asian income tiers and over time. It is not surprising to see subcritical plants in the 1996-2005 time-frame because cleaner plants were less available. However, the post-2015 project pipeline is a concern, because those plants are under construction in an era when the Southeast Asian region is undergoing a major energy boom, cleaner options are more available, and Beijing is banning sub-critical technologies domestically.

Chinese firms are beginning to bring some cleaner projects to the region. As of 2016, Chinese companies had participated in 4 cleaner-coal projects, with another 17 in the pipeline. However, China is much more active on the subcritical side, with 154 units completed and another 75 in pipeline as of 2016.

Table 1: Chinese Involvement in ASEAN Coal-Fired Power Development

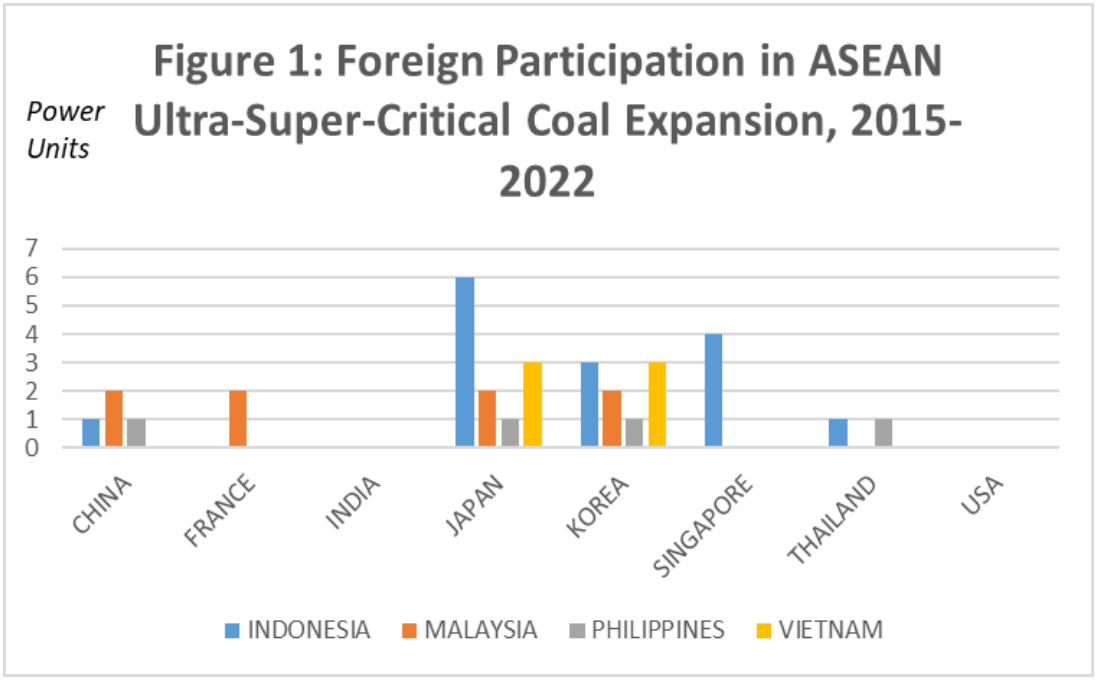
	1996-2005		2006-2015		Post-2015*	
Lower-Income	USC Units:	0	USC Units:	0	USC Units:	0
	SuperC Units:	0	SuperC Units:	2	SuperC Units:	6
	Sub-C Units:	0	Sub-C Units:	32	Sub-C Units:	12
Mid-Tier	USC Units:	0	USC Units:	0	USC Units:	2
	SuperC Units:	0	SuperC Units:	1	SuperC Units:	8
	Sub-C Units:	6	Sub-C Units:	101	Sub-C Units:	60
Higher-Income	USC Units:	0	USC Units:	1	USC Units:	1
	SuperC Units:	0	SuperC Units:	0	SuperC Units:	0
	Sub-C Units:	9	Sub-C Units:	6	Sub-C Units:	3

Source: Center for American Progress analysis using data from S&P Global Platts.
Note: The "post-2015" category includes plants operating in 2016 and early 2017 but is mostly composed of plants under construction or planned for 2017-2021. This chart does not include plants that were retired or canceled before 2016.

