Agora Energiewende

DOCUMENTATION

Low-carbon transition of states and state-owned power companies

Briefing Report

Please cite as:

Agora Energiewende (2024): Briefing Report – Low-carbon transition of states and state-owned power companies.

Written by
Agora Energiewende
Anna-Louisa-Karsch-Straße 2
10178 Berlin | Germany
P +49 (0) 30 7001435-000
www.agora-energiewende.org
info@agora-energiewende.de

Project lead
Run Zhang-Class
run.zhang@agora-energiewende.de

Authors
Run Zhang-Class
Denny Hidayat

Date: November 2024

Acknowledgements

The authors are incredibly thankful to all the experts who contributed their valuable insights to this briefing report. Completing it would not have been possible without the input from those who participated in the conference on 27–28 September 2023 and the enriching discussions that followed. The authors sincerely appreciate the open and constructive exchanges throughout the process.

Special thanks go to Philippe Benoit, Dr. Alex Clark, Prof. Michael Davidson, Christopher Beaton, Siddharth Goel, Melissa Brown, Clorinda Wibowo, Varinthon Kessayom, Lixue Lin-Siedler and colleagues at Agora Think Tanks – Dr. Tharinya Supasa, Chidchanok Mekkajornwong, Mathis Rogner, Zaffar Hussain, Mareike Herrndorff, Ernst Kuneman, Simon Müller, Dr. Ming Yin, and particularly Markus Steigenberger, Kevin Tu and Dimitri Pescia, for their unwavering support of this project.

The authors are profoundly grateful to Émeline Spire, Karin Kritzinger, Ernst Kuneman and Laura El-Katiri at Agora Energiewende, as well as Anders Hove and Mengyuan Zhang, whose valuable reviews greatly enhanced this briefing report.

Last but not least, a heartfelt thank you to Maia Haru Hall, Anja Werner, Alexandra Steinhardt, Maxi Matzanke and Dr. Jahel Mielke, whose strong support and efforts made the presentation of this project possible.

Content

Introduction

This report summarises the second conference on the low-carbon transition of state-owned power companies (SPCs) that focused on the challenges facing SPCs and the measures needed to accelerate their low-carbon transition. The report highlights multiple obstacles that need to be addressed, including finance, market reforms and data transparency. It provides seven takeaways based on the contributions of conference participants, including presentations, discussions and debates, along with subsequent exchanges and supporting research.

State-owned power companies (SPCs),[1] both in emerging economies and in OECD countries, are at the forefront of the transition to decarbonised energy systems.[2] These entities play a pivotal role in their respective national economies, whether as monopolies in vertically integrated electricity systems or as dominant players in competitive markets. They generally own substantial fossil fuel assets. Many are also major investors in renewable energy sources or are responsible for building the grid infrastructure necessary to integrate renewable energy.

All scenario pathways for achieving the global 1.5-degree climate target have featured renewable electricity as a key strategy. For example, the International Energy Agency's (IEA) Net Zero Emissions by 2050 (NZE) Scenario anticipates a significant shift in the global energy landscape, with electricity's contribution to total final energy consumption worldwide projected to surge from 20 percent in 2023 to 49 percent by 2050.[3] In this context, the electricity sector globally is expected to achieve net-zero emissions by 2040 to accelerate deep decarbonisation across all sectors and the entire value chain, predominantly through wind and solar photovoltaic (PV) sources, which are projected to generate 68 percent of electricity globally by 2050.[4] This transformation vision contrasts starkly with the current situation. Wind and solar PV collectively accounted for merely 13 percent of global electricity generated in 2023. 2023 also marked a record high in electricity generation-related carbon emissions, which constitute 38 percent of global emissions.[5]

1 There is no standard definition of an SPC. This report takes an SPC to mean a utility established or nationalised by its national government with more than 50 percent shareholding, potentially in competition
2 OECD: Organisation for Economic Cooperation and Development
3 International Energy Agency (2024a)
4 International Energy Agency (2021a)
5 Ember (2024)

Given the importance of SPCs in decarbonising the global economy, ensuring they can support the clean energy transition requires a detailed understanding of how SPCs operate, the challenges they face and how their actions and decisions are coordinated with those of other players.

Against this background, Agora Energiewende (Agora) has organised two convenings on SPC low-carbon transition since 2022. These in-person gatherings have fostered dialogue among SPCs, civil society organisations and the academic community globally, focusing on the barriers and prospects associated with SPCs' transition to low-carbon energy sources.

The first SPC Low-Carbon Transition Conference was held in Berlin on 28-29 September 2022. It aimed to identify the drivers, inherent operational challenges and status of the SPC low-carbon transition, and to help foster community exchange by mapping the landscape of stakeholders working on this topic. Nearly 30 stakeholders from think tanks, universities, consultancies and utilities including SPCs contributed to the discussions. The discussion focused on the following jurisdictions: South Korea, China, Indonesia, India, Türkiye, Poland, South Africa and Mexico. These countries accounted for over half of global emissions from electricity,[6] and their governments have substantial control over the electricity sector. As an output of the first convening, a **briefing report** highlighted the following points:

- → Three major forces are pushing SPCs towards a low-carbon transition: policies led by national-level climate goals, financial market consensus favouring sustainable investments and the potential to grow profits by reducing long-term costs and enhancing competitiveness in new fields of clean energy.
- → However, SPCs face significant challenges, such as complex governance structures with conflicting stakeholder interests, potentially high system costs regarding coal phase-out and the social implications of transitioning from fossil fuels.
- → To overcome these issues, SPCs need clear and consistent political guidance, financial incentives and risk-sharing instruments for projects that, by their nature, are riskier and harder to assess than traditional investments and hence often face difficulties accessing finance.
- → Multisectoral and multilateral engagement, including alliances with other industries and international stakeholders, can facilitate knowledge-sharing and access to funding and technical support.[7]

The second SPC Low-Carbon Transition Conference was held in Bangkok on 27-28 September 2023. The conference explored ways to address security of electricity supply and affordability during the energy transition. The role of fossil gas in the energy transition was sharply debated. The conference also discussed the financing of SPCs' low-carbon transitions, with a particular emphasis on Just Energy Transition Partnerships (JETPs) and the role of China. The convening encompassed a range of countries – South Korea, China, Indonesia, Thailand, India, South Africa and Mexico – where the issues above are particularly pertinent. Almost all the countries involved are among the world's top 15 carbon emitters. The specified countries collectively accounted for over half of global carbon dioxide emissions from electricity in 2023.[8] [9] Nearly 30 stakeholders from SPCs, government-affiliated organisations, financial institutions, think tanks, universities and consultancies participated in the conference.

6 Ember (n.d.)
7 Agora Energiewende (2023)
8 Tiseo (2023)
9 Ember (n.d.)

Key takeaways from the second SPC Low-Carbon Transition Conference (the 2nd Conference):

1. The role of fossil gas as a transitional fuel is contentious. SPCs lacking upstream gas ventures and countries with limited resources and infrastructure could consider leapfrogging from coal to renewables. This approach avoids the financial and environmental risks associated with reliance on gas as a bridge fuel.

2. To ensure resource adequacy, the phase-in of renewables needs to coincide with the phase-out of coal. Resilient grid resources are crucial for integrating variable renewables (VREs) and maintaining system security. Reforming regulatory frameworks and tariffs would unlock greater investment in global power sector infrastructure.

3. It is essential to understand the specific business model challenges SPCs face in investing in system upgrades to accelerate VRE integration. It is also crucial to identify the gaps between current market designs and mechanisms that can provide long-term investment certainty.

4. To a certain extent, multilateral financial mechanisms such as JETPs can address financial challenges in electricity system investments, particularly in the short term, where profitable business models are yet to be established.

5. China, via the Belt and Road Initiative (BRI), may play a role in financing power decarbonisation efforts in some countries, especially in early retirement of coal plants.

