Decarbonising state-owned power companies: A framework for applying policy actions

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Decarbonising state-owned power companies: A framework for applying policy actions

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Overview

State-owned power companies (SPCs) are major drivers of greenhouse gas emissions. SPCs emit over 6.0 $GtCO_2$ per year, nearly 45% of total global power sector emissions. These government-owned companies are particularly dominant in many emerging economies, such as China, Indonesia, Mexico, and South Africa where they are major sources of domestic emissions.

At the same time, SPCs are also large providers of low-carbon power alternatives. While governments own nearly 50% of fossil fuel generation capacity, they also control about 60% of utility scale "zero-carbon" capacity (including large-scale hydropower and nuclear) and many transmission and distribution networks.

SPCs have been largely overlooked in the international climate discourse, with much of the focus on private investor-owned companies. While SPCs are the dominant firm type in the global electricity sector, representing nearly two thirds of large-scale global electric power generation capacity and controlling many of the world's largest power grids, most climate policy literature focuses on private sector companies when analysing decarbonisation interventions.

Government ownership of SPCs calls for SPC-tailored tools that will often differ from those used to incentivise independent private sector companies. This ownership provides both opportunities (e.g., the ability to nominate SPC executives) and challenges (political patronage) to decarbonise their activities.

While the climate policy literature has produced an extensive toolbox of market-wide policies and regulatory initiatives designed to incentivise private sector companies to transition to a low carbon future, it has paid relatively little attention to SPCs and their country- and market-specific contexts.

We propose a policy framework that recognizes the role of government equity ownership but considers it a part of a wider set of features that might determine SPCs' reactions to a range of possible policies and other interventions. These interventions are separated into targeted (i.e., SPC-specific) and market-wide actions. Targeted actions are broken down further into direct (exercise of shareholder power within the SPC corporate governance structure) and indirect (deployment of government resources outside this structure). We link these two aspects in order to evaluate the most promising climate policies for the SPC context and identify several insights:

Insight 1: SPCs require the application of tailored tools for them to be effectively incentivised to decarbonise. These tools will often differ from those used to incentivise private sector companies. SPCs typically operate under governance structures and incentives that are quite different from those facing their private investor-owned counterparts. These differences have major implications for the reactiveness of SPCs to government incentives to implement climate action. Simply applying conventional tools that are normally directed at private sector companies is unlikely to yield the desired results.

Insight 2: Under certain circumstances, an SPC can be a more effective vehicle for decarbonisation relative to private sector companies. While governments can influence SPCs through a range of tools, SPCs themselves often enjoy a degree of influence over the power sector which, if pointed in the right direction, can prove to be effective in pivoting to low-carbon electricity generation. Policies focused on private sector companies might not have the greatest potential to mitigate emissions, especially in countries where well-resourced and pseudo-monopolistic SPCs dominate. SPCs resembling the Grinding Behemoth and Statist Caterer archetypes, which are insulated from competition but relatively well equipped in terms of agency and capacity, could in practice far outstrip the speed and effectiveness (as distinct from efficiency) of a private utility in decarbonising the power sector asset base, and contribute more forcefully to sector-wide efforts, if the right targeted interventions are leveraged.

Insight 3: For many SPCs, market-based interventions (such as carbon pricing) are likely to catalyse a more limited response than for their private sector counterparts. This is particularly the case when the SPC is ill-equipped to translate purely price-based incentives into a shift to low-carbon investment and activity. Many SPCs operate with multiple mandates, including non-financial ones, and are also protected from competition such as to lessen the influence of carbon pricing mechanisms on their operations. It is therefore likely that for all but the most profit-oriented SPCs, most of the options in the traditional, neo-classical policy toolbox may not be the most effective in delivering timely and sufficiently ambitious climate mitigation outcomes.

Insight 4: Developing a generalised approach to climate policy design for SPCs can be instrumental in deploying appropriate tools to SPCs operating in different jurisdictions. Our initial attempt to do so results in the emergence of four SPC archetypes, which may be used as illustrative inspirations when considering an SPC that combines elements of two or more. Not all SPCs globally – or even within our sample - fit cleanly into the four archetypes, but the key factors used to generate them are, in this analysis, the most important considerations for policy makers in deciding which tools to deploy.

Governments across the globe face a stark challenge: they will need to rapidly and comprehensively raise their power sector decarbonisation ambitions if they are to achieve, collectively and individually, the end game of sector-wide carbon neutrality. SPCs can, and where they are major market players, must, be key actors in driving decarbonisation when the appropriate interventions are utilised.

1. Introduction

The electricity and heat sectors were estimated by the International Energy Agency (IEA) (2022) to be responsible for just under 40% of global CO_2 emissions in 2021. Electricity generated by coal-fired power plants (36% of total generation in 2021) and natural gas (23%) dominates the sector. Renewable power generation provides about 28% of the world's electricity (with hydropower constituting over half of that share) while nuclear provides 10% overall.

By comparison, model scenarios consistent with limiting global warming to 2°C above pre-industrial averages show that a dramatically different generation mix needs to emerge in less than two decades. In its 'Sustainable Development Scenario', modelling by the International Energy Agency (IEA) finds that remaining below 2°C requires coal's share of power generation to fall to just 8% by 2040, and natural gas' share to 14%, with renewables' role growing rapidly to provide two-thirds of all electricity. Non-hydro renewables account for three-quarters of the renewable share, or roughly half of total generation (International Energy Agency, 2019). Achieving the even more ambitious target of 1.5°C set out in the Paris Agreement will require an even larger and faster shift to zero-carbon electricity sources.

The power sector will need to undergo a radical transformation within the next fifteen years for these climate goals to be met. The power companies that own, operate, and build fossil-fuelled and zero carbon electricity generation assets are central actors in making this unprecedented shift happen. Alternative distribution and ownership models to those of the large-scale on-grid generation assets that characterise the power sector today are increasing in significance, largely in the form of small-scale decentralized renewables. But the power sector is likely to remain dominated by large power companies and utility-scale power plants for the foreseeable future, even as these smaller producers expand their presence. Power companies will also continue to play an important role in delivering power to consumers through large-scale transmission and distribution systems, as well as implementers of energy efficiency measures and users of demand-side response to support the emergence of a more sustainable energy mix. The decarbonisation of the energy sector will inevitably involve these companies at every stage.

Many of the world's largest and most important power companies are owned by governments. Companies owned in whole or part by a government are the dominant firm type in the global electricity sector, representing nearly two thirds of global large-scale electric power generation capacity either operating or under construction (Prag et al., 2018). To date, the systematic and idiosyncratic features of these companies have largely been

overlooked in the international climate change and climate finance discourse, with much of the focus remaining on private investor-owned companies. Despite governments' overwhelming presence in the power sector, the climate policy literature largely focuses on private sector companies when analysing decarbonisation interventions (Benoit, Clark, Schwarz, & Dibley, 2022), with correspondingly narrow interpretations of how investments are made and managed (Clark, Benoit, & Walters, 2022).

Moreover, there is a tendency to focus on the influence of independent power producers (IPPs) and national-level generation profiles on emissions, with too little attention paid to the role that state-owned vertically integrated utilities play in determining the fuel mix. In countries where state ownership in the power sector is prevalent, such integrated utilities are typically the sole purchasers of IPP-generated power, and in also acting as transmission and distribution companies (and, in some cases playing a role in grid operation), can play in determining the actual electricity fuel mix.

While certain common characteristics can be identified by analysing and comparing companies with government shareholders (Benoit et al., 2022), there are also important differences between them. These differences emerge not just in comparison to private (investor-owned) power companies, but are also closely linked to the country context, market(s) and corporate structure within which government-owned companies operate, as well as associated historical and political factors. This heterogeneity presents both opportunities and challenges to governments seeking to accelerate action on climate by firms in which they are sole or partial shareholders (Benoit, 2019a).

Section 2 of this report summarises the key characteristics of state-owned power companies (SPCs) and how they differ from private power companies. In Section 3, we survey six SPCs operating in large developing economies covering a range of macroeconomic, regulatory and political environments. In Section 4, we lay out a toolbox of potential interventions a government can use to incentivise climate action by SPCs. In Section 5, we present a brief guide to matching policy tools to SPCs with different characteristics and operating in different contexts. Section 6 concludes.

2. SPCs and the low-carbon transition

THE RELEVANCE OF SPCS

In this report, we define SPCs as those in which governments hold the majority of voting shares and therefore have financial control over the company. Government shareholders thus defined are the largest of all the institutional players in global power generation, with controlling shares in about 50% of utility-scale power generation capacity (see Figure 1).

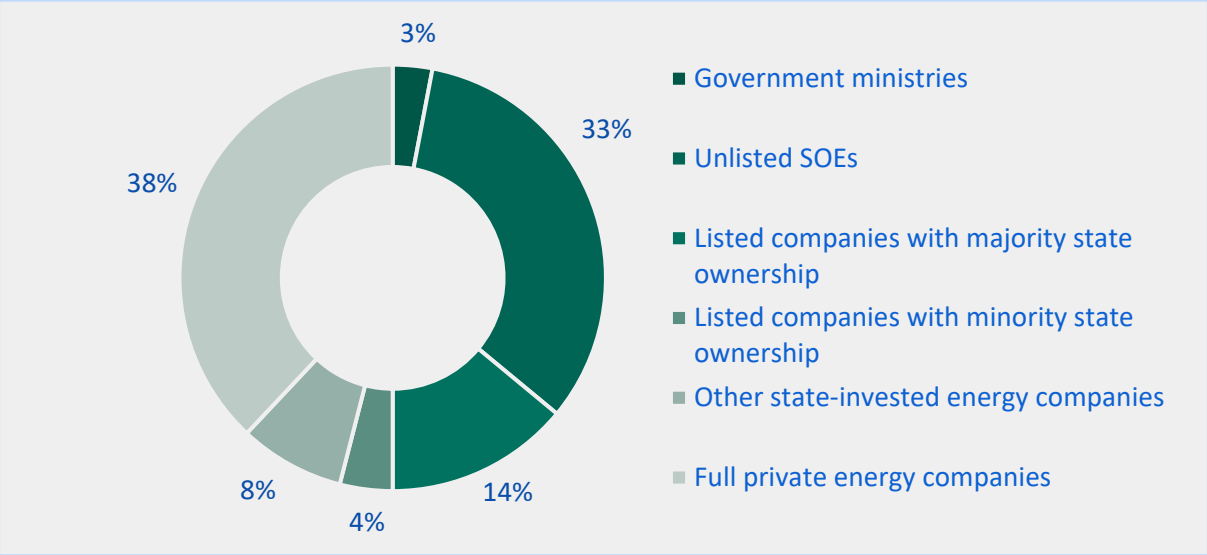

Figure 1. Government shareholding of power generation capacity in operation or under construction globally in 2016. Source: Prag et al. (2018)

SPCs are major drivers of emissions, as they are estimated to own about 42% of fossil-fuelled power generation capacity (see Figure 2) and an even larger share of new fossil fuel generation capacity commissioned in 2015 (54%), with nearly 75% of this capacity being coal-fired power plants (Adkins et al., 2016).