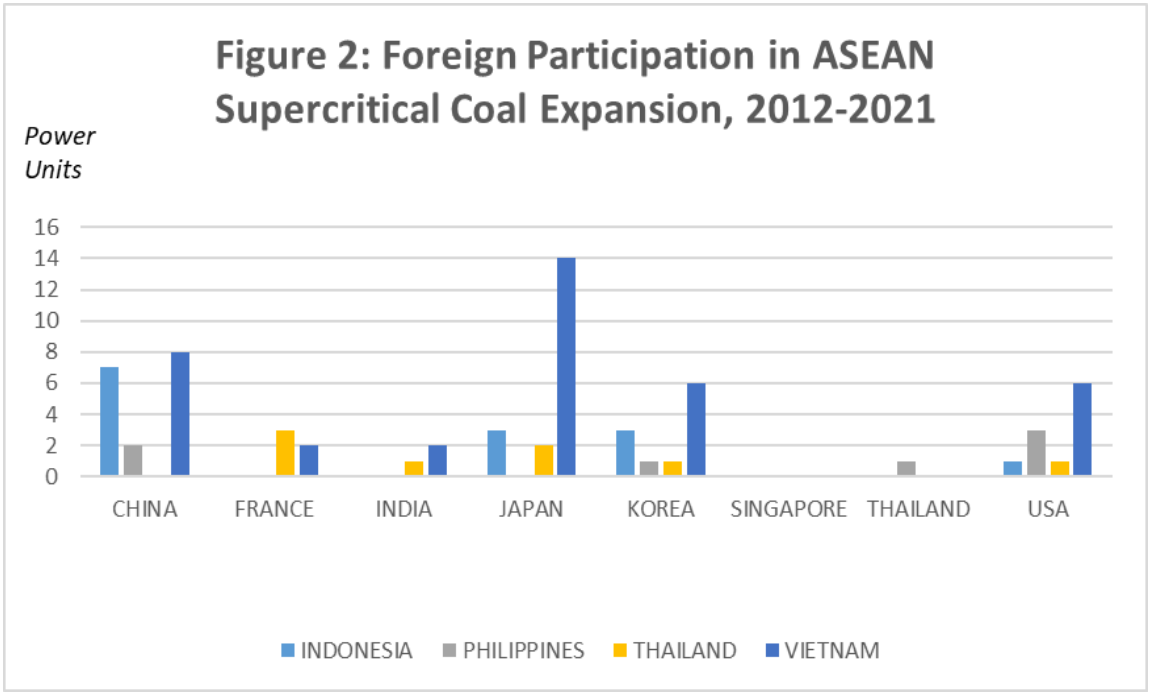
Chinese officials and development experts routinely claim Chinese firms are simply providing what the recipient nations can afford and once those nations can afford cleaner technologies, Chinese companies will be delighted to provide them.[10] However, the reality is that other major development funders are already building cleaner projects in nations where China is still actively promoting subcritical coal. For example, Japan currently has sixteen ultra-supercritical coal-fired power projects underway in the region while China has only three.

Across Southeast Asia, government officials describe China as the primary provider of low-cost, low-tech energy solutions and Japan and South Korea as the primary providers of higher-tech, lower-emission technology.[11] China has been particularly active in Indonesia. That nation's experience with Chinese subcritical coal technology highlights some of the downsides that are likely to emerge if China continues to push low-tech options instead of seeking ways to help developing nations leapfrog to more sustainable infrastructure.

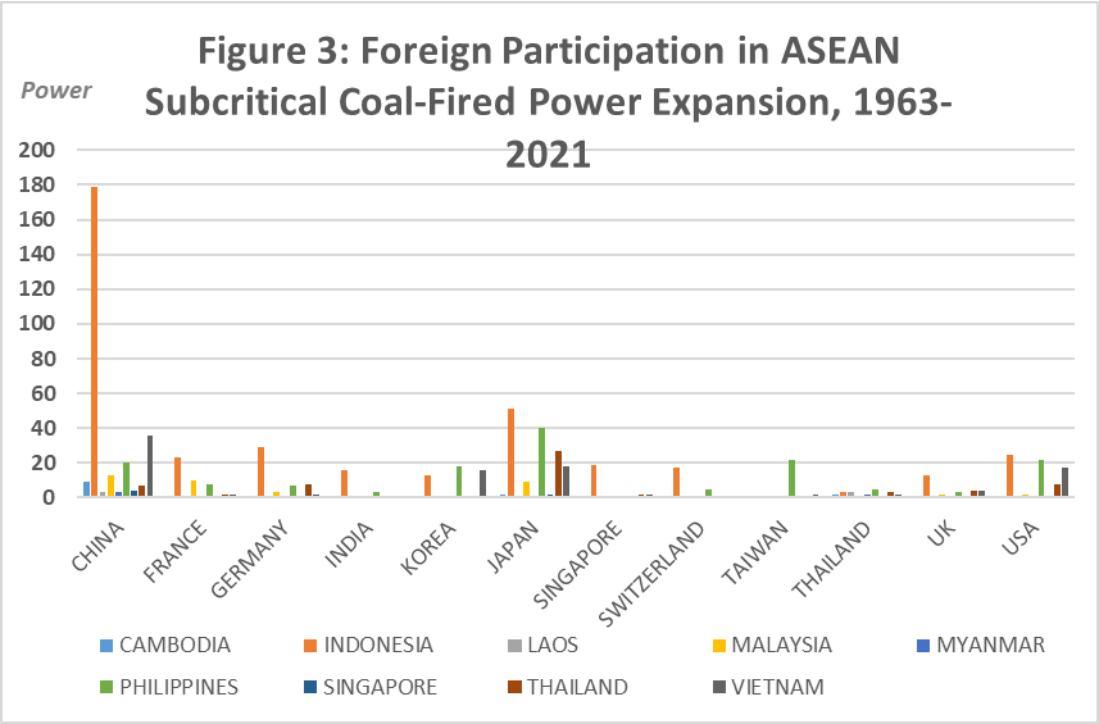
[10] Center for American Progress exchange with Asia Infrastructure Investment Bank (AIIB) leadership, Beijing, March 2015. Author interview with China Ministry of Finance leadership, March 2016.
[11] Author's field interviews in Indonesia and Malaysia, April 2017.