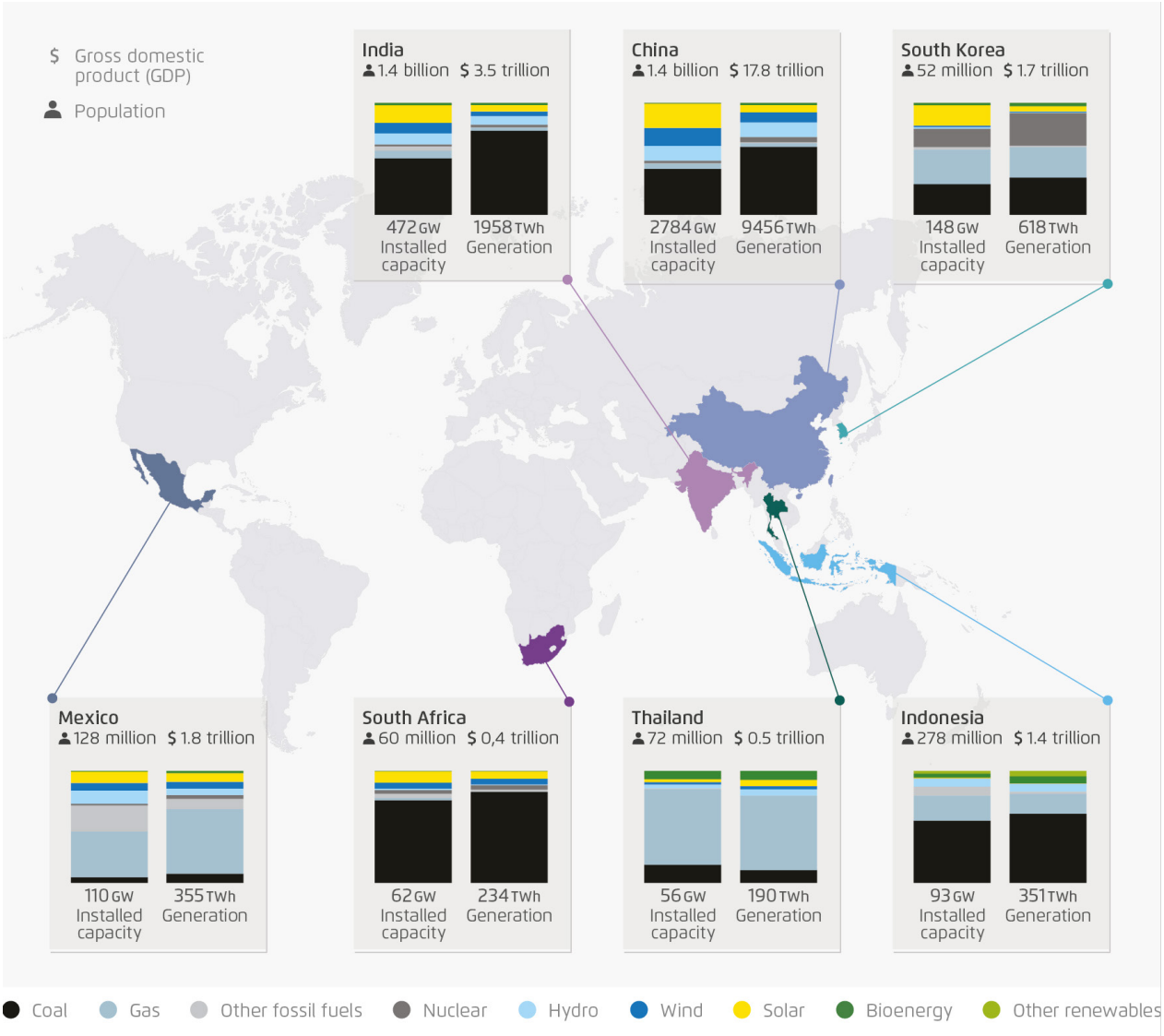
6. Seeking consensus among stakeholders is crucial for the successful transition of states and SPCs. Factual data and modelling tools are also essential.

7. Data transparency is a prerequisite for comprehensive analysis of resource adequacy and system security. Transparency enables stakeholders to identify areas for improvement at the SPC and the national levels, and it helps investors and financiers make informed decisions towards a more secure, equitable and sustainable electricity system.

Country context matters when discussing SPCs

In the countries examined in this report, SPCs maintain control over a large share of electricity generation, particularly from fossil fuels. In some cases, they are competing with an increasing number of renewable energy independent power producers (IPPs). SPCs are primarily responsible for securing present and future electricity supply. Furthermore, SPCs are tasked with withstanding external shocks and ensuring resilience within vertically integrated systems. Profitability has also become a key performance indicator for the management in some SPCs.

Top emitters whose power supply is mainly from fossil fuels and dominated by SPCs (2023) → Figure 1



World Bank (2024) Ember (2024). This map is for illustrative purposes and does not represent the opinion of Agora Energiewende concerning the legal status or sovereignty of any country or territory, the delimitation of frontiers or boundaries or the names of any territory, city or region.

The role of selected SPCs in their countries' electricity system (2024) → Table 1

Country	SPC	Governance bodies	Sectors covered	Vertically integrated	Unbundling process
South Korea	Korea Electric Power Corporation (KEPCO)	Ministry of Trade, Industry and Energy (MOTIE)	Generation, transmission, distribution	Yes	The generation segment was unbundled into six subsidiaries in 2001, all remaining wholly owned by KEPCO. The government suspended its electricity market reform in 2004.[10]
China	CEIC, Huaneng, SPIC, Huadian, Datang[11]	State-owned Assets Supervision and Administration Commission of the State Council (SASAC), National Energy Administration (NEA)	Generation	No	/
Indonesia	Perusahaan Listrik Negara (PLN)	The Ministry of State-Owned Enterprises (KemenBUMN), Ministry of Energy and Mineral Resources	Generation, transmission, distribution	Yes	PLN adopted a holding structure in 2022 with four sub-holding companies.[12]
Thailand[13]	Electricity Generating Authority of Thailand (EGAT)	Ministry of Energy, Ministry of Finance	Generation, transmission	Yes	/
India	National Thermal Power Corporation Limited (NTPC)	Ministry of Power, Ministry of Finance (Department of Public Enterprises)	Generation, distribution	No	/
South Africa	Eskom Holdings SOC Limited (Eskom)	Department of Electricity and Energy (DEE), National Treasury, Department of Forestry, Fisheries and the Environment (DFFE), Presidential Climate Commission (PCC), National Energy Crisis Committee (NECOM), National Energy Regulator of South Africa (NERSA)[14]	Generation, transmission, distribution	Yes	National Transmission Company South Africa (NTCSA), a wholly owned subsidiary of Eskom, has been trading since July 2024.[15] The Electricity Regulation Amendment Act, signed into law in August 2024, paves the way for full unbundling.[16]
Mexico	Comisión Federal de	Ministry of Energy (SENER),	Generation, transmission, distribution	Yes	Power sector reforms unbundled CFE into