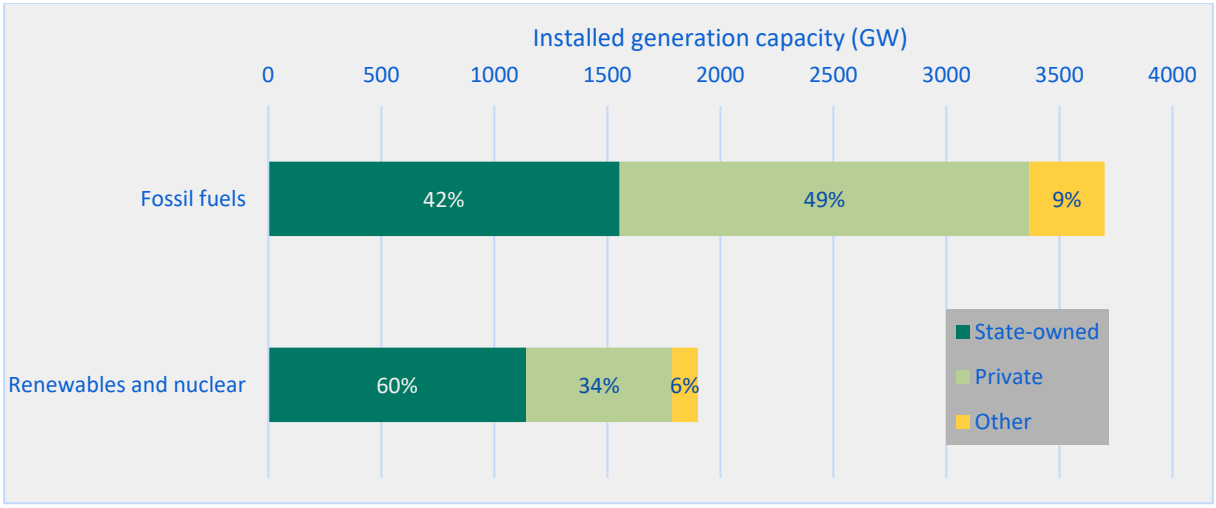

Figure 2. Governments own a significant percentage of fossil-fuelled generation and an even higher share of low-carbon generation globally. Source: reproduced from Benoit (2019a), which is based on IEA data for 2012. Renewables data is for utility-scale installations (i.e., excluding small household-size solar photovoltaic systems).

While SPCs exist in some form in most countries, SPCs with major or dominant roles in national power markets are particularly prevalent in large emerging economies that occupy a growing share of projected global electricity demand growth to 2030 and 2050 under current policies (see Figure 3).

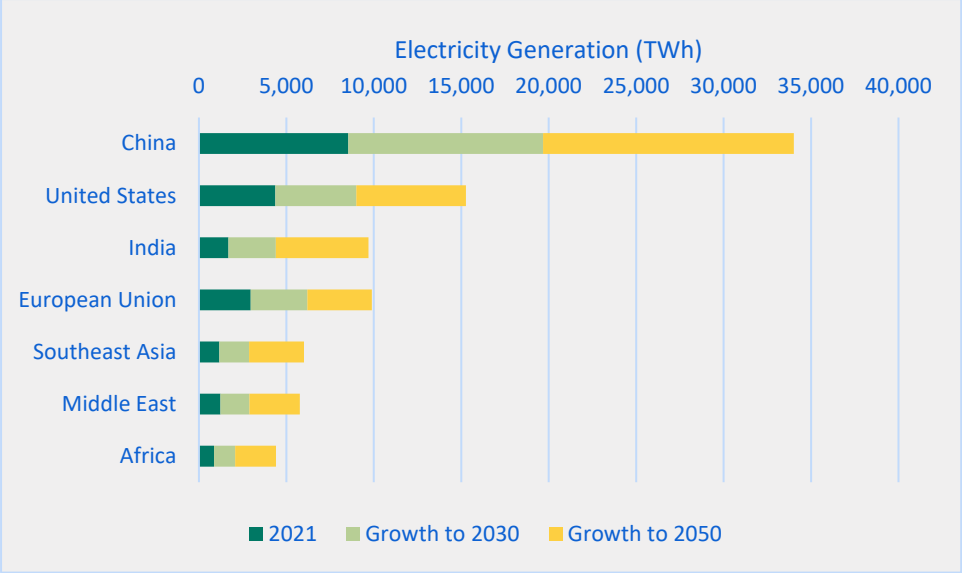

Figure 3. Electricity demand growth in emerging economies projected to outpace growth in US and EU, based on stated policies. Source: International Energy Agency (2022), Stated Policies Scenario.

Among these countries, China, India, Indonesia, and a handful of others are also heavily reliant on SPCs and state-owned enterprises (SOEs) generally (see Figure 4) to deliver and

make use of the expansion in electricity supply required to meet demand. Addressing the emissions associated with supply-side growth, and particularly reducing emissions – or even simply preventing emissions from rising – as electricity systems expand, will require dramatic action to be taken by SPCs in these countries.

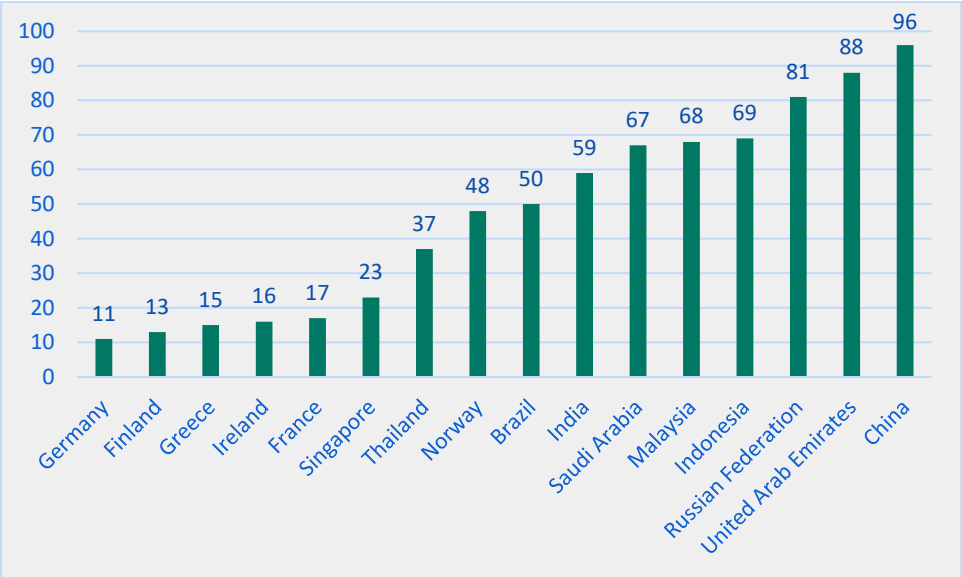

Figure 4. SOEs' share of top ten firms in large developing and developed economies. Source: Kowalski and Perepechay (2015), Figure 1. Note from source: "The shares refer to equally-weighted average of shares of state-owned enterprises in sales, assets and market value of country's top ten firms. Only countries with shares above 10% are shown."

To decarbonise while also meeting increased electricity demand (driven both by economic growth, and by increased electrification of final energy demand as part of the decarbonisation process itself) will require not only a sharp and permanent decline in absolute fossil-fuelled power generation, but also large additional investments in clean energy technologies. Once again, this is an area in which SPCs play active and in certain countries, dominant, roles.

Globally, about 60% of utility-scale renewable and nuclear (henceforth 'low-carbon') generation capacity is state-owned (see Figure 2). In Brazil, China, Mexico and elsewhere, SPCs own a majority of large-scale hydropower generation. This includes the world's largest hydroelectricity sites, such as the Three Gorges Dam in China, and the Itaipu Dam in Brazil/Paraguay. Of new low-carbon capacity commissioned in 2015, 45% was state-owned, with hydropower, wind, and nuclear accounting for over 90% of this capacity (International Energy Agency, 2016).

In discourse and in practice, developing countries have been strongly encouraged –in some cases through the promotion of structural adjustment programmes – to pursue industrial strategies based on market principles, with mixed results (Rodrik, 2008; Smets & Knack,

2016; Swaroop, 2016). Despite the dominance of this liberalisation discourse (see Box 1), SPCs continue to play, and in some cases are consolidating, central roles in executing national economic development and growth strategies. China's SPCs, and state-owned enterprises generally, play an explicitly strategic role on behalf of the country's national and provincial governments in advancing the country's economic and social interests. Under the López-Obrador administration, Mexico's government has actually been increasing the strategic role of the state-owned *Comisión Federal de Electricidad* (CFE) in the power sector, and centring Mexico's other large state-owned enterprises in the country's development planning processes.

Besides generating power themselves, SPCs are major actors in transmission, distribution, and – in some cases – dispatch. They are also often procurers of electricity from privately-held IPPs. Indeed, total government investment in electricity network infrastructure in 2015 exceeded that for generation (see Figure 5). The public sector owns and manages a large share of transmission and distribution assets and supporting infrastructure globally. Governments are the largest shareholders, or majority shareholders, in electricity network infrastructure companies in some of the world's largest electricity consumers, including China (State Grid Corporation of China, 2023), Mexico (Comisión Federal de Electricidad, 2023b), Indonesia (Perusahaan Listrik Negara, 2023) and Brazil (Eletrobras, 2023). State ownership of network assets is also not confined to developing economies: France's transmission system is managed by the *Réseau de transport d'electricité* (RTE), the largest such operator in Europe with over 100,000 km of lines. RTE is in turn a subsidiary of the SPC *Electricité de France* (EDF) (see Prag et al., 2018, Figure 2).

The extent of transmission and distribution losses across electricity networks, and the transmission capacity of those networks (especially across long distances), is a key driver of system efficiency, in turn determining the need for – and in some cases, location of – electricity generation activity. Public sector entities are also generally responsible for the operation and regulation of electricity dispatch and ancillary market systems that determine the energy mix at any point in time. The system operators also set the rules that determine how high- versus low-carbon assets are dispatched. These, among others, are operational issues that, beyond the technology mix of installed capacity, will affect the actual energy mix by shaping how fossil versus low-carbon capacity is dispatched and what it is used for. Where state-owned generation, distribution and dispatch coincide, government has a high degree of influence, through power sector SOEs and regulatory bodies, over electricity market decarbonisation.