Source: Center for American Progress analysis using data from S&P Global Platts.
Note: Figure includes plants in operation as of December 2016 and those under construction or planned through 2022 as of early 2017.



Source: Center for American Progress analysis using data from S&P Global Platts.
Note: Figure includes plants in operation as of December 2016 and those under construction or planned through 2021 as of early 2017.



Source: Center for American Progress analysis using data from S&P Global Platts.
Note: Figure includes plants in operation as of December 2016 and those under construction or planned through 2021 as of early 2017.

Lessons from Indonesia

In 2004, the government of Indonesia announced an ambitious plan—dubbed the "10,000 MW Crash Program"—to add 10,000 MW of coal-fired generation capacity to the nation's electricity system by 2010.[12] Indonesia's generation capacity was not keeping pace with rising electricity demand and black-outs were becoming a persistent problem, dragging down production and growth across the economy. Susilo Bambang Yudhoyono had just become the nation's first directly-elected president and taking action to prevent a massive power-supply crisis was a major political imperative for his administration. At that time, the new administration viewed coal as the obvious solution to the nation's power problems. Coal is abundant in Indonesia and the nation's natural gas and oil supplies were increasingly being sucked up by the global market, leaving gas-and oil-fired power facilities scrambling to secure affordable inputs. Furthermore, coal production is backed by powerful political interests, so policies that aim to expand the nation's coal consumption are always easier to pass and implement than policies aimed at reducing coal use.

Indonesian officials were particularly concerned about project costs. Indonesian state-run energy company Perusahaan Listrik Negara (PLN) was responsible for implementing over half of the 10,000 MW expansion, and PLN viewed China as the most cost-effective component and financing provider. Chinese companies promised to build 600 MW coal-fired generation units at $700,000 per MW, or 30 percent below prevailing market rates

[12] Harvard Kennedy School Indonesia Program, "From Reformasi to Institutional Transformation: A Strategic Assessment of Indonesia's Prospects for Growth, Equity and Democratic Governance," April 2010. http://unpan1.un.org/intradoc/groups/public/documents/UN-DPADM/UNPAN042322.pdf.

(McBeth 2016). Nearly all of the 10,000 MW program went to Chinese firms. Problem was, Chinese firms managed costs by delivering low-quality generation technology. They provided around 35 coal-fired power plants to meet the 10,000 MW total. All used subcritical technology. Many were old coal-fired power units dismantled in China and re-assembled in Indonesia to save costs and wring more profit out of aging and retiring domestic Chinese coal-fired power units. Some of the boilers used in those plants did not actually match the type of coal that is plentiful in Indonesia. The end result was that the 10,000 MW project was a disaster that the Indonesian government is still working to clean up. In addition to producing high particulate air pollution and carbon emissions, the fleet of Chinese coal plants does not produce the amount of power promised.

Indonesian officials and energy experts admit that the Chinese firms who provided subcritical coal-fired power units for the 10,000 MW program were delivering what Indonesia was asking for, which was a low-cost solution.[13] Indonesian officials report that Japanese and South Korean firms tend to walk away and refuse to build plants at ultra-low price points, but Chinese firms are more likely to try to make things work, which sometimes brings bad consequences.[14]

Today, Indonesia recognizes that subcritical coal technology is a bad investment, particularly when subcritical plants are manufactured using out-of-date and/or second-hand components. Under current Indonesian President Joko Widodo, Jakarta has announced a new planned 35,000 MW expansion in generation capacity, which is supposed to include cleaner coal technology as well as renewables. In theory, the 35,000 MW expansion would be great opportunity to bring in China's more cutting-edge technology solutions. In reality, however, recent field interviews suggest that Indonesian officials are largely avoiding Chinese technology in this round due to the government's experience with previous Chinese-financed and Chinese-manufactured subcritical coal-fired power expansions.[15] Instead, local officials report that they are looking primarily to Japan and South Korea for cleaner alternatives.