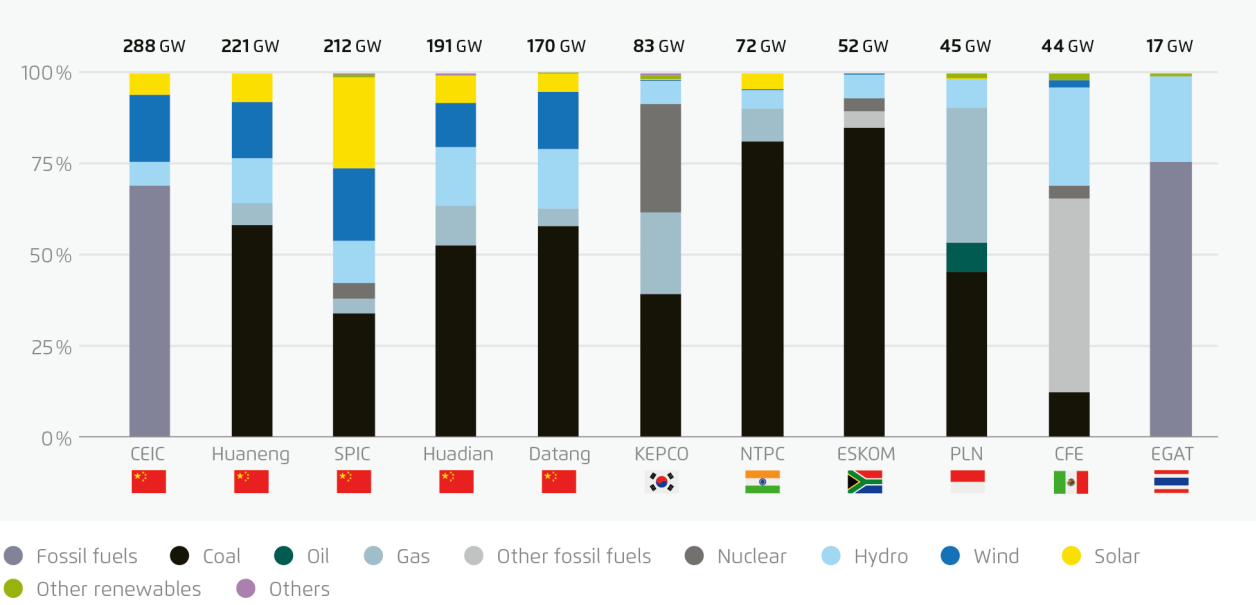
10 Lee & Ahn (2004)
11 China Energy Investment Corporation (CEIC), China Huaneng Group (Huaneng), State Power Investment Corporation (SPIC), China Huadian Corporation (Huadian), China Datang Corporation (Datang)
12 The Jakarta Post (2022)
13 Besides EGAT, two other state-owned enterprises act as integrated distribution network operators in Thailand: The Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA). Both MEA and PEA operate under the Ministry of Interior.
14 The Department of Public Enterprises (DPE) is set to be shut down after the 2024 general elections in May. Until June 2024, Eskom was overseen by the Department of Mineral Resources and Energy (DMRE). Parliamentary Monitoring Group (2024)
15 Eskom (2024)
16 The Presidency of the Republic of South Africa (2024)

	Electricidad (CFE)	Ministry of Finance and Public Credit (SHCP), Energy Regulatory Commission (CRE)			functional subsidiaries in 2014.[17]

Unless otherwise noted, this information is sourced from the SPCs' annual reports (2023 & 2024). For details on each SPC's role in electricity generation within their respective countries, please refer to the SPC Dataset.

Asset portfolio of selected SPCs (2022)

→ Figure 2



SPCs' annual reports (2023)

Decarbonisation has become a responsibility for the SPCs examined in this report, whether propelled by internal dynamics or political directives, and SPCs' transition pathways vary.

Local circumstances, such as resources, often drive energy choices. For example, in South Korea, the largest utility, KEPCO, formulates the government's Basic Plan for Long-Term Electricity Supply and Demand. As highlighted by a participant at the 2nd Conference, the scarcity of available land for developing onshore wind and solar PV projects can influence KEPCO's business decision and, accordingly, the country's energy transition strategy, which currently prioritises nuclear power and fossil gas as the replacements for coal in the country's electricity supply.

Consensus – or lack thereof – among stakeholders can also influence the transition pathways of SPCs and their countries. In the case of South Africa, according to a participant at the 2nd Conference, Eskom, under the oversight of multiple ministries, faces challenges in mapping out a comprehensive long-term trajectory to sustain the country's electricity supply. South Africa often experiences failures in its ageing coal plants, prompting the critical question of how to replace these retiring plants. The adequacy of installed capacity has been a crucial issue in this country, leading to instances of load shedding – forced power interruptions – for which Eskom has faced criticism for over a decade. Despite the existence of an Integrated Resource Plan, the

17 SENER amended regulations in March 2019 to allow CFE's generation subsidiaries to reorganise and reunify if necessary, aiming to enhance CFE's competitiveness in generation and improve cooperation among its entities. Strunk et al. (2020)

absence of consensus among various stakeholders, including within the government itself, has hindered the formulation of a coherent and clear top-down vision and implementation strategy.

Seven takeaways on the low-carbon transition of the state and SPCs

1. **The role of fossil gas as a transitional fuel is contentious. SPCs lacking upstream gas ventures and countries with limited resources and infrastructure could consider leapfrogging from coal to renewables. This approach avoids the financial and environmental risks associated with reliance on gas as a bridge fuel.**

Globally, to align with the 1.5-degree climate goal, most of the world's coal plants require early retirement or retrofitting strategies. This includes mitigating potential social and economic consequences of the coal exit, a concern expressed by participants at the 2nd Conference. SPCs face a daunting challenge in this regard, given that SPCs in some countries, such as South Korea, China, South Africa and Mexico,[18] own a large share of coal plants, and given the critical role of SPCs in securing electricity supply for economic development. As of January 2024, the world has built more than 1,570 gigawatts (GW) of new coal plants since 2000.[19] As of 2020, the average age of existing coal plants was approximately ten years in Southeast Asia, 13 years in India and China, and 21 years in Japan and Korea.[20] The average operational lifespan of coal plants is approximately 46 years, with potential operation extending to 50–60 years or more. The IEA NZE Scenario stipulates that these coal fleets necessitate early phase-down, retrofit with carbon capture, utilisation and storage (CCUS), or retirement to align with the 2040 coal phase-out.[21]

Whether in the context of South Africa's ageing coal plants creating a pressing capacity gap discussed previously, or in Southeast Asia, where the issue is young coal plants with decades of remaining life, discussions arose at the 2nd Conference focused on the questions of what will replace coal-generated capacity, and whether electricity supplies remain reliable.

Facing potential generation capacity shortages due to technical or operational issues, countries reliant on coal power often resort to short-term measures to secure electricity supply, including reassessing the decommissioning timelines of coal plants to extend their service life. This was observed in South Africa in 2023 during a major power shortage. Another approach, seen in several countries following the 2022 gas shortage caused by Russia's invasion of Ukraine, involves increasing coal power production at existing plants. Such strategies, however, hinder decarbonisation efforts at both national and global levels.

Despite recent experiences of fossil gas shortages and significant price increases, countries like South Korea and Thailand still consider fossil gas a transitional energy source as part of their low-carbon transition plan, according to participants at the 2nd Conference. This view stems from concerns about system security under a transition directly to a system with a high share of VRE. Fossil gas is favoured for several reasons. It has a lower emission factor than coal, provides stable output and offers fast ramp capabilities. Additionally, it contributes to inertia and system stability while the power system is transitioning towards more sustainability. This is

18 Agora Energiewende (2024)
19 Global Energy Monitor (2024)
20 International Energy Agency (2021b)
21 Cui, et al. (2019)

especially true in countries with firmly established gas-fired electricity technologies and a fossil gas supply chain.

Participants at the 2nd Conference shared the dilemmas SPCs face when relying on fossil gas as part of their low-carbon transition strategy:

- In South Korea, KEPCO has accumulated significant debt, partly attributable to the high fossil gas prices during the recent global fossil fuel crisis. Fossil gas, predominantly liquefied natural gas (LNG), contributes approximately a quarter of South Korea's electricity generation. In the short to medium term, the government plans to further replace coal plants with fossil gas plants to ensure generation adequacy, drawing upon KEPCO's operational expertise in managing fossil fuel assets. Given KEPCO's elevated debt ratio, however, the deployment of fossil gas-fired generation introduces additional financial risks to KEPCO, which lacks ownership of upstream fossil gas assets.
- In Thailand, the government is aware of the risks associated with developing fossil gas projects but lacks a clear exit strategy for fossil gas. The country's primary decarbonisation vision is to gradually reduce coal consumption, with fossil gas currently constituting more than half of the electricity mix. EGAT has grappled with elevated electricity costs due to higher gas prices. In contrast to the Korean government's decision to increase KEPCO's debt instead of significantly raising electricity prices during the recent fossil fuel crisis, in Thailand, rising costs of fossil gas were partially transferred to consumers through the Automatic Tariff Adjustment, which has imposed financial strains on both households and businesses.[22]

Before resorting to fossil gas as a transitional fuel, maximizing the potential of renewables offers several benefits, such as more rapid decarbonisation and long-term operational cost savings. In 2022, the global weighted average levelised cost of electricity (LCOE) from solar power fell to a third less than the cheapest fossil fuel. For new onshore wind projects, the LCOE decreased to less than half the price of the cheapest thermal power.[23] Considering potential carbon prices at either the national level or in international trading, electricity from renewables can be even more competitive for industry. According to the IEA's NZE Scenario, the share of unabated fossil gas in total electricity generation will fall from 23 percent (2020) to 17 percent by 2030. Compared with the unabated fossil gas power generation in 2020, gas generation will sharply fall by 90 percent by 2040, and its share in total electricity generation will be only 0.4 percent by 2050.[24]

For countries like South Africa, which do not have adequate upstream fossil gas ventures or gas infrastructure, and also face issues around SPC debt loads and electricity affordability concerns, the government could consider lessons from the experiences of KEPCO and EGAT and adopt a strategy of leapfrogging from coal to renewables. This approach, leveraging the country's abundant land and exceptional wind and solar resources, would aim to avoid asset lock-in and mitigate risks associated with fluctuating operational expenditures.