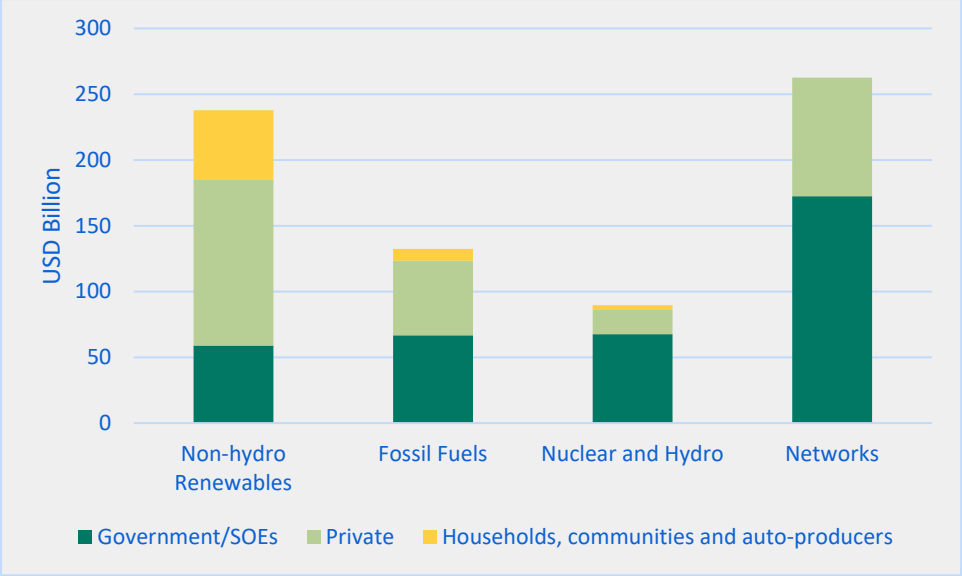

Figure 5. Share of government investment in networks and generation (renewables, fossil fuels, nuclear) in 2016. Source: Prag et al. (2018).

SPCs that also own network infrastructure have a particularly central role to play in adaptation and resilience to climate change.[i] How and where transmission infrastructure is installed will affect power markets' ability to tap into renewable sources. This is especially the case for wind and hydropower (which are often relatively distant from demand centres) and for island geographies with a mixture of centralised and decentralised capacity (such as Indonesia). Transmission and distribution systems are also critical points of vulnerability to extreme weather events and other sources of climate-related disruption. In Mexico, Puerto Rico, and France (all of which have state-dominated electricity sectors), hurricanes and the resulting damage to both network infrastructure and generation capacity have laid bare the hazards climate change creates for the power sector.

Strengthening the resilience of physical infrastructure in the power sector will require a combination of new technologies, greater system redundancy and low-carbon backup power for use during grid interruptions, additional investment in network infrastructure, new business practices and models based on public-private partnerships, more systematic integration of predictive algorithms and monitoring services into planning and operations, and upgrading of energy system management tools. It will also require investment in institutions, beginning with strengthened cooperation and planning across public and private sector actors. The ability of SPCs to build resilience into their assets and strategy will be a key factor in determining the short- and long-term performance of power systems in the countries in which they operate.

SPCs ARE DIFFERENT FROM THEIR PRIVATE SECTOR COUNTERPARTS

While SPCs produce electricity in the same way as private companies, they often operate under corporate mandates, market conditions, and governance structures that differentiate them from their private sector counterparts (Benoit, 2019a; Benoit et al., 2022). While no two SPCs are alike, they share certain distinctive features with respect to their private sector counterparts which can help to inform strategies for reducing SPCs' greenhouse gas emissions (Benoit, 2019b).

a. Service delivery versus shareholder value maximisation. Private power companies, even highly regulated ones, typically operate in order to generate returns for their private shareholders. In contrast, many SPCs are explicitly mandated not to be pure profit maximisers, but primarily to deliver reliable, low-cost electricity to support a combination of national economic growth and social development objectives. While most SPCs aim to maintain some degree of profitability and avoid chronic or unsustainable operating losses by aiming to recover their costs at a minimum, large profits (especially in a monopolistic or oligopolistic market setting) can engender hostility from government shareholders and the public. In response to this risk, SPCs' mandates and incentive structures can be designed such that SPCs prioritise the expansion of their asset bases through continued construction of power plants and supporting infrastructure. By giving them more relative control over service provision, these investments can serve to enhance their contribution to national economic performance and entrench the commercial and political power associated with this.[ii] SPCs can also function as a tool for ensuring government control over strategic power sector assets and systems from an energy and national security perspective.

b. Social and economic mandates. SPCs are often mandated to fulfil social and other nonfinancial government goals, such as subsidising the provision of electricity to those who lack it when there is no business case for doing so, generating employment, and providing subsidised low-cost electricity to households and even businesses. An SPC might be tasked with providing these services at very low or even negative profit margins, or cross-subsidising unprofitable segments with profits from other operations, to ensure that higher-order government priorities are fulfilled. Governments also look to their SPCs to act as driving forces in expanding electricity access and reliability, as in the case of Brazil's *Luz Para Todos* programme (Eletrobras, 2017).

c. Protection from competition. Through a combination of market controls and privileged access to public funds, governments tend to insulate their SPCs from fully competing with private sector peers. Some of the largest SPCs still hold monopoly rights over power generation and/or marketing (Eskom, 2023; Perusahaan Listrik Negara, 2023), as well as

over transmission networks (which have traditionally been viewed as natural monopolies).[iii] The government has significant latitude to directly determine the domestic market conditions SPCs face. Similar protections can also apply to private investor companies under regulated regimes, such as regulated asset bases providing a guaranteed minimum rate of return on regulated assets, and protections against competition in certain areas, including in the US (Hale, 2021; U.S. Environmental Protection Agency, 2023), However, these private companies are still ultimately in business to generate financial returns for profit-seeking shareholders in financial markets, not to serve the social and economic goals of a government shareholder.[iv]

d. Government shareholder prerogative. State ownership gives governments the ability to directly leverage their shareholder power in order to influence SPCs' strategy, and therefore their emissions trajectory. This is a tool that it does not possess with respect to private companies. As sole or majority shareholder, governments can exercise their power through formal corporate governance structures and mandates (such as shareholder resolutions), and appointments to (and dismissals from) the board of directors and senior executive cadre. In some cases, senior personal or board members at SPCs hold parallel roles in the government's civil service or hold ministerial portfolios. In 2015, for instance, the ruling Communist Party of China began "formally requiring the joint appointment of Party secretary–board chairman posts in SOEs" (Leutert & Eaton, 2021). In Mexico, the chairman of CFE is also the energy minister, while other board members include the ministers of finance and the civil service (Comisión Federal de Electricidad, 2023a). Government owners can also exercise their influence through less formal channels, such as periodic consultations with the SPC's chief executive and joint strategy exercises with government officials. This influence is not unidirectional, however: larger and more powerful SPCs may enjoy sufficient political influence or economic weight to be able to effectively resist government guidance, or delay its implementation.

e. Access to public sector resources. SPCs typically form part of a wider network of other state-owned and state-controlled companies, agencies, and ministries that governments can mobilize to support them. Of particular importance is the possibility of financial support from state-owned banks or direct transfers from government budgets. Having a common government owner can make it easier to coordinate activity among public sector entities than to coordinate with private sector actors. This can in principle extend to accessing financing on preferential terms, and to permitting and the ability to expedite other regulatory processes. Moreover, governments may be more willing and able to mobilize substantial direct public sector support for SPCs than for private sector companies (e.g., in the name of energy security), not least because overt assistance to the latter can give rise to claims of corruption,

preferential treatment or otherwise unjustified government backing to specific private interests.

f. Dampened commercial culture. To the extent that SPCs are insulated from competition and enjoy privileged access to government resources, as well as facing a myriad of non-financial mandates, their responsiveness to market signals, including prices and risk, can be dampened relative to their actual private sector peers or an idealised free-market firm. This differential in responsiveness can also help to engender an inflexible or complacent business culture, a criticism often directed at large state companies, making it more difficult for them to undertake many of the technical and strategic innovations that are required for the low-carbon transition to proceed at pace. This in turn highlights the important role of the CEO, the composition of the senior executive team, and the incentives facing managerial staff.

Given the range of distinctive features they exhibit, enlisting SPCs in the effort to address climate change requires different tools to those used for directing the behaviour of private companies. There is copious and robust literature on theoretically efficient policy tools for decarbonisation, particularly carbon pricing and trading mechanisms. This literature, and the real-world systems put in place to operationalise its findings, are however designed to cater to private companies that are, in principle, responsive to anything affecting short- and long-term profitability. However, much less has been written about how state-owned power companies might respond to these 'traditional' policy approaches to decarbonisation, and what other incentives or tools might be more effective at inducing them to embark on transformative low-carbon development pathways (Benoit, 2019b).

NOT ALL STATE-OWNED POWER COMPANIES ARE CREATED EQUAL

Notwithstanding the several common characteristics of SPCs, there are also important differences between them that require any decarbonisation strategy to be tailored to the circumstances of specific companies. While the range of circumstances in which SPCs operate is extensive and complex, below are several elements that are particularly relevant to this discussion:

a. State and market philosophy: Governments have wide-ranging views on the appropriate role of SPCs (and the public sector generally) in economic activity, which affects the regulatory framework within which SPCs operate. For example, contemporary China is more supportive of SOEs as direct drivers of economic growth than the US. Even the US government, however, does control several SPCs (the most important of which is the Tennessee Valley Authority), even while SPCs are collectively far less dominant in the US than in China. Korea, by contrast, has generally pursued a private enterprise model in

developing its economy, with the power sector remaining one of few sectors where state ownership continued to dominate, in the form of KEPCO and its many subsidiaries.

b. Government interventionism: A separate but related dimension is the extent to which a government, based on its ideological foundation and political culture, is willing to intervene directly in the business affairs of its SPCs. The willingness and ability of a government to guide the corporate activity of individual SPCs depends on both the historical context in which the SPC is embedded, and the prevailing political and business cultures in which the government and the SPC operate. Power relations between SPC and government, informal communications, and unwritten norms, can also have a profound effect on the nature and consequences of government-SPC interactions.

c. Commercial autonomy and capacity: SPCs enjoy differing levels of operational and financial autonomy. Some have robust governance structures in place designed to enable management to operate the company on a commercial basis and limit scope for political interference (see Box 1). In other cases, management is purposefully subjected to political pressure, particularly in times of economic crisis or when the government or political leaders are acting under duress. In general, several factors may determine the extent of an SPC's commercial autonomy, including: (i) government's desire to dictate or guide its SPCs directly, or to influence them at arm's length through broader market instruments; (ii) whether or not the corporate governance structure provides for managerial and board independence;[v] (iii) the technical capacity of the SPC and its exposure to market competition; and (iv) the SPC's capacity to resist government pressure. An overarching factor affecting all of these, is whether the SPC generates enough revenue to reliably cover its costs, or is chronically dependent government budget transfers. Most SPCs rely on a mixture of budgetary and other public financing to fund capital investments that would otherwise be difficult to justify on a financial basis alone, especially where regulated tariff structures or consumers' inability to pay limit SPCs' ability to generate revenue. Where government makes greater contributions to an SPC's budget, it may be able to exert greater influence over its investment choices by attaching conditions to the funding or financing that it provides.