The Indonesian case suggests that when China provides low-cost, high-emission systems to developing markets, medium-to-longer term performance or sustainability problems may not only affect those nations' climate and emission trajectories but also impact their openness to choosing Chinese technologies as they move up the economic development ladder.

Chinese officials are assuming that, by providing low-cost solutions today, they will have an opportunity to provide cleaner, higher-performing solutions down the road. In reality, negative experiences with first-round Chinese development projects could turn recipient nations away from future Chinese projects. If so, that trend has the potential to undermine China's position as a low-emission technology provider across the region, despite the fact that China has already developed impressive technology innovations at home and has much to offer, not only in the coal sector but also in renewable energy technology.

Going Forward: Can China Avoid Building a Dirty Belt and Road?

China's development programs are filling energy infrastructure needs across Southeast Asia. In less-developed nations such as Cambodia, China is often the only alternative, as Chinese firms are generally more willing than firms from the United States, Japan, and other developed nations to build and fund projects where political risks

[13] Author interviews, Jakarta, April 2017.
[14] *Ibid.*
[15] *Ibid.*

are high.[16] China should be commended for stepping in to address the region's infrastructure needs. However, if Chinese involvement locks those nations into sub-standard energy infrastructure with high social and environmental costs, China's role is significantly less beneficial.

There are two potential pathways for Chinese involvement in Southeast Asia's energy infrastructure expansion going forward. China could continue with the status quo approach, pushing low-standard technologies in less-developed regions and reserving China's most innovative energy technologies for higher-income nations that can afford to pay higher up-front project costs. The backlash that China's subcritical coal projects are already generating across Indonesia suggests that, if China pursues this approach, it will become a less attractive development partner over time. Once recipient nations gain the ability to pay for higher-standard projects, they may follow Indonesia's example and turn to other nations instead of seeking to upgrade with a new generation of Chinese products. That would be particularly unfortunate in the coal sector because, as China transitions its domestic energy sector toward cleaner coal generation, it increasingly has cutting-edge technology and operational knowledge that could benefit Southeast Asian nations.

Alternatively, China could change its approach and seek to leverage the Belt and Road Initiative and other state-supported programs to help developing nations leapfrog up to the same standards China is implementing domestically. That would require a mix of capacity building—to help recipient nations understand the full array of innovative technologies available and how to deploy them in their own markets—as well as innovative financing to help those nations meet the higher up-front costs associated with cleaner projects. This approach would shift the role China is playing as an international infrastructure developer, providing increasing rather than decreasing opportunities for Chinese investment over time. This approach would also provide broad regional and global benefits, particularly on the climate front.

The international community has a role to play as well. Currently, under Trump administration leadership, the United States is pressuring other nations to avoid Belt and Road funding without putting alternatives on the table to give those nations a wider array of low-cost energy infrastructure options. Instead of forcing developing countries to choose between affordability and sustainability, the United States should work collaboratively with other nations to develop common standards for infrastructure development projects. In the energy sector, for example, the OECD and the World Bank have adopted sustainability standards for coal-fired power projects, but China's development banks have not. That initiative should also include regional transparency platforms to give the international community and local civil society the ability to see what lenders are building and how project standards compare to those underway in other nations or regions. For example, the United States could work with ASEAN to help the region develop a transparency platform were all lenders—not only China but also the multilateral development banks and other nation-state lenders—must share information about proposed projects. That information should include not only a project's technical, environmental, and social governance standards, but also the terms of the grants or loans involved.

Conclusion

China's approach to overseas energy infrastructure development is a logical one: Beijing aims to provide what

[16] Center for American Progress field research in Cambodia, August 2017.

recipient nations ask for. When those nations ask for low-cost projects, Beijing fills that need with low-end technology; when nations ask for clean projects, Beijing provides higher-end technologies at a higher price. There are two problems with that approach. From an environmental standpoint, when China builds high-emission coal plants across the developing world, that locks developing nations in to infrastructure that is not environmentally sustainable, producing negative impacts at a local, regional, and global level. From the standpoint of China's diplomatic interests, this approach risks defining China as the low-cost dirty energy provider; when nations seek better alternatives, they may pivot to other nations, bypassing some of the low-cost cleaner energy solutions that Chinese firms are already producing. Going forward, broader international engagement will be needed to help developing nations—and China—find the right balance between cost and sustainability. ■

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This working paper is the result of research activity of East Asia Institute's Future of China and Regional Order in the Asia-Pacific Research Group.

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