2. **To ensure resource adequacy, the phase-in of renewables needs to coincide with the phase-out of coal. Resilient grid resources are crucial for integrating VRE and maintaining system security. Reforming regulatory frameworks and tariffs would unlock greater investment in global power sector infrastructure.**

Currently, SPCs are pursuing widely divergent low-carbon energy transition pathways, and typically face ongoing challenges due to the absence of consensus among stakeholders within each country. Nonetheless,

22 Electricity prices in Thailand comprise a base rate alongside an Automatic Tariff Adjustment, referred to as the Ft rate. The base rate embodies estimations concerning the fixed costs associated with electricity generation, while the Ft rate fluctuates in response to changes in variable costs, such as fuel expenses. Guild (2023)
23 International Renewable Energy Agency (2023)
24 International Energy Agency (2021a)

SPCs present at the 2nd Conference have opted to deploy more renewable energy sources, particularly wind and solar PV, to meet their countries' climate objectives.

Regarding VRE integration, participants at the 2nd Conference agreed that among the array of systemic issues, the grid has emerged as the major bottleneck. Participants shared different country cases:

- China's grid expansion has not kept pace with the growing installed capacity of VRE, one expert noted at the 2nd Conference. In China, wind and solar PV together account for 36 percent of China's total installed capacity in 2023, while the installed capacity of coal fell below 40 percent for the first time.[25] Also, wind and solar PV have constituted the majority of China's annual incremental installed capacity additions since 2020.[26] However, instances of systemic shortages – mainly due to the decline in hydropower in the 2023 summer drought – prompted reliance on coal plants to meet short-term shortages. Following the power crunch in 2021 caused by a confluence of economic, political, policy, market design and weather factors,[27] China has prioritised electricity supply security, accelerating coal plant permitting. Meanwhile, the lag of grid buildout is yet to be addressed systematically. Distributed solar PV accounts for about half of China's annual incremental solar PV installed capacity, but the limited distribution network load-carrying capacity has resulted in several provinces halting new distributed solar PV connections. Due to grid integration challenges, some Chinese SPCs have restricted their investment in distributed solar PV projects, which could slow renewable energy development in China.[28]
- Indonesia's potential shift to a higher percentage of VRE could pose challenges in maintaining grid performance and ensuring reliable electricity supply across diverse islands, another participant at the 2nd Conference noted.[29] The grid operates five high-capacity systems along with hundreds of isolated systems. The largest are the Java-Madura-Bali (Jamali) and Sumatra systems, accounting for nearly 90 percent of PLN's market revenue. To harness the abundant renewables on Sumatra Island and transmit the output to Java, the primary load centre, PLN must bolster the Sumatra grid and establish interconnections by 2030 – a goal with tight time constraints, the participant emphasised. In terms of electricity supply security, specific island grids in Indonesia, notably Jamali and Sumatra, encounter periods of oversupply, whereas others suffer from considerable undersupply owing to inadequate investment in generation capacity. Interconnection infrastructure should, therefore, be established.

Grid connection is not only a pressing issue for China and Indonesia. According to the IEA, at least 3,000 GW of renewable generation projects globally, including 1,500 GW in advanced stages, are currently in grid connection queues, equivalent to five times the wind and solar PV capacity added in 2022.[30]

The private sector can play a greater role in grid expansion, participants at the 2nd Conference agreed. When states and their SPCs cannot meet infrastructure demands due to funding, political, or operational challenges, it is crucial to establish mechanisms that stimulate private investment. This can enhance market dynamics, with the private sector acting as a catalyst for the SPCs' transition. According to the IEA, in emerging markets and developing economies, grid investments primarily rely on government funding, typically channelled through SPCs or unbundled state-owned grid entities. Given the financial challenges facing SPCs in some countries such as South Korea, Indonesia and South Africa, enabling private participation can bring additional funding.[31]

25 China Electricity Council (2024)
26 Ember (n.d.)
27 China Electricity Council (2022)
28 Solarzoom (2024)
29 Soejachmoen et al. (2023)
30 International Energy Agency (2023)
31 International Energy Agency (2023)

Investors require a predictable regulatory framework and are likely to favour tariff structures that reflect the true costs of grid buildout to ensure cost recovery and a return on investment.

The following country cases reflect the need for more transparent remuneration mechanisms for accelerating private investment in infrastructure to complement state funding.

- In China, the government has allowed private sector investment in incremental distribution networks since 2016 as part of the latest round of electricity market reforms. Despite issuing over 20 policy documents to promote pilot projects, project development has been slow. By 2022, only 44 percent of the 459 pilot projects were qualified to operate distribution networks. Apart from challenges in obtaining operational qualifications from the government, the core issues include conflicts of interest among stakeholders and difficulty aligning transmission and distribution tariffs to provide adequate returns for investors.[32]
- In South Africa, over the past decade, Eskom has added 4,347 kilometres of transmission lines and 19 Gigavolt-ampere of transformer capacity to support the integration of power producers from the first five rounds of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). However, the grid expansion has not addressed the electricity supply crisis or allowed Eskom to meet South Africa's decarbonisation goals. The sixth round of the REIPPPP bid in 2022 was significantly curtailed by a lack of grid connection capacity.[33] Eskom aims for a 14,000 kilometres of grid expansion over the next ten years. Eskom's delay in upgrading and expanding its grid primarily stems from political challenges, a shortage of skills and inefficient procurement processes, according to experts contacted following up on the 2nd Conference. Eskom will need to seek private funding to implement its grid expansion plan.[34] However, the electricity tariffs for transmission are insufficient to attract private investment, leading to a reluctance among private investors to commit capital. Modelling shows that regulatory and network tariff reforms would incentivise IPPs to invest in grid connections.[35]

Introducing or reforming regulatory frameworks and network tariffs would not only stimulate private investments in grid infrastructure, but also provide a clearer revenue model for SPCs' investment in the grid. In Indonesia, network charges constitute only 2 percent of PLN's revenue. Given this, PLN is constrained to rely on public funding for grid investments.[36]

3. **It is essential to understand the specific business model challenges SPCs face in investing in system upgrades to accelerate VRE integration. It is also crucial to identify the gaps between current market designs and mechanisms that can provide long-term investment certainty.**

Investment in the electricity sector has historically centred around generation, participants at the 2nd Conference noted. Generation investment is inherent in the goal of tripling global renewable capacity by 2030, as agreed at COP28. However, non-generation investments are also needed – especially in supporting infrastructure such as grids, storage, flexibility and demand-side management. The IEA has also showed a pressing need for investment in the comprehensive energy system. Grid infrastructure investments accounted for 29 percent of total investments in the electricity sector globally in 2023, a decline from 37 percent in 2015, while the share of renewable energy investments rose from 38 percent in 2015 to 56 percent in 2023. Global grid investments reached 375 billion US dollars (USD) in 2023, only 11% growth since 2015, while renewables investments grew by 114 percent. In many emerging markets and developing economies outside China, grid investment growth lagged the global average and even declined in some regions. In the NZE Scenario, grid

32 Kang (2024)
33 The Presidency of the Republic of South Africa (2023)
34 Bavier (2024)
35 Meridian Economics (2024)
36 Agora Energiewende et al. (2024)

investments need to double by 2030. Although energy storage investments are increasing, they must accelerate to keep pace with renewable expansion.[37]

Market design is crucial to resolving financing challenges, one expert emphasised at the 2nd Conference. Investments in grid infrastructure and flexibility resources such as storage and demand-side response depend on whether market design creates profitable business models for these investments. SPCs could benefit from international exchange on market design, especially as it relates to tariff structure, ancillary services markets and capacity compensation. Some SPCs have long experience unbundling generation or transmission, while others are currently engaged in unbundling activities. Some SPCs are exploring additional restructuring measures, such as the spin-off of renewable energy businesses or the potential public listing of subsidiaries, areas where Chinese SPCs can offer valuable perspectives and experiences.