d. Exposure to competition: While SPCs often differ from private sector counterparts in their degree of exposure to competitive forces, this is also the case amongst SPCs. For example, SPCs in South Africa (Eskom), Indonesia (PLN) and Korea (KEPCO) face little to no competition in their dominance of domestic power generation markets. To the extent that IPPs operate in these markets, they are still generally obliged to sell their power to SPC monopolies. In contrast, notwithstanding the tightly regulated nature of Chinese electricity markets, China's 'Big Five' and 'Small Four' power generators operate in a somewhat

crowded field populated by numerous public sector generators of various sizes and specialisations, as well as some private companies.

e. Listed companies and minority private shareholder structures: Private market participants hold minority shareholdings in several major SPCs, some of which are also publicly traded on stock exchanges. As of December 2022, about 11% of France's EDF was owned by private shareholders (EDF, 2023). This is also the case for Chinese SPCs. Some of the more specialised subsidiaries of China's largest power companies are listed on the Hong Kong and Beijing exchanges, although they typically constitute a small share of the companies' total assets (Herve-Mignucci, Wang, Nelson, & Varadarajan, 2015). The presence of shareholders (and corresponding voting rights) focused on generating returns can limit SPCs' ability to take decisions that deviate from profit maximising behaviour. Public listing, and its corresponding disclosure obligations, can also provide advocacy groups and activist shareholders with venues for attempting to influence company behaviour or file resolutions demanding changes in strategy, structure or board composition. This does not mean, however, that listed SPCs are effectively private corporations. Firstly, where the majority shareholder is a sovereign entity with a high degree of discretion over the SPC's license to operate, minority shareholders' power can be in practice be limited to accessing disclosed information associated with being a publicly listed company, particularly where the government owner is already committed to a particular regulatory, economic or commercial model within which it expects its SPCs to operate. Second, the low-carbon transition is, particularly outside OECD countries, still driven more by policy objectives than pure commercial outcomes. Consequently, profit-driven minority shareholding will not necessarily favour low-carbon investments, even accounting for increasingly salient shareholder activism.

f. Subnational dynamics: The direct owners of SPCs are not always national governments. In India, the government's shareholding in NTPC (a large and heavily coal-based utility) is at the national level, while India's state governments are the direct owners a number of important distribution and other power companies. In China, the Big Five SPCs that generate about half the country's power are all owned at the national level (albeit with provincial and listed subsidiaries). However, subnational authorities, such as provinces and municipalities, are the direct owners of thousands of SPCs and SOEs in other industries (see Herve-Mignucci et al., 2015, Figure ES-1). Consequently, not all SPCs within a country answer to the same governmental owner, generating an additional layer of complexity. This is especially true where subnational and national government incentives and priorities are not fully aligned, or even entirely misaligned.

g. Corporate cultures*:* Although SPCs are public sector entities, their corporate cultures can differ markedly, in turn affecting their openness to, and ability to embrace, the low-carbon transition (see Box 2). SPC corporate culture can be driven by many different factors. Company leadership and the CEO play a role, but a range of aspects of corporate governance also matter. Even China's Big Five, all of which are ultimately owned by the Chinese national government, have developed markedly different approaches to the transition. A particularly relevant aspect of corporate culture is the ability of SPCs to cultivate entrepreneurial approaches to strategic and operational challenges. This capacity to innovate may prove crucial in facilitating an SPC's transition away from traditional high-carbon operations into new, less-tested low carbon areas using less well-understood technologies and system management tools. Where an SPC enjoys some degree of insulation from wider market risks, they can act as an incubator for taking new technologies to large-scale markets (reflected in China's use of SOEs to rapidly scale up solar panel and wind turbine manufacturing in its nascent phase, initially for export then later for domestic deployment).

h. Power procurement: Most SPCs generate their own power directly, through operating their own assets. Many also procure electricity from IPPs, either by contracting with them directly, or by supporting government procurement processes. To the extent they do purchase power from third parties, SPCs can exert influence over the choice of generation technologies through their involvement, if any, in the administration and management of the procurement process (typically through an auction or other competitive means). Vertically integrated utilities, such as PLN in Indonesia, play strategic roles in managing IPP procurement, given their responsibility for network infrastructure. Vietnam's SPC, Electricity of Vietnam (EVN) is vertically integrated and also has responsibility for system operation and dispatch (Brown & Vu, 2020). In Mexico, CFE played a direct role in IPP administration until an independent system operator was established in 2014 (Vietor & Sheldahl-Thomason, 2017). SPCs and other publicly-managed entities in transmission, distribution and system operation – which can, for vertically integrated power sectors, be one and the same company – are responsible for managing the dispatch of power from different plants, and are able to exercise a degree of control (formal or otherwise) over which capacity additions are made, and criteria for the dispatch of different generation sources (typically focused on cost and reliability).

i. Restructuring and consolidation: In many jurisdictions, SPCs are vertically integrated utilities with monopolies over transmission, distribution and generation, while in others, the power sector features a number of SPCs whose corporate profile has varied over time. Eskom and KEPCO are clear illustrations of the former, while the various restructuring exercises that resulted in the current incarnation of China's Big Five illustrates the latter. Like

any other company, SPCs evolve over time. Government shareholders, have the ability to expand, restructure or otherwise shift the mandate of existing SPCs, or even create new companies specialised in particular technologies. Effective restructuring may be vital to the success of the low-carbon transition, especially where it requires large-scale investment and rapid deployment of new or immature low-carbon energy technologies. This has long been the case in China, where restructuring of SPCs (and SOEs more widely) is a constant and ongoing process, and where the creation of the Big Five from their single monopolist predecessor played a major role in facilitating specialisation in solar and nuclear experimentation and growth, and in wind turbine manufacturing and deployment (Lai & Warner, 2015). Despite appearing relatively static in its corporate structure, Mexico's CFE in fact absorbed (at the direction of the government) the country's second-largest SPC, *Luz y Fuerza*, in 2009 (BBC News, 2009). The structural and cultural changes that result from these consolidations, as well as the impact on technical capacity and physical capital stocks, can have a significant impact on SPCs' approaches to the low-carbon transition.

j. High-carbon asset incumbency: The absolute size and relative share of capital asset stocks dedicated to high-carbon operations will directly affect the willingness of an SPC to engage in a new pattern of low-carbon activity, both from a financial and change management perspective. SPCs with fewer high-carbon assets to transition to low-carbon equivalent will face fewer practical challenges in doing so than SPCs with, for example, a large fleet of coal power plants that have not yet been fully amortized.[vi]

Box 1: What does a self-motivated SPC look like? (Adapted from Benoit (2019a)).

One of the most powerful sources of effective change for an SPC can arise from a clear decision by management to pursue the low-carbon transition as an expression of the SPC's corporate interests (whether these are purely profit-driven, or reflect a combination of priorities). The major SPCs globally count themselves among the world's largest companies, with control over extensive physical asset portfolios and financial resources (Benoit, 2019a; Prag, Röttgers, & Scherrer, 2018). They can boast a high degree of technical and commercial competence and run sophisticated and complex businesses across not only power (especially hydro and nuclear), but also – in the cases of some state-owned conglomerates – oil and gas, mining, steel and finance.

This powerful combination of resources available to SPC management can greatly facilitate the implementation of ambitious corporate strategies designed to exploit the commercial and economic development co-benefits of low-carbon pathways. Examples of the former may include using low-carbon assets to expand existing markets or enter new ones, even those traditionally served by other SPCs; or taking immediate action to lower emissions from existing assets to pre-empt regulatory or policy measures and anticipate changes in market conditions as renewables markets become more competitive. In the latter case, SPCs can also leverage their access to government resources to strengthen their contribution to national economic development by using low-carbon development to enhance energy security, improve health outcomes, lower electricity generation costs, and reduce dependence on oil, gas, and coal.

3. A survey of selected real-world SPCs

To provide an empirical grounding for our analysis, we conducted case studies of six major SPCs, all operating in different jurisdictions. These are KEPCO (Korea), NTPC Limited (India), State Power Investment Corporation (SPIC, China), Comisión Federal de Electricidad (CFE, Mexico), Perusahaan Listrik Negara (PLN, Indonesia), and Eskom (South Africa).

We limited our focus to SPCs (i.e. majority government-owned companies) operating in countries where a substantial share of power generation is generated by SPCs, and in which the power sector in turn represents a large share of total energy emissions (Table 1). In China's case, SPIC is responsible for 5% of total national generation, but SPCs in general are responsible for the vast majority of total emissions from the country's power sector (Herve-Mignucci et al., 2015), while also dominating low-carbon capacity additions (Prag et al., 2018). In Indonesia, the power sector is responsible for about 40% of total energy emissions, while in India, estimates indicate that its SPCs produce over 40% of total thermal electricity, which in turn emits half of India's energy-related CO_2 emissions (Benoit, 2018; OECD, 2015b).

Table 1 ***Overview of selected cases.*** *Adapted from Benoit et al. (2022).*

Country	Company	Income group	Power market concentration (HHI) [1-100]	Government equity ownership	Share of total national generation	Installed capacity (GW)
Korea	KEPCO	**H**	High (60)	51%	92%	83.7
India	NTPC	**M/L**	Very low (6)	51%	25%	65.8
China	SPIC	**M/H**	Very low (8)	100%	5%	165
Mexico	CFE	**M/H**	Moderate (52)	100%	79%	56.18
Indonesia	PLN	**M/L**	Moderate (50)	100%	66%	41.7
South Africa	Eskom	**M/H**	Very high (87)	100%	85%	44.2

We selected specific SPCs to exploit variation in power market concentration (as a rough proxy for competition) and government equity ownership (as a proxy for the degree of control government exercises over the SPC) to ensure representation of different regulatory and

market environments, and different roles for government shareholders, as potential drivers of SPCs' responses to policies designed to accelerate their decarbonisation efforts.

Table 2 presents a selection of data points across five categories relating to the SPCs studied, covering (a) ownership; (b) operations; (c) financial structure and viability; (d) market structure; and (e) the enabling environment for low-carbon investments. Data was gathered prior to the very significant disruption in economic and energy markets that accompanied both the advent of COVID-19 in 2020, and Russia's invasion of Ukraine in 2022, both of which may have had a significant impact on each SPC – but this is of limited relevance to our analysis, since our objective is not to develop recommendations specific to each but to build a holistic understanding of SPCs in general. For each category, we summarise key observations, similarities and sources of variance.

OWNERSHIP

While governments' equity ownership of the six SPCs studied is an important indicator of their control over firm governance, the details of the regulatory relationship between government and firm are also important in defining the extent of government influence over the SPC beyond its equity stake alone. Government holds 100% of the equity interest in four of the six SPCs studied (PLN, Eskom, SPIC, and CFE), and approximately 51% of KEPCO and NTPC, just enough to retain majority control. IN KEPCO's case, the government's stake is held primarily through the Korea Development Bank. In each case, the remaining shares are held by a combination of stock market participants – for the proportion of shares that are tradable – and other actors, some of which may be pseudo-governmental (e.g. national pension funds).

At least as important as equity ownership (and sometimes linked to it) is the ability of government shareholders to intervene on board composition, executive appointments, and introduce formal directives that the SPC is required to follow. In all of the 100% owned cases, government has wide-ranging control over the board and executive appointments, with consequent influence over the SPCs' strategy and operations. In the case of KEPCO and NTPC, this control is more limited. In some cases – like SPIC – some of the parent company's assets are held by publicly listed subsidiaries over which external investors may hold some influence, but government retains full control at the parent level and in practice, of the overall corporate structure.

Table 2. Meso-level comparative assessment of six major SPCs in detail.

Characteristic	CFE	Eskom	KEPCO	NTPC	PLN	SPIC
a. Ownership						
Government	Mexico	South Africa	Korea	India	Indonesia	China
Proportion of government equity ownership	100%	100%	51%	51%	100%	100%
Company listed in a domestic stock market	No	No	Yes	Yes	No	Subsidiaries only
Government control on Board composition	Yes	Yes	Limited	Limited	Yes	Yes
Government control over executive appointments	Yes	Yes	Limited	Yes	Yes	Yes
b. Operations						
Vertical integration	Yes	Yes	Yes	No	Yes	No
Technological diversification	Low	Very low	Moderate	Low	Very low	High
Generation source(s)	Fuel oil, gas, hydro	Coal	Coal, nuclear	Coal, gas	Coal	Coal, solar, wind, hydro, nuclear
Access to fossil inputs	High (including via Pemex)	Moderate (domestic coal)	High (owns coal mines)	Moderate (domestic coal)	High (domestic coal)	High (owns coal mines)
Technical/commercial Capacity	Moderate	Low	High	High	Moderate	High
c. Financial						
Financial Performance	Moderate	Low	High	High	Low	High
Subsidies	Producer, consumer	Direct	Electric vehicles	Consumer	Direct	Direct, producer, offtaker
Profitable (subsidised)	Yes	No	Yes	Yes	Yes	Yes
Profitable (unsubsidised)	No	No	Yes	Yes	No	Unclear
d. Market structure						
Exposure to competition in generation market	Yes (IPPs)	Very limited (94% share)	Yes (IPPs)	Yes	Yes (IPPs)	Yes
Private participation in generation	Yes	Very limited (8% of total)	Yes (30%)	Yes	Yes (33%)	No
Competition in T&D	No	No	No	Yes	No	Yes
Prospects for unbundling	No	Uncertain	No	Completed	No	Completed
Power dispatch	Merit order reversed in 2021. CFE sources prioritised	N/A	Merit order	Bilateral PPAs with distribution companies	N/A	Equal shares (thermal)
Electricity demand growth rate	High	Moderate	None/negative	Very high	Moderate	Moderate
Energy policy uncertainty	High	High	Low	Moderate	Moderate	Low
e. Enabling environment for low-carbon investments						
Climate policy ambition (trend)	Moderate (weakening)	Moderately Low	High (rising)	Moderately Low	Moderately Low (rising)	Moderate
National net-zero emissions target	No	No	2050	No	2060	2060
SPC-level net-zero emissions target	No	No	2050	No	2050	Peak 2023, 75% low-carbon capacity by 2030

OPERATIONS

All of the SPCs except SPIC and NTPC are vertically integrated utilities with major roles not just in power generation, but also transmission and distribution to the industrial, commercial, and household electricity market segments. CFE in Mexico and PLN in Indonesia have their own generation assets, but also procure a significant amount of electricity from private IPPs for which, in most cases, they are the soler offtaker. In India, NTPC is the largest single generator, but government relies on subnationally-owned, heavily-subsidised distribution companies to implement the electrification agenda that is a prerequisite for decarbonising parts of the energy system. In China, SPIC has a very large portfolio of generation assets, but is one of nine major centrally-owned SPCs with different specialisations and competes with a much larger number of subnationally-owned SPCs at the provincial level, while grid operation is controlled by two other state-owned companies.

All of the SPCs studied have large fossil fuel-based electricity generation portfolios. Coal-fired power generation remains the key power generation mechanism for most SPCs with the exception of CFE (fuel oil and gas). Consequently, strategic access to fossil fuel reserves remains a key priority for SPCs and governments alike. This being said, SPIC has emerged as a dominant player in domestic and overseas renewable energy markets, with major investments in wind and solar power having made it the largest corporate generator of renewable power globally (Shaw & Hall, 2021). Beyond fossil, SPCs have often been instrumental in launching, supporting, and expanding national nuclear power programs and other capital-intensive power sources such as large hydro. SPIC is one example; KEPCO has historically played this role in Korea too, but a recent decision by the government to phase out nuclear power may result in it losing this position going forward.

MARKET STRUCTURE

While all the SPCs studied face some form of competition in the electricity market, the degree to which this competition influences SPCs' decision making varies. In principle, Eskom controls the entire South African market, as do PLN, KEPCO, and CFE for their respective markets. Although they are all vertically integrated and act as near-sole purchasers of on-grid electricity, they all face competition from IPPs in developing generation assets. IPPs compete with SPCs' internal capacity to self-develop assets and may be able to provide electricity supplies on more attractive terms than the SPC can offer itself. Where an SPC is mandated to provide low-cost, secure power supplies and is also responsible for power delivery, it may be incentivised to purchase power from IPPs where it is cheaper to do so, even at the expense of its own market share in power generation. Despite China's power sector being overwhelmingly state-owned, SPIC is confronted with intense competition from

centrally and provincially-owned peers. NTPC operates in a context that most closely resembles a liberalised electricity market, although there are still sharp divergences from free markets, with coal price controls and subsidised distribution endemic in the Indian system.

In terms of future outlook, with the exception of Korea, all SPCs will be faced with moderate-to-high electricity demand growth rates that in some cases will prove extremely challenging – albeit not impossible – to satisfy at the same time as decarbonising, especially for Indonesia (depending on the availability of external support through the Just Energy Transition Partnership package recently announced by a number of major donor governments).

IDENTIFYING SPC CHARACTERISTICS RELEVANT TO CLIMATE POLICY

Notwithstanding the wide variety of SPCs and the many sources of differences among them, in this section we seek to understand which are the most relevant to prospects for decarbonisation, and why. Drawing on the case study analysis and combining it with the existing literature on SPCs, SOEs and their respective characteristics vis-à-vis private firms surveyed and presented in Section 2, we identify a set of key high-level factors characterising and distinguishing SPCs from each other (Table 3).

When considering the sources of difference both from private sector peers and among SPCs, the four key factors that may be most important in driving SPCs' responsiveness to decarbonisation policies emerge as: agency (corresponding to 'ownership' in the case study analysis), profit motivation (financial structure), capacity (operations), and exposure to market competition (market structure). Table 3 defines each factor and describes 'low' and 'high' performance against it. The 'enabling environment' category is of course important, but is a more exogenous factor relating to government policy rather than a characteristic of the SPC or its structural position within the power market. These factors are broad enough to capture a wide range of possible sources of variation, but also specific enough to be useful in narrowing the set of climate policy tools appropriate to SPCs exhibiting different combinations of characteristics.

Table 3. Key factors driving SPC responsiveness to decarbonisation policies, and descriptors for low/high performance against each.

Factor	Definition	"Low" descriptor	"High" descriptor
Agency	*Degree of independence SPC has over decision-making, and by extension its ability to influence government decision-making to ensure favourable treatment.*	- Government exercises close control over management and operational decisions. - Replacement of executives and board members is politicised and reflects (party) political affiliations.	- SPC exercises a high degree of autonomy and independence in commercial operations, staffing and strategy decisions. - Replacement of Executives and Board members is undertaken for commercial reasons and with input from advisors outside government.
Profit motivation	*Degree to which financial goals drive SPC decisions, relative to non-financial goals.*	- Predominant focus on non-financial goals (e.g., national development, energy security, low-cost service provision, employment, rent-seeking, political patronage).	- Focus on maximizing profits (or similar financial goals, including revenue growth) over non-financial goals.
Capacity	*SPC's degree of financial, operational, technical and commercial capacity to implement a low-carbon strategy.*	- Poor financial situation, tending towards bankruptcy without government support. - Chronic dependence on transfers from public budget. - Faces difficulty in guaranteeing reliable delivery of services. - Very limited experience with low-carbon technologies.	- Ample financial resources; able to tap capital markets to finance strategic investments. - Strong commercial, operational and technical competence. - Direct experience in deployment of low-carbon technologies.
Exposure to competition	*Degree of exposure to free market competition.*	- Faces significant competition in generation markets. - Limited or no involvement in distribution and transmission.	- No or very limited competition from other generators. - Monopoly over transmission and distribution, typically as a vertically integrated utility.

4. Incentivising SPCs to decarbonise: a toolbox of interventions

SPCs can exhibit a wide range of characteristics that not only affect their potential to drive decarbonisation, but also how they would respond to the introduction of incentives to begin or accelerate their decarbonisation efforts. In turn, the set of possible interventions available to government in dealing with their SPCs are broader and more diverse than for private firms. Some interventions can be tailored to account for the distinctive features of SPCs as a class of actor. Others are market-wide regulatory actions or price/quantity-based mechanisms that target SPCs and private sector companies alike. Both types of intervention can be effective, but just *how* effective, and *which* tools are best, depends on how SPCs feature in the power sector landscape in any given jurisdiction and what characteristics they exhibit. Moreover, SPCs themselves have internal corporate and management dynamics that, leveraged in the right way, can drive these enterprises to actively engage in the low-carbon transition. These include the commitment of the CEO, incentives for mid-level managers, and the training, incentives and capacities of operational, commercial, administrative and other managerial staff.

In this section, we outline the expanded suite of possible interventions governments can use to mobilise SPCs in decarbonising the power sector. We comment briefly on the relevance of SPCs' corporate culture and performance in determining the efficiency and effectiveness with which a given strategic or operational goal is achieved. Finally, we examine the relevance of more exogenous contextual factors in SPC decision making and implementation. In the section following this one, we suggest ways of matching these interventions to SPCs, bearing in mind their possible reactions to different types of intervention.