There are four principal avenues of financing SPCs' low-carbon transition, a participant at the 2nd conference indicated. Similar to private companies, SPCs can utilise internal corporate funds, borrow from state-owned and commercial banks as well as from multilateral development banks, and obtain finance via the bond market. Additionally, SPC also receive injections from the state budget.

Each funding source comes with its own set of limitations, as observed by financial experts at and beyond the 2nd Conference. State budget allocations are contingent upon government policy agendas. Internal financing is chiefly allocated towards sustaining corporate financial health, but SPCs have low operating margins due to political and social requirements that differentiate them from private corporations and limit the scope for corporate financing. Loans and bonds, especially those sourced from the private sector, are predominantly directed towards investments in generation assets, which generally provide greater clarity regarding revenue streams, tariffs and rules for market participation.

State-owned enterprises enjoy favourable interest rates on average when compared to private companies.[38] On the other hand, SPC access to financing is contingent on the credit rating of their countries, participants at the 2nd Conference noted. Consequently, even when an SPC has a significant and viable project to undertake, it may struggle to secure a loan due to a low sovereign rating. The sovereign rating also impacts private companies. However, firms with less transparency and limited financial flexibility, operating within countries with underdeveloped banking systems and weak investor protection frameworks, may be more affected.[39] This may be especially true for some SPCs closely associated with the sovereign credit.

To address the above financing constraints, one SPC present at the 2nd Conference has proposed that SPCs and financial institutions collaborate on establishing a global clean energy index. Such an index, supported by the development expertise of civil society organisations and international stakeholders, could gauge the low-carbon transition performance of utilities through key indicators. Improvements in the index would subsequently enhance the financing conditions for utilities, thereby facilitating their transition efforts.

4. **Multilateral financial mechanisms such as JETP could help address financial challenges in electricity system investments to some extent, particularly for the short term, where profitable business models are yet to be established.**

Participants at the 2nd Conference discussed their experience with Just Energy Transition Partnerships (JETPs) in Indonesia and South Africa.

37 International Energy Agency (2024b)
38 Asia Development Bank (2021)
39 To (2022)

JETPs engage stakeholders from developed countries to support developing countries in transitioning from fossil fuels to renewables. JETP financial commitments in the form of grants, concessional loans, guarantees and commercial loan facilities have included USD 11.6 billion for South Africa,[40] [41] USD 21.6 billion for Indonesia,[42] [43] USD 15.5 billion for Vietnam,[44] and 2.5 billion euros for Senegal for the first 5-year period.[45] These funds are to be sourced from a combination of the public and private sectors, involving key players in the financial institutions, such as multilateral development banks and investment banks.

Following multilateral coordination and negotiations among domestic and international stakeholders, Indonesia, South Africa and Vietnam began implementing their respective just energy transition plans within one to two years after the launch of the respective partnerships in 2021 (South Africa) and 2022 (Indonesia and Vietnam).[46] [47] [48] The experiences and lessons learned from these processes can be beneficial for JETP stakeholders in different sectors and countries and facilitate the implementation of future JETPs.

Lessons from Indonesia, presented by a participant at the 2nd Conference, include the following:

- → It is key to establish a JETP Secretariat, which coordinates between stakeholders, such as the government, international financiers, and project owners, including PLN. The Secretariat identifies investment focus areas to develop a comprehensive investment policy and plan (CIPP), which is regularly updated to ensure a consistent view of transition pathways.
- → Comprehensive technical modelling for each electricity system in Indonesia before setting any objectives ensured the feasibility and credibility of targets. Close collaboration with PLN, particularly for technical assistance, has been essential throughout this process. Additionally, a policy reform plan is crucial alongside the investment plan.
- → Most public funding is channelled through multilateral development banks or other development finance institutions (DFIs) as intermediaries. Their funding terms come with significant risks and costs for PLN, including foreign exchange risk exposure due to non-local-currency-denominated facilities and costs associated with compliance with specific provisions on environmental and social safeguards imposed by DFIs. Furthermore, limited funds are available for coal retirement due to the internal lending policies of DFIs. Currently, only the Asia Development Bank has shown a willingness to allocate part of its funding to finance early coal retirement, presenting challenges for PLN, especially considering Indonesia's overcapacity and fleet of relatively new coal plants.

Power sector transformation is the focus of JETPs, as outlined in South Africa's Implementation Plan 2023-2027, Indonesia's CIPP 2023 and Vietnam's Resource Mobilisation Plan for JETP. These JETP implementation plans position SPCs as key stakeholders.[49] [50] [51]

- → On the one hand, JETPs, to a certain extent, address SPCs' financing challenges. As stated in South Africa's JETP implementation plan, the government announced a 254 billion South African rands (approximately USD 14 billion) debt relief package for Eskom, in amount of approximately equal to one year's revenue of Eskom, effective April 2023 over three years. Indonesia's JETP implementation plan aims to ensure long-

40 The initial commitment was USD 8.5 billion. European Commission (2021)
41 The Presidency of the Republic of South Africa (2023)
42 The initial commitment was USD 20 billion. European Commission (2022a)
43 International Energy Agency (2024c)
44 European Commission (2022b)
45 European Commission (2023)
46 JETP Indonesia Office (2023a)
47 South African Government News Agency (2023)
48 Vietnam's JETP Implementation Secretariat (2023)
49 The Presidency of the Republic of South Africa (2023)
50 JETP Indonesia Office (2023b)
51 Vietnam's JETP Implementation Secretariat (2023)

term financial sustainability for PLN by transitioning to a performance-based model, linking subsidies to efficiency achievements, implementing short- to long-term reforms such as restoring automatic tariff adjustments, diversifying financing sources, unbundling PLN, and establishing an electricity sector regulator.[52]

→ On the other hand, SPCs face challenges in JETP implementation, participants at the 2nd Conference noted. South Africa's JETP implementation was delayed due to the energy security issue. Eskom had to conduct additional studies regarding transmission. The unbundling process of Eskom's transmission business has further complicated the implementation. In Indonesia, the top-down setting of JETP targets increased PLN's decarbonisation mandate, mainly because captive coal plants in the pipeline were not initially included in the JETP plan. Consequently, PLN must adjust its transition plans, which is challenging given the tight timeline of six to seven years to deliver decarbonisation results, whereas some transition projects may require up to ten years to complete.

For the JETP implementation in general, international financial pledges fall significantly short of the projected investment needs based on modelling estimates, according to JETP observers. Grants are critical for supporting low-carbon projects that are not yet profitable under current technology development or market condition. However, grants constitute a very small portion of the total JETP funding: 6.5 percent for South Africa, 1.4 percent for Indonesia and 2 percent for Vietnam. Moreover, the absence of a clear timeline and a funding pipeline for JETP projects has slowed implementation.[53] [54]

Compared to the private sector, SPCs bear inherent social responsibilities, which in many instances require them to invest in projects with no profits, such as in critical infrastructure and the "just" elements of the energy transition. A higher proportion of grants and clearer funding pipeline would boost SPCs' JETP implementation in these areas.

Despite its design and implementation flaws, some experts at and beyond the 2nd Conference still consider JETP a significant for the energy transition, both as a financing mechanism and as a platform for implementation. These issues highlight the need for ongoing multilateral dialogues to unlock complementary financing mechanisms. JETPs facilitate country-led energy transition schemes and have transformed a familiar narrative of focusing narrowly on closing coal plants to a more comprehensive approach that aligns with developing countries' climate targets and addresses social equity impacts. This approach is crucial for SPCs' low-carbon transition.