The first type of intervention comprises the standard climate policy toolbox of **market-wide** actions designed to apply equally – in principle – to all market participants, private and state-owned alike. Market-wide measures either affect, or are available to all firms active in the components of the power market to which the measure applies, and are not specific to an SPC or group of SPCs (unless there are no private firms in that market). Traditionally, market-based mechanisms are designed under the assumption that target firms are profit-maximising, investor-owned private companies. They include carbon pricing mechanisms such as emissions trading systems and carbon taxes, as well as regulatory measures such as renewable portfolio standards, technology standards, changes in dispatch regulation, changes to pricing regimes (e.g., introduction and withdrawal of subsidies), use of feed-in-tariffs and other price support measures, and broader funding of relevant research and deployment.

The second broad category of intervention is the possible set of **targeted** actions specifically affecting an SPC or set of SPCs. Targeted actions are broken down further into **targeted direct** actions in which government directly exercises its shareholder prerogative within an SPC's corporate governance structure; and **targeted indirect** actions in which government uses the deployment of resources outside an SPC's corporate structure to influence its behaviour.

- **Targeted direct** actions rely on the government's prerogative as sole or majority shareholder in the target SPC. These 'targeted direct' actions are mechanisms and policies designed to influence SPCs directly, where the government exercises its ownership rights. These include formal directives and instructions, appointments and dismissals of board members and senior executives, and informal discussions between government and SPC executives. Relative to a typical private sector firm (publicly listed or otherwise), the ability to exercise shareholder power in this way presents the clearest advantage for governments, since it can simply require the SPC to take certain specific actions, change the parameters under which it operates, and hold it accountable for meeting certain objectives.
- **Targeted indirect actions** operate primarily through the deployment of government resources as a means of influencing the decision-making of an SPC. Government can make use of financial, administrative, and other resources outside the SPC's corporate structure to indirectly influence its decision-making by (dis)incentivising certain strategies, including through preferential financing, construction or subsidisation of facilities that disproportionately benefit an SPC or otherwise incentivise it to pursue a certain strategy (such as the construction of transmission lines for SPC-owned low-carbon assets), coordinated SPC/public-sector research, development and deployment (RD&D), and changes to pricing regimes facing SOEs in sectors relevant to SPC operations either upstream (e.g., state-owned coal mining companies) or downstream (e.g., state-owned grid companies), thereby affecting prices faced by the SPC.

In the following, we provide a non-exhaustive summary of the market-wide and targeted tools available to governments in working with their SPCs.

MARKET-WIDE ACTIONS AND "MARKET-BASED MECHANISMS"

Almost all existing climate-related incentives, taxes, and regulations[vii] are designed to target every company that meets a given set of criteria, regardless of its ownership structure. The design and execution of these policies, therefore, focuses on creating sufficient financial

incentives or penalties to induce companies to act, based on the assumption they are profit-maximisers. Of these broader market incentives, carbon taxes and emissions trading systems are the most prominent, but other measures include shadow carbon pricing, a range of direct subsidy policies, bailouts for non-performing high-carbon assets at risk of becoming stranded, and requirements (or incentives) to prioritise procurement from low-carbon suppliers. Few robust market-wide climate policy measures have been implemented in countries featuring large or dominant SPCs. Market-based mechanisms may well prove to be effective in such cases, but it will be crucial to properly monitor and evaluate them in order to understand how well each policy is implemented, and what its impact is (especially the extent to which outcomes for state-owned and private companies differ).

a. Carbon pricing and taxation influences corporate behaviour by changing the relative prices, hence relative economics of business decisions (strategic and tactical). SPCs that are highly exposed to market competition, and operating under a strong commercial mandate, could be expected to respond to carbon pricing measures similarly to their private sector counterparts. However, carbon pricing may be far less suitable for incentivising SPCs insulated from market forces and operating under (sometimes heavily) politicised mandates. For companies in which profitability and financial returns to shareholders are less important than providing sufficient and reliable electricity, there may be a more muted response to attempts to price carbon. Thus, even while carbon pricing would in general pressure any SPCs in the direction of decarbonisation, they may far less effective a policy instrument for some SPCs than for others. For SPCs incurring operating losses masked by budgetary transfers from government, or making very little profit (if, for example, their revenues are constrained by end customer tariffs under political control), the financial incentives created by carbon taxes may be severely muted or even counterproductive if they cause the SPC's financial position to deteriorate such that its ability to invest in low-carbon alternatives is further curtailed.

b. Emissions trading systems (ETS) set limits on quantities of carbon or high-carbon goods, and allows market trading to set a corresponding carbon price. These systems may suffer from similar limitations to carbon pricing in incentivising SPCs. As with direct carbon pricing, trading regimes' effectiveness with respect to SPCs may depend heavily on the latter's characteristics. SPCs staffed by engineers that have not traditionally engaged in trading of financial instruments or financial speculation, and lack the expertise more commonly associated with commodities trading, may not be well-equipped from a business practice and culture point of view to engage in the emissions trading behaviours that are most likely to augment their effectiveness (Guelff & Adkins, 2014). Quantity-based approaches do, however, present a key advantage over taxes: they set a fixed cap on

emissions allowances that can be reduced over time, providing governments with an instrument for allocating emissions (either directly or through market trading, or a combination of the two) across different SPCs and private firms. Coupled with an effective monitoring and enforcement system, governments can use ETS caps to progressively lower firm emissions in an integrated and systematic manner that accounts for different expected responses across SPCs and private actors.

c. Electricity dispatch and procurement: Governments can directly improve the attractiveness of low-carbon power generation both requiring power purchasers (either end users or grid companies) to meet targets for the share of low-carbon power in their portfolios, and through ensuring electricity dispatch rules systematically favour low-carbon sources whenever they are available. Merit-order dispatch systems, in which the sources with the lowest operating costs are dispatched first, generally achieve this goal by ensuring solar and wind resources with near-zero operating costs are always dispatched first. Merit-order dispatch rules managed by independent system operators are in effect in many developed countries' electricity grids, but not as widespread in countries featuring large SPCs. In these jurisdictions, long-term fixed-hour procurement contracts can be a major presence in electricity markets, giving coal- and gas-fired power plants (and also nuclear and hydro in some cases) an advantage over renewable sources, even in cases where the SPC has a monopoly over generation. Changes to dispatch systems and/or the introduction of renewable portfolio standards can improve the ability of SPCs to recover investments in renewable assets through the actual sale of electricity, reduce overall levelized generation costs, and limit high-carbon assets' ability to generate artificially high financial returns.

d. Protection from competition: Governments often insulate the power companies they own (as well as private companies in some cases) from open competition, especially if doing so is considered to be in the national interest by safeguarding the stable delivery of power, even if it comes at monopoly prices. How governments choose to exercise the latitude they have to determine the market conditions facing their SPCs will influence their operations and investment choices. In some circumstances, increasing an SPC's exposure to competition may prompt it to decarbonise more rapidly. In cases where competition from nimbler private firms is restricting the SPC's ability to invest for the long term, the opposite might be true.

TARGETED TOOLS: DIRECT ACTIONS AS SHAREHOLDER PREROGATIVES

a. Make changes to senior personnel: Governments with a majority of voting shares generally (but not always) have the ability to appoint and remove senior executives as well as to make changes to its board of directors. Selecting candidates with the commitment, vision and managerial capacity to support the SPC in decarbonising can be useful, just as

removing those who resist this path can also create incentives for their successors to pursue similar pathways.

b. Update mandate and formal objectives: Personnel appointments and dismissals may not be enough on their own to force a change in direction, and are also vulnerable to weakening government commitments or policy reversals. Making changes to SPCs' formal mandates and directives on variety of issues can help to entrench a low-carbon transition strategy, especially where these are backed by legislation. While changing the wording of mandates alone is a formalistic exercise and not by itself sufficient to fundamentally alter what companies are doing in practice, doing so does establish a formal yardstick for measuring and guiding corporate action as a first step towards long-term transformation. Action by governments to align SPC mandates more closely with clean energy investment requirements, will affect company operations and managerial incentives, while also sending a potentially powerful signal to the markets. This can include formal requirements to favour the construction of new low-carbon generation wherever possible, rather than traditional thermal plants, or to deploy a given share or volume of low-carbon generation, or to install carbon capture and storage technology on remaining high-carbon generation. The Boundary Dam power plant in Canada, operated by a provincial level state-owned utility, is an example of the latter (SaskPower, 2022, 2023). Less formal directions can also be made through regular consultant with SPCs' corporate directors, which in turn are often appointed by the governing party.

c. Shadow carbon pricing: While externally imposed carbon prices may have a limited impact on SPCs (as discussed above), shadow pricing, in which a carbon price is applied to internal decision-making in parallel to standard financial evaluations, can help SPCs to make choices consistent with the low-carbon transition, act as a hedge against the possibility of climate policy tightening, and help to prepare them for the eventual introduction of a market-wide carbon pricing mechanism. Internalising a shadow carbon price into key decisions and operations can also help SPCs to make choices across a range of low-carbon options (such as comparing the carbon-weighted cost effectiveness of energy efficiency investments in a high-carbon asset that reduces its fuel needs, with the decommissioning and replacement of the asset). Designing market-wide regulations requiring all firms to use shadow pricing is intricate and difficult to enforce. Governments can use their leverage over senior management and board positions in SPCs to establish shadow pricing as an operational standard much more directly than through regulatory processes.

d. Enhance corporate capacity: Depending on their market position and experience with low-carbon generation, SPCs may be able to more efficiently identify opportunities to

transition out of high-carbon operations and expand low-carbon activities than their government shareholders, especially where they are familiar with individual technologies and associated business models. Weakly solvent or insolvent SPCs tend to rely more heavily on government transfers. Large power companies sell vast volumes of electricity, thereby generating large pools of revenue. Even where they are forced to operate under conditions that generate small or negative profits, SPCs still generate large amounts of revenue internally, as part of their day-to-day operations and collections. An apparently loss-making business can mask a powerful source of revenue for reinvestment, supplemented where necessary with additional government support. How they choose to use those very significant resources will affect their emissions. The SPC's board of directors have an important role in holding senior management accountable for its choices in allocating funds and taking strategic decisions.

e. Specialist recruitment and cadre evaluation: SPCs are often large and densely structured organisations employing tens or even hundreds of thousands of people. Internal recruitment and evaluation systems present an additional avenue for influencing company action, beyond the selection of senior executives. The government, through the board of directors (for whom personnel policies are firmly within its core purview), can work to recruit and promote specialists in low-carbon technologies, giving them bureaucratic authority within the enterprise for them to support efforts by senior management to shift the company onto, or along, a low-carbon pathway. Cadre evaluation systems that reward mid-level managers and employees for delivering low-carbon projects can also be important engines of strategic change (Wang, 2013). Company-wide capacity building programmes designed to equip key SPC personnel with the knowledge, tools, and resources, to carry out different aspects of decarbonisation can also be useful, and can be pushed by a board with a mandate for funding such measures. As noted already, change in large SPCs can begin at the C-suite and board level, but to permanently and comprehensively take hold, a sustained effort to change company culture may be necessary.

f. Enhance transition risk management practices: Stranded asset risks have emerged as a salient issue for companies and investors with high-carbon assets. Requiring SPCs to formally integrate asset stranding risks into their strategic planning and resource allocation is well within the mandate of the board. Moreover, the fact the assets are ultimately state-owned alters the nature of the analysis. For a government owner, stranded assets issues are not merely a question of financial risk to new or existing high-carbon investments (based on scenarios for future climate policy, electricity demand, etc), but also whether they represent an economically inefficient use of resources that are ultimately government funds. In principle, government investments in national power infrastructure aim primarily to maximise

country-level economic returns (i.e., net benefits to the country's citizens) rather than the impact on the SPC's balance sheet (see Clark et al., 2022). Thus, perceptions of stranded asset risk by government and its SPCs may diverge moderately or sharply, depending on how profit-focused the SPC is.

g. Corporate restructuring: Governments have the ability to expand, restructure or otherwise shift the corporate structures of the portfolio of enterprises under their stewardship. In some circumstances, breaking up a large SPC into renewable and high-carbon sections may allow the former to expand, and the latter to wind down without jeopardising the financial position of low-carbon assets. In others, well-structured consolidations and mergers may serve the same function. In still others, breaking up vertically integrated utilities into dedicated generation, transmission and distribution components may reinforce low-carbon investments; in others, the opposite may be true. Restructuring may be viewed in some contexts as an extreme or politically challenge measure (e.g. in the case of South Africa's Eskom), but the experience of China – among others – has demonstrated how powerful such measures can be, if pursued in accordance with external conditions.

TARGETED TOOLS: INDIRECT ACTION THROUGH MOBILISING GOVERNMENT RESOURCES

Governments can also influence the behaviour of their SPCs by taking targeted action beyond the SPC's corporate structure.

a. Green finance: One key way in which government can support SPCs in implementing the low-carbon transition is by extending targeted (or conditional) financing to support investments in low-carbon power generation through state-owned development and commercial banks. This can involve making fully additional financing available, or conditionally refinancing existing debt on more favourable terms to encourage SPCs to invest in low-carbon alternatives. Concessional green lending can also help to justify the early retirement of existing assets, or otherwise provide financial space to reduce incumbent fossil fuel assets' output. State-owned commercial and development banks are useful vehicles for providing this support.

b. Budget transfers and conditional funding: Most SPCs receive some degree of direct financial support from government, in the form of direct budget transfers, or public financing for capital investments from state banks (in some cases because regulated tariff structures limit their ability to generate sufficient revenue to fund new investments). Government can influence the company's investment choices through the conditions it required state banks to attach to this funding. Governments can use this channel to support SPC decarbonisation by (a) restricting the non-low-carbon investments or refinancing deals banks can support, (b)

implementing targets for the share of total power sector lending directed to low-carbon activities; and (c) imposing climate mitigation requirements on all proposed lending (e.g., financed emissions or emissions intensity limits).

c. Infrastructure: Government can also support SPCs' implementation of low-carbon technologies by facilitating the construction of supporting infrastructure. Utility-scale renewable energy tends to be generated at some distance from demand centres, requiring extensive and costly investments in transmission capacity sufficient to evacuate peak power. Government plays a key role in permitting, contracting, regulation and financing of grid expansion and associated technological standards in most countries, and is well-placed to prioritise infrastructure that benefits SPCs' low-carbon activities most. These and other government-backed complementary infrastructure improvements can play a catalytic role in incentivising SPCs to decarbonise more rapidly.

d. Innovation: Lowering the costs of low-carbon energy and increasing access to associated technologies is key to moving economies from high-carbon energy growth tracks onto low-carbon ones. In achieving this, carefully targeted RD&D funding can be extremely important, especially for economies more dependent on imported low-carbon technologies and products. While individual governments' ability to influence global costs and characteristics of key technologies (e.g. solar panels and wind turbines) may depend less on their investment in research in a given year, and more on their long-term role in the world market and depth of research experience and resources, research efforts in countries with smaller roles in global low-carbon supply chains can still improve the relative attractiveness of these technologies at the margin. For example, RD&D efforts that improve SPCs' ability to maintain, repair and improve upon existing technologies, adapt standardised technologies to particular geographies, deploy large wind turbines offshore, and lower the costs of carbon capture and storage demonstrate where innovation and cumulative experience can help. Innovation in infrastructure associated with the integration of intermittent power sources is also important: minimising transmission losses (e.g., though the deployment of ultra-high voltage long-distance transmission) can help to better link remote renewable generation sources with centres of demand within and across borders. Beyond technologies, innovation in business models and contracting can also help to lower costs (e.g., the use of reverse auctions to procure electricity and stimulate SPC or IPP investment, and changes to tariff or dispatch regimes favouring renewable sources, as described above).

e. Public procurement: Upstream and downstream actors in SPC supply chains are key drivers of emissions resulting from their activities. By exercising their role as purchaser of goods and services for different components of these supply chains, governments can shape

the evolution of SPC asset bases (Baron, 2016). Procurement rules that favour or require low-carbon technologies to be used in contracts with suppliers (e.g., renewable energy mandates) have been widely used by large-scale private sector companies to support the decarbonisation of their own asset bases. This tool is also available to SPCs. Especially where SPCs are the sole purchasers of electricity from IPPs, their ability to influence power supplies makes they themselves important actors in their own right with significant influence over upstream investment and power generation activity.

SPCs AND CORPORATE CULTURE

While addressing climate goals is a strategic imperative, it is also important to retain a focus on **corporate culture** – that is, improving, or at least maintaining, SPCs' operational and financial performance. Governments should seek to strengthen sound and effective SPC governance and corporate performance even as they work to intensify SPCs' engagement in decarbonisation.[viii] To the extent that these measures reduce the scope for local or regional clientelism and corruption and increase the transparency with which government directives are translated into SPCs' corporate objectives, they may also serve to reduce the scope for principal-agent problems to emerge between the SPC's internal bureaucracy and government policy goals.

However, while SPCs are effectively public sector organisations, their corporate cultures can differ widely. An SPC's openness to, and willingness to embrace, a low-carbon investment model, can be driven by a range of competing factors. These include the authority and executive competence of the company's CEO and senior leadership and the response of its governing board(s) to government directives and other leaders, but also potentially a range of more nuanced and company-specific elements of corporate governance and culture (Aiello, Alberti, & Lopez-Soto, 2020). China's Big Five power generating companies are a useful illustration. While all of them are ultimately owned by the same Chinese national government and theoretically subject to the same objectives, they have taken very different approaches to low-carbon development.

A particularly important consequence of SPC's corporate culture is the extent to which it encourages entrepreneurialism among key decision-makers and managers, which may tend to facilitate efforts to move away from the traditional high-carbon operations that are still the status quo for most SPCs in terms of their entire asset basis, into new and less tested technologies, markets and business models. Where an SPC is characterised by a more conservative business culture that does not favour innovation, the incentives for individuals to deviate from established practice may constitute a key limitation on how government directives are translated into operational decision-making. This may be a factor in explaining

why private sector companies, including small and medium-sized enterprises (SMEs), are active in the development of less conventional renewable technologies, and more innovative projects, as they often smaller and more commercially and technologically agile than their SPC counterparts (Koirala, 2019). Indeed, since SPCs are often less exposed to market risks than their private counterparts, they should arguably be the primary incubators for, and first movers in, new technologies. Recognition of these advantages are reflected in China's use of its large SOEs to scale up solar panel and wind turbine manufacturing in their nascent phases; and then its use of large SPCs to deploy these technologies at scale, both within China and internationally.

CONTEXTUAL FACTORS

In addition to the three categories of tools available to governments in influencing SPCs, it is also important to acknowledge the impact of **contextual factors** that are largely exogenous to the SPC. The first of these is the rate of progress in delivering cost reductions and performance improvements in technologies related to low-carbon power generation. The financial and economic viability of transitioning to low-carbon alternatives is underpinned not only by avoided greenhouse gas emissions, but by economic, operational, and other technological advantages of low-carbon power sources over incumbents. Rapid reductions in solar and wind generation costs, and similar cost declines in battery storage technologies, have altered the relative attractiveness of renewable and fossil fuel sources much more quickly than most forecasts had expected (Way, Ives, Mealy, & Farmer, 2022). Beyond generation technologies, efforts to lower transmission losses and improve grid flexibility by developing and deploying smart ultra-high voltage transmission systems – notably by Chinese grid companies, both within China and internationally – is another example of how technological innovation can help SPCs to engage in the low-carbon transition, in this case by facilitating the offtake of renewable power generated by SPCs. Future advancements in hydrogen-based fuels and the deployment of related infrastructure may create further opportunities for SPCs to decarbonise their asset bases.

Secondly, all of the strategies and policies discussed here are influenced by the strength and depth of the government's commitment to climate goals. The excessive modesty and inconsistency of climate commitments by most governments with SPCs, particularly when they come into conflict with short-term growth goals driven by high-carbon assets, has led to limited engagement with, and pressure for, SPCs to drive major emissions reductions. Making the most of SPCs' dominant presence in the power sector will require stronger and firmer commitments by their government shareholders, and much more extensive engagement with SPCs. Frequent and frank dialogue between governments and SPCs is

essential for governments to align SPC boards and executive with their long-term decarbonisation goals, and to understand what SPCs need from their shareholders in order to deliver on these goals. While strengthening government commitments is beyond the scope of this report, international institutions and academia must greatly intensify their efforts to help governments develop a much deeper understanding of how pursuing ambitious climate goals is compatible with, if not imperative for, simultaneously pursing economic growth and social improvement objectives.

5. Matching policy tools to SPCs

ASSESSING INTERVENTIONS AGAINST THE FOUR KEY FACTORS

SPCs are, as outlined above, different to private companies in general. As a class of actors, they themselves also vary widely across different jurisdictions and market segments. We have also discussed how the suite of climate policy tools available to governments with the dual roles of regulator and shareholder also differ significantly in the incentives they offer to SPCs, and which particular elements of SPCs and power markets that they primarily utilise to achieve their desired impact.

Since SPCs exhibit a wide range of characteristics, the effectiveness of a given climate policy is likely to vary across different SPCs. The choice of policy tool(s) should therefore consider the attributes of the particular SPC(s) that it is intended to affect. For example, a SPC with a high degree of agency and/or financial independence may be less susceptible to the use of informal directives from government where these directives conflict with other corporate objectives. Similarly, a company that is more exposed to market competition may be more responsive to its competitors' activities than the instructions or advice of a government official.

Error! Reference source not found. maps 'High' performance on each of the four key SPC factors analysed in Section 2 against a selection of the tools discussed in Section 3 as an illustration of why SPC attributes should inform policy design.