5. **China, via the BRI, may play a role in financing power decarbonisation efforts in some countries, especially in early retirement of coal plants.**

Over the past two decades China's SPCs and development finance institutions invested in or built roughly 39 GW of overseas coal plants, predominantly in South and Southeast Asia. In Indonesia, 41 percent or 12.9 GW of its coal-fired capacity received full or partial financing from Chinese entities, with two Chinese SPCs, China Energy Investment Corporation (CEIC) and China Huadian Corporation, emerging as the second and third-largest IPP project owners by 2021, excluding the subsidiaries of PLN.[55]

Financing the retirement of China's extensive fleet of coal plants abroad is essential for global decarbonisation efforts, participants at the 2nd Conference pointed out. Moreover, depending on the profitability of the projects, which varies from country to country, China can contribute to large-scale renewable energy projects and related infrastructure to strengthen supply security and grid stability. Data on China's overseas finance for

52 JETP Indonesia Office (2023b)
53 The Jakarta Post (2024)
54 Ferris (2023)
55 Hamdi & Adhiguna (2021)

electricity generation projects commissioned from 2013–2030 show that fossil fuel projects dominated investments in terms of total installed capacity, but renewable energy projects have constituted approximately two-thirds of the total number of China's overseas electricity generation projects.[56] China's overseas investments in electricity generation assets are primarily concentrated in Asia and Africa, in regions that boast abundant and inexpensive natural resources. Meanwhile, China's investments in electricity grids are predominantly in regions with relatively mature electricity markets, such as the Philippines, Chile and a few European Union countries.[57]

China introduced the Belt and Road Initiative (BRI) in 2013 to enhance connectivity and foster transcontinental cooperation through overseas equity and debt investments in infrastructure projects. Cumulative BRI engagement through financial investments and contractual cooperation has surpassed the USD 1 trillion mark by 2023, with approximately USD 634 billion in construction contracts and USD 419 billion in non-financial investments.[58] The energy sector has accounted for 31–53 percent of annual engagement since 2013. BRI capital investment, technical expertise and upstream equipment supply chains have significantly enhanced electricity capacity in BRI countries,[59] particularly coal-fired capacity in the early years.[60]

As the world's second-largest economy, China has recognised its potential leadership role in global decarbonisation efforts, enacting policies to stop financing new coal projects abroad and pivot towards the green BRI, a participant at the 2nd Conference noted. Data also shows that 2023 marked China's greenest BRI in terms of energy sector engagement: Wind and solar PV accounted for 28 percent (USD 7.9 billion) of engagement, with an additional 6 percent (USD 1.6 billion) allocated to hydropower. China is also increasingly engaging in electricity transmission from USD 4.5 billion in 2022 to USD 7 billion in 2023, which accounts for about a quarter of BRI engagement in the energy sector.[61]

Still, China and BRI countries face the challenge of decarbonisation due to high coal-fired capacity and the relatively young age of these units, according to a participant at the 2nd Conference. Despite the increasing involvement of China's private sector in BRI projects, state-owned companies continue to dominate the electricity sector.[62] Chinese SPCs could establish a hierarchical system to execute the mandate of discontinuing overseas coal plants, anticipating future compensation from the state regardless of current financial costs, if the government were to issue such a directive as part of an international agreement. An expert at the 2nd Conference raised this hypothetical policy. This would enable the Chinese government to potentially leverage its BRI framework to retire coal plants early and make room for the phase-in of renewables.

Conversely, high debts associated with BRI projects have made China cautious towards BRI-related investments, particularly in utilities, resulting in a noticeable decline in BRI engagement in this sector, another Chinese observer at the 2nd Conference suggested.[63] Additionally, both SPCs and the Chinese government are under pressure to address financial losses from past BRI investments. Consequently, market-oriented strategies are expected to increasingly influence China's BRI initiatives. Mechanisms such as concessional finance by major financial institutions for repurposing coal assets, alongside market incentives like carbon pricing, could facilitate China's involvement in early coal retirement and broader decarbonisation efforts.

56 The calculation excluded the projects whose commissioning dates were not unspecified in the dataset. Zhou & Ma (2023)
57 Henares & Delina (2022)
58 Nedopil Wang (2024)
59 150 countries and regions have signed cooperation agreements with China on BRI, which are considered BRI countries.
60 Zhou et al. (2022)
61 Nedopil Wang (2024)
62 Nedopil Wang (2024)
63 Nedopil Wang (2024)

6. **Seeking consensus among stakeholders is crucial for the successful transition of states and SPCs. Factual data and modelling tools are also essential.**

The lack of consensus has hurt long-term planning and implementation of SPCs' low-carbon transitions, participants at the 2nd Conference agreed.

In South African, messages from within the government are conflicting, participants at the 2nd Conference noted. For example, while the Presidential Climate Commission advocated for decarbonisation, the Ministry of Mineral Resources and Energy remained committed to coal and nuclear power. This inconsistency has delayed necessary restructuring and unbundling efforts. The contradicting narratives among different ministries also confuse both domestic and international stakeholders and have made the JETP implementation and Eskom's transition challenging.

Consensus-building is not only essential within the government, but also requires broader engagement, an SPC observer at the 2nd Conference stated. This engagement should include a diverse array of stakeholders, such as financial institutions, SPCs, civil society organisations and the academic community. For example, these groups could work together to establish and deliberate on standards or guidelines for adopting economical, efficient and climate-neutral technologies. Such collaboration is vital, as demonstrated by the complex considerations and uncertainties surrounding hydrogen's role in decarbonisation pathways and its integration into the power system, facing SPCs in Mexico and India.[64]

Participants at the 2nd Conference also shared positive cases where countries appear to be making strides towards achieving consensus. In South Africa, appointing a Minister in the Presidency responsible for electricity in March 2023 has created a centralised point of accountability, instilling a sense of urgency and focus. This has also broken down the silos between different governmental departments involved in the development of South Africa's electricity sector and in governing Eskom's operations. In Mexico, stakeholders had long called for climate legislation, with some success prior to the change to an administration more hostile to decarbonisation in 2018. To reduce the risk that long-term decarbonisation targets will be watered down, legislation can bolster consensus-building efforts.

Ideally, consensus-building should be grounded in rigorous scientific debate among stakeholders, where calculation and modelling tools can facilitate constructive discussions. As an example, to address a country's land resource constraints for VRE buildout, Agora has recommended the utilisation of a calculator for wind and solar PV deployment areas to pinpoint specific challenges and pave the way for exploring corresponding solutions.[65] Stakeholders from Indonesia and South Africa both highlighted the importance of modelling for JETP implementation.

Capacity varies within government ministries involved in decision-making and planning, a participant at the 2nd Conference observed. In some countries, bureaus within the same ministry use different software, tools, assumptions and constraints. This creates challenges in communication and planning, as the ministries may have different perspectives on their current situation and goals or outcomes they need to achieve. To address this, the participant suggested governments should harmonise their modelling processes to align the diverse

64 The hard-to-abate sectors include steel, chemicals, long-haul aviation and maritime shipping. Hydrogen utilisation is also deemed suitable for heating grids after the maximisation of renewables and waste heat usage, which is relevant for sizable existing district heating systems with high flow temperatures. There is controversy surrounding the use of hydrogen for high-temperature industrial heating, heavy-duty vehicles, buses, short-haul aviation and shipping, trains, and absolute size of need in the electricity sector, given other flexibility and storage options. Conversely, employing hydrogen for low-temperature heating, passenger cars, light-duty vehicles and building-level heating is discouraged. Agora Energiewende (2021a)

65 Agora Energiewende (2021b)

priorities of various ministries. Ultimately, they need to collaborate on a unified roadmap that reflects a consensus and effectively communicates the country's direction to financiers and other stakeholders.

7. **Data transparency is a prerequisite for comprehensive analysis of resource adequacy and system security. Transparency enables stakeholders to identify areas for improvement at the SPC and the national levels, and it helps investors and financiers in make informed decisions towards a more secure, equitable and sustainable electricity system.**

Information transparency is an important enabler of consensus for the clean energy transition. Yet countries also need to develop a consensus also about what data to share, one participant at the 2nd Conference emphasised. Promoting data transparency and public access would significantly aid stakeholders in tracking SPCs' performance towards both company and national climate targets. It would enable SPCs and civil society organisations to conduct comparative studies, identify areas to improve and propose corresponding solutions. Furthermore, enhanced data availability assists investors and financiers in decision-making, fostering a more secure, equitable and sustainable electricity system.

Electricity supply crises in recent years, such as those in China and Vietnam, have heightened concerns surrounding electricity supply security, a participant noted. Though these countries maintained their long-term climate targets through these crises, the clean energy transition lost momentum in the short term. Power generation from fossil fuels, particularly coal, continues to serve as a crucial aspect of security of supply.[66] [67] During the crises, SPCs had to rely on fossil fuels to secure electricity supply when renewable generation fell short, despite high gas and coal prices. They couldn't significantly raise electricity prices, leading to financial losses and slower decarbonisation. To mitigate the reliance on fossil fuels during power shortages, a participant advocated that governments and SPCs need to release comprehensive resource adequacy analyses encompassing both backward and forward-looking perspectives. Transparent post-crisis analyses, which include the release of data and scenario information, and forward-looking assessments regarding the capacity to meet demand in upcoming seasons, years and beyond, can better inform and prepare market players. Informed reactions from stakeholders, including other SPCs in the market, private IPPs and corporates, can minimise system costs and enhance electricity supply security.

Even in the absence of official analyses, think tanks, civil society organisations and academia have examined these crises, revealing challenges related to generating comprehensive reports, particularly concerning technical data. These challenges underscore the data scarcity at both national and SPC levels in certain countries. Additionally, for monitoring SPCs' annual performance, substantial hurdles exist regarding data availability, including:

- → Technical information appropriate to renewables' variability is not disclosed, such as the breakdown of generation by energy source over short time intervals.
- → Some SPCs partially disclose information, for example, the breakdown of installed capacity by only selective energy sources.
- → Reports and disclosures in English are limited, despite its widespread use as the primary language for business communication. Translating reports from various languages introduces complexities and potential inaccuracies.

Clean energy spending allocations are often guided by energy system modelling, the 2nd Conference participants specialised in modelling noted. Financiers, including investors and bankers, are particularly interested in the data underlying these scenarios. They seek to test the impact of key policies on market

66 Lin (2021)
67 Maguire (2023)

performance, whether these policies are historical or planned, and to understand the sequencing of policy interventions.

Concluding remarks

A low-carbon power transformation is essential to achieving global climate targets all the more because we need to increase the share of electricity in total final energy consumption. Despite recent net-zero targets established by countries observed by Agora's two SPC convenings, current data show that SPC emissions from electricity generation still constitute over half of global emissions from the power sector, with noticeable growth in China, India, Indonesia and Mexico.[68] This trend points to the urgent need for accelerated action towards decarbonizing the power system.

Country-specific contexts significantly influence the narratives surrounding low-carbon transitions for both the countries and their SPCs. Whether vertically-integrated monopolies or players in competitive markets, SPCs face similar problems – including technical, regulatory, economic and political challenges. This dynamic landscape highlights the importance of exchanging experiences among SPCs and with international stakeholders. Ongoing dialogue, partnership and joint efforts are essential to realizing a cost-effective and just low-carbon energy transition at SPCs.

68 Ember (n.d.)

References

Agora Energiewende (2021a): *12 insights on hydrogen.* 18 November 2021. https://www.agora-energiewende.org/publications/12-insights-on-hydrogen

Agora Energiewende (2021b): *Photovoltaik- und Windflächenrechner. Photovoltaic and wind area calculator.* 15 October 2021. https://www.agora-energiewende.de/daten-tools/photovoltaik-und-windflaechenrechner

Agora Energiewende (2023): *Decarbonisation in state-owned power companies. Briefing from the workshop on 28–29 September 2022. 1 June 2023.* https://www.agora-energiewende.org/publications/decarbonisation-in-state-owned-power-companies

Agora Energiewende (2024): *SPC Dataset: Annually updated Excel file of data collection on operations and financial performance of state-owned power companies*. Link: https://www.agora-energiewende.org/news-events/low-carbon-transition-of-states-and-state-owned-power-companies

Agora Energiewende, NewClimate Institute & Energy Research Institute (2024): *Electricity market designs in Southeast Asia: Harnessing opportunities for renewable energy growth – Indonesia, Thailand, Vietnam and the Philippines. Clean, Affordable and Secure Energy for Southeast Asia programme.* October 2024. https://www.agora-energiewende.org/publications/electricity-market-design-in-southeast-asia

Asia Development Bank (2021): *The Bankable SOE. Commercial Financing for State-Owned Enterprises.* September 2021. https://www.adb.org/sites/default/files/publication/729321/commercial-financing-state-owned-enterprises.pdf

Bavier, J. (2024): *S. Africa's power sector needs more private investment, Eskom chair says.* 21 February 2024. https://www.reuters.com/business/energy/safricas-power-sector-needs-more-private-investment-eskom-chair-says-2024-02-21/

Belt and Roal Portal (n.d.): *International cooperation.* (Accessed 25 August 2024). https://eng.yidaiyilu.gov.cn/list/c/gbjg

China Electricity Council (2024): *2023—2024年度全国电力供需形势分析预测报告. Analysis and forecast report on national power supply and demand for 2023-2024.* 30 January 2024. https://www.gov.cn/yaowen/liebiao/202401/content_6929204.htm

China Electricity Council (2022): *2021年电煤与电力供应紧张原因分析调研报告. Analysis report on the causes of the 2021 coal and power supply shortage.* November 2022. https://m.bjx.com.cn/mnews/20221124/1271443.shtml

Clark, A., Jindal, A., Shrimali, G., Springer, C. & Rafaty, R. (2023): *Capitalizing on Coal: Early Retirement Options for China-Financed Coal Plants in Southeast Asia and Beyond.* 28 March 2023. https://www.bu.edu/gdp/2023/03/28/capitalizing-on-coal-early-retirement-options-for-china-financed-coal-plants-in-southeast-asia-and-beyond/

Cui, R. Y., Hultman, N., Edwards, M. R., He, L., Sen, A., Surana, K., McJeon, H., Iyer, G., Patel, P., Yu, S., Nace, T. & Shearer, C. (2019): *Quantifying operational lifetimes for coal power plants under the Paris goals.* 18 October 2019. https://www.nature.com/articles/s41467-019-12618-3

Ember (2024): *Electricity Review 2024.* May 2024. https://ember-climate.org/app/uploads/2024/05/Report-Global-Electricity-Review-2024.pdf

Ember (n.d.): *Electricity Data Explorer.* (Accessed 14 August 2024). https://ember-climate.org/data/data-tools/data-explorer/

Eskom (2024): *Media Statements: Department of Public Enterprises, Eskom and the National Transmission Company South Africa announces commencement of trade by NTCSA.* 1 July 2024. https://www.eskom.co.za/department-of-public-enterprises-eskom-and-the-national-transmission-company-south-africa-announces-commencement-of-trade-by-ntcsa/

European Commission (2021): *France, Germany, UK, US and EU launch ground-breaking International Just Energy Transition Partnership with South Africa.* 2 November 2021. https://ec.europa.eu/commission/presscorner/detail/en/ip_21_5768

European Commission (2022a): *The EU and International Partners launch ground-breaking Just Energy Transition Partnership with Indonesia.* 15 November 2022. https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6926

European Commission (2022b): *International Agreement to support Vietnam's ambitious climate and energy goals.* 14 December 2022. https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7671

European Commission (2023): *The EU and the International Partners Group announced a Just Energy Transition Partnership with Senegal combining climate and development goals.* 22 June 2023. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3448

Ferris, N. (2023): *Don't write off the Just Energy Transition Partnership just yet.* 18 September 2023. https://www.energymonitor.ai/policy/just-transition/dont-write-off-the-jetp-just-energy-transition-partnership-just-yet/

Global Energy Monitor (2024): *Newly Operating Coal Plants by Year, 2000-2024 (MW).* July 2024. https://globalenergymonitor.org/projects/global-coal-plant-tracker/

Guild, J. (2023): *Who Pays and Who Profits from High Energy Prices in Thailand?* https://thediplomat.com/2023/06/who-pays-and-who-profits-from-high-energy-prices-in-thailand

Hamdi, E. & Adhiguna, P. (2021): *Indonesia Wants to Go Greener, but PLN Is Stuck with Excess Capacity From Coal-Fired Power Plants: It's Time for Japanese and Chinese Investors to Step Up and Be Part of the Solution.* November 2021. https://ieefa.org/wp-content/uploads/2021/11/Indonesia-Wants-to-Go-Greener-but-PLN-Is-Stuck-With-Excess-Capacity_November-2021.pdf