This qualitative assessment yields some useful insights:

- SPCs with high agency (i.e., a high degree of independence and autonomy), strong profit motivations, and/or operating in highly competitive environment may be considerably more difficult for government to influence through **targeted direct interventions**, particularly the less coercive approaches of holding informal discussions with management. Where SPCs do not depend on public financial resources for operating expenses or investment capital, formal directives may also have a limited effect. In such cases, making personnel changes by replacing the CEO or senior management, may be more effective in inducing a change. Where the SPC has less agency, and/or less capacity, even replacing senior leadership might face obstacles in terms of bureaucratic resistance and a lack of sufficient financial or technical expertise to undertake ambitious low-carbon investment plans.
- High agency SPCs may also be less responsive to **targeted indirect interventions** through the deployment of government resources. Profit-seeking SPCs, and/or those with high capacity and/or operating in competitive environments, would be motivated

and/or able to take advantage of any government investments or actions that could enhance their ability to generate profits, undertake low-carbon investments, or gain an edge over their competitors, respectively.

- **Market-wide interventions** would naturally be most effective when deployed in power sectors where SPCs most closely resemble private sector companies: that is, when they are highly profit-motivated, and exposed to competition from other firms. SPCs with high agency and capacity may be less affected by market-wide interventions, especially where they enjoy privileged access to government officials such that they may be less subject to enforcement than other firms; or where they already have the capacity and interest to invest in low-carbon infrastructure such that market-wide measures have a limited additional effect.

Table 4. Initial mapping of 'High' performance on key SPC factors to the potential impact of selected intervention types (and specific interventions) on decarbonisation (Red = low impact; orange = moderate impact; green = high impact).

Selected Climate Intervention	Agency	Profit Motivation	Capacity	Exposure to Competition
Targeted tools: direct (shareholder prerogative)				
Formal shareholder/board directives to SPCs				
Appointment/replacement of *executives*				
Informal engagement *with board & executives*				
Targeted tools: indirect (government resource deployment)				
Preferential financing for low-carbon activities through state-owned financial institutions				
Investment in supporting infrastructure (transmission, storage, etc.) for *low-carbon* ***energy assets***				
Mobilisation of public sector agencies and other technical/administrative resources to support low-carbon investments				
Market-wide interventions				
Carbon pricing *(permits* ***or taxes)***				
Price regulation reform ***(e.g.,*** *reducing (increasing) explicit or implicit* ***subsidies favouring high*** *(low)* ***carbon*** *assets,* ***portfolio standards****,* ***or*** *increased low-carbon* ***dispatch***				
Increased R&D spending on low -carbon technologies (e.g., nuclear, hydrogen, storage, renewables)				

Overall, this analysis strongly suggests that the traditional policy tools of market-wide interventions (acting either through prices or regulation) will not always be the best option for incentivising SPCs to adopt low-carbon strategies. Market-based mechanisms such as carbon pricing or trading are likely to work better for profit-oriented SPCs with relative commercial autonomy, operating in competitive markets, and with sufficient resources to respond to market signals.

SUMMARY OF CASE STUDY ANALYSIS

In all of the case studies explored in Section 3, avenues for action across the breadth of tools available to government as regulator and shareholder to accelerate decarbonisation efforts can be identified (Table 5). Targeted direct interventions in particular, such as the appointment of appropriate senior management personnel, corporate restructuring to enable greater investment in renewables, and mandating corporate climate targets, all have considerable potential to bring SPCs' decarbonisation timelines forward in all the case studies considered. Within the targeted direct options, informal directives to take decisions in the long-term national interest but not necessarily in the SPC's financial interests, may be less effective for KEPCO and NTPC, since their strong profit-making motivation and relatively high degree of agency may allow them to effectively resist such directives.

Table 5. Application of case studies to potential SPC interventions for inducing decarbonisation action.

	Key factors				Potential impact of interventions		
	Agency	Profit motivation	Capacity	Exposure to competition	Targeted direct - shareholder prerogatives	Targeted indirect – Government resource deployment	Market-wide
NTPC	**M/H**	**M/H**	**M/H**	**H**	**M**	**H**	**M/H**
SPIC	**M**	**M/H**	**H**	**M**	**H**	**H**	**M**
KEPCO	**M**	**M/H**	**H**	**L**	**M**	**H**	**M**
PLN	**M/L**	**M/L**	**M**	**M/L**	**H**	**M**	**L**
CFE	**L**	**M**	**M/H**	**M/L**	**H**	**H**	**L**
Eskom	**L**	**M/L**	**M/L**	**L**	**H**	**M**	**L**

A promising picture also emerges on the potential for targeted indirect interventions to effect change, particularly through the mobilisation of government resources beyond the SPC.

Examples of such policies include investment in supporting infrastructure such as transmission lines, the expansion of preferential access to financing for low-carbon projects (either directly at below-market rates, or through guarantees for SPC-issued bonds), and targeted RD&D funding. SPCs with limited financial and implementation capacity, notably PLN and Eskom, could however face difficulties in taking advantage of such measures owing to chronic financial stress and ongoing operational challenges distracting them from long-term planning.

Lastly, we find that market-wide interventions may have a much more limited impact on the SPCs in our sample. Policies such as carbon pricing or trading, renewable portfolio standards might not be nearly as effective as they would be in a competitive free market, when deployed in environments in which SPCs with limited financial incentives and agency dominate. Similarly, efforts to reform electricity markets in a more renewable-friendly direction may affect SPC decision-making on the margin, but should be viewed in the wider context of the four key factors in assessing the extent to which they may stimulate systematic changes in strategy and operations. In our analysis, the absence of robust competition, presence of non-financial objectives, and degree of dependence on government subsidies can all act to limit the effectiveness of market-wide actions in general. In the cases of Eskom, CFE, and PLN, the combination of monopolistic control over generation, transmission and distribution markets with motivations that are not fully (or even primarily) profit-oriented, could undermine the effectiveness of carbon pricing measures that require profit-seeking market participants and competitive markets in order to function as designed.

It is also noteworthy that the threat of stranded asset and other transition-related risks as a potential motivator for investment in renewable assets and halting of investments in high-carbon assets for an SPC is not directly comparable to the equivalent calculus faced by a profit-maximizing private sector actor. This is not only the case for SPCs with a mandate to invest in the national interest rather than to maximise profits (Clark et al., 2022) but also a moral hazard issue for SPCs that expect the probability of a government bail-out in the case of financial difficulties caused by stranded asset risk materialisation to be relatively high.

In the cases of Eskom and PLN, limited financial and operational capacity and the lack of competitors in the market further limit the scope of reacting to price signals linked to transition risks, such as a rise in borrowing costs. Limited competition between SPCs and IPPs (KEPCO and, to an extent, PLN), as well as with other SPCs (SPIC), could induce some degree of competitive behaviour, but not necessarily solely on price. In our analysis, we posit that only NTPC, the closest to a private sector firm, would be likely to swiftly and meaningfully respond to market-wide incentive changes.

SPC ARCHETYPES AS A GUIDE TO POLICY SELECTION

By assessing the characteristics of the six case study SPCs against the key factor framework developed from both the case studies and wider literature, we derive a set of SPC archetypes that represent the breadth of attributes identified, and act as heuristic approximations of general SPC characteristics (Table 6**Error! Reference source not found.**). The archetypes are also useful for differentiating SPCs that resemble one or another archetype from an idealised private sector company. In this typology, an SPC need not be tied to a single archetype and may exhibit characteristics of more than one. Similarly, an SPC may evolve over time such that it moves from one archetype to another.

In our conception, an idealised private firm's high financial and operational capacity, and profit-seeking motivation, allow it to be effective and efficient in implementing decarbonisation actions when it chooses to do so, but its small market share limits its influence on sectoral decarbonisation to its own activities and any indirect influence on those of competing firms. Private firms play a limited role (generally as IPPs for which the dominant SPC is the offtaker) in economies featuring vertically integrated SPCs. It is difficult for governments operating within the confines of their regulatory frameworks to influence private firms' behaviour beyond the use of market-wide mechanisms and regulations.

The four core SPC archetypes, as distinct from idealised private firms, are as follows:

- The "Competitive Player", which is similar to an idealised private sector firm in its capacity to execute efficiently and its limited market share. The main distinction is simply that it operates under majority government control and as a function of its ownership structure, enjoys some privileged access to resources, while also being both slightly constrained in its ability to unilaterally pursue commercial objectives, and relatively capable of resisting demands by government when they conflict with these objectives.
- The "Grinding Behemoth", emblematic of a large SPC with a dominant present in its domestic power market, a monopoly in wholesale power markets, and a large asset base. Often a vertically integrated utility, the Behemoth is motivated – either through a formal mandate, informal political pressure, or both – to prioritise reliable delivery of electricity supplies at affordable prices over financial profit. Through its monopoly power and access to state resources, a Behemoth enjoys substantial protections from market competition, and plays several key roles in the power sector (including, potentially, as a grid operator as well as distributor). To the extent that a Behemoth internalises government climate policy priorities, it can play a decisive role in sectoral

decarbonisation, but also suffers from some operational inefficiencies and capacity constraints.

- The “Statist Caterer”, which operates primarily to serve strategic government interests that are often also sensitive to the political priorities of the incumbent party. It is characterised both by its dominance of the power sector, a low degree of independent agency, and a mandate that de-emphasises profitability and revenue targets in favour of being an effective conduit for political priorities (e.g. low-cost electricity supplies for residential consumers) and the government’s retention of strategic control over the electricity sector. Its subservience to government make it an effective vehicle for climate policy priorities, but this is limited by operational inefficiencies, business model limitations and the need to meet multiple developmental and commercial objectives simultaneously.
- The “Depleted Provider”, an SPC engaged in a chronic struggle to meet its core electricity delivery obligations under financially and/or operationally stressed conditions, and with very limited capacity to develop new assets or even maintain existing ones. In turn, this limits its ability to reliably execute its mandate, let alone embark on a strategic decarbonisation pathway, without significant and sustained additional financial support, from government or external sources, or wholesale reform and restructuring of the power sector (through liberalisation, unbundling of integrated utilities and/or the opening of the market to new private or state-owned entrants).

Table 6. Mapping archetypes to the four key factors. Red corresponds to low performance, amber to moderate, and green to high.

	Key factors				Potential impact of interventions		
SPC Archetype	**Agency**	**Profit Motivation**	**Capacity**	**Exposure to Competition**	**Targeted direct**	**Targeted indirect**	**Market-wide**
Private Sector	H	H	H	H	N/A	M*	H
Competitive Player	M/H	M/H	H	M/H	M	H	M/H
Grinding Behemoth	M	M	M/H	M/L	H	M	M/L
Statist Caterer	L	M/L	M	L	H	H	L
Depleted Provider	L	M/L	L	L	H	M	L

** Accounting for effect of use of government resources (e.g. infrastructure investment) on private firms' incentives.*

Which of these archetypes