Henares, T. J. & Delina, L. (2022): *Beyond the narratives of trade and domination: How ecology, connectivity, and history shape Chinese investments in foreign electricity grids.* November 2022. https://www.researchgate.net/publication/363982580_Beyond_the_narratives_of_trade_and_domination_How_ecology_connectivity_and_history_shape_Chinese_investments_in_foreign_electricity_grids

Ian Tiseo (2023): *Carbon dioxide emissions of the most polluting countries worldwide in 2010 and 2022.* 7 December 2023. https://www.statista.com/statistics/270499/co2-emissions-in-selected-countries/

International Energy Agency (2021a): *Net Zero by 2050: A Roadmap for the Global Energy Sector.* October 2021. https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

International Energy Agency (2021b): *Average age of existing coal power plants in selected regions in 2020.* 13 October 2021. https://www.iea.org/data-and-statistics/charts/average-age-of-existing-coal-power-plants-in-selected-regions-in-2020

International Energy Agency (2023): *Electricity Grids and Secure Energy Transitions.* October 2023. https://www.iea.org/reports/electricity-grids-and-secure-energy-transitions

International Energy Agency (2024a): *Electricity 2024: Analysis and forecast to 2026.* January 2024. https://iea.blob.core.windows.net/assets/6b2fd954-2017-408e-bf08-952fdd62118a/Electricity2024-Analysisandforecastto2026.pdf

International Energy Agency (2024b): *World Energy Investment 2024 Datafile.* 6 June 2024. https://www.iea.org/data-and-statistics/data-product/world-energy-investment-2024-datafile

International Energy Agency (2024c): *Indonesia's Just Energy Transition Partnership (JETP) Comprehensive Investment and Policy Plan (CIPP).* 9 June 2024. https://www.iea.org/policies/19483-indonesias-just-energy-transition-partnership-jetp-comprehensive-investment-and-policy-plan-cipp

International Renewable Energy Agency (2023): *Renewable power generation costs in 2022.* 2023. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Aug/IRENA_Renewable_power_generation_costs_in_2022.pdf

JETP Indonesia Office (2023a): *JETP Investment Plan Launched; Indonesian Government Aims for Swift Implementation.* 21 November 2023. https://jetp-id.org/news/just-energy-transition-partnership-jetp-investment-plan-launched-indonesian-government-aims-for-swift-implementation

JETP Indonesia Office (2023b): *Just Energy Transition Partnership. Comprehensive Investment and Policy Plan 2023.* 21 November 2023. https://jetp-id.org/storage/official-jetp-cipp-2023-vshare_f_en-1700532655.pdf

Kang, K. (2024): *增量配电网迎新政, 试点或将加速落地. New policies for incremental distribution networks: Pilot projects may accelerate implementation.* 8 April 2024. http://paper.people.com.cn/zgcsb/html/2024-04/08/content_26051260.htm

Lin, B.H & Ahn, H.H (2004): *Electricity industry restructuring revisited: The case of Korea.* 18 November 2004. https://www.researchgate.net/publication/223472221_Electricity_industry_restructuring_revisited_The_case_of_Korea

Lin, B. (2021): *林伯强：目前煤电装机增长是"煤电"与"缺电"选择的最优解.* The Current Growth in Coal Power Capacity is the Optimal Solution Between "Coal Power" and "Power Shortages". https://m.yicai.com/news/101999452.html

Maguire, G. (2023): *Vietnam's coal emissions primed for surge after imports jump.* Reuters. 12 July 2023. https://www.reuters.com/markets/commodities/vietnams-coal-emissions-primed-surge-after-imports-jump-maguire-2023-07-12/

Meridian Economics (2024): *New business and funding models to resolve grid infrastructure constraints in South Africa.* 18 April 2024. https://meridianeconomics.co.za/our-publications/new-business-and-funding-models-to-resolve-grid-infrastructure-constraints-in-south-africa/

Nedopil Wang, C. (2024): *China Belt and Road Initiative (BRI) Investment Report 2023.* 5 February 2023. https://greenfdc.org/china-belt-and-road-initiative-bri-investment-report-2023/

Parliamentary Monitoring Group (2024): *Department of Public Enterprises Annual Performance 2024/25; with Ministry.* 16 July 2024. https://pmg.org.za/committee-meeting/39117/

Soejachmoen, M. H., Halimatussadiah, A., Ketelsen, T., Rachmatika D. A, A., Rangkuti, K. & Afifi, F. A. R. (2023): *Grid financing challenges for energy transition in Indonesia.* June 2023. https://www.energytransitionpartnership.org/wp-content/uploads/2024/04/Grid-Financing-Challenges-for-Energy-Transition-in-Indonesia.pdf

Solarzoom (2024): *2024年新挑战：暂缓、收缩分布式光伏投资并购. New challenges in 2024: Delaying and reducing distributed solar PV investment and mergers.* 21 February 2024. http://m.solarzoom.com/article-182807-1.html

South African Government News Agency (2023): *Cabinet approves Just Energy Transition Implementation Plan. 20 November 2023.* https://www.sanews.gov.za/south-africa/cabinet-approves-just-energy-transition-implementation-plan

South African Reserve Bank (2023): *Exchange rate: Rand per US Dollar*. 16 November 2023. (Accessed 2 September 2024). https://www.resbank.co.za/en/home/what-we-do/statistics/key-statistics/selected-historical-rates

Strunk, K.G., Geffert, W. & Meehan, E. (2020): *Advising Mexico's Energy Ministry on Electricity Market Reforms.* 2020. https://www.nera.com/experience/2020/mexico-s-electricity-market-reforms.html

The Jakarta Post (2022): *Analysis: PLN restructuring paves way for subsidiary privatisation*. 5 October 2022. https://www.thejakartapost.com/opinion/2022/10/05/analysis-pln-restructuring-paves-way-for-subsidiary-privatization.html

The Jakarta Post (2024): *Time to look beyond JETP.* 6 May 2024. https://www.thejakartapost.com/opinion/2024/05/06/time-to-look-beyond-jetp.html

The Presidency of the Republic of South Africa (2023): *Just Energy Transition Implementation Plan 2023–2027.* 16 November 2023. https://www.stateofthenation.gov.za/assets/downloads/JET%20Implementation%20Plan%202023-2027.pdf

The Presidency of the Republic of South Africa (2024): *President Ramaphosa assents to Electricity Regulation Amendment Bill.* 16 August 2023. https://thepresidency.gov.za/president-ramaphosa-assents-electricity-regulation-amendment-bill

To, T. Y., Wu, E. & Zhang, L. (2022): *Mind the sovereign ceiling on corporate performance.* August 2022. https://www.sciencedirect.com/science/article/abs/pii/S0929119922000967

Vietnam's JETP Implementation Secretariat (2023): *Resource Mobilisation Plan. Implementing Vietnam's Just Energy Transition Partnership (JETP).* November 2023. https://climate.ec.europa.eu/system/files/2023-12/RMP_Viet%20Nam_Eng_%28Final%20to%20publication%29.pdf

Xu, J. & Cao, X. (2022): *Regulatory institutional reform of the power sector in China.* December 2022. https://www.sciencedirect.com/science/article/abs/pii/S2666278722000125

Zhou, L., Ma, Z., Liu, S., Ma, X., Acker, K., Myers, M., Brautigam, D. & Gallagher, K. (2022): *China Overseas Finance Inventory Database.* 22 February 2022. https://www.wri.org/research/china-overseas-finance-inventory-database

Zhou, L. & Ma, Z. (2023): *2022 Data Added to the China Overseas Finance Inventory.* 11 July 2023. https://www.wri.org/update/2022-data-added-china-overseas-finance-inventory

Imprint

About Agora Energiewende
Agora Energiewende develops scientifically sound, politically feasible ways to ensure the success of the energy transition – in Germany, Europe and the rest of the world. The organisation works independently of economic and partisan interests. Its only commitment is to climate action.

Agora Energiewende
Agora Think Tanks gGmbH
Anna-Louisa-Karsch-Straße 2
10178 Berlin | Germany
P +49 (0) 30 7001435-000

www.agora-energiewende.org
info@agora-energiewende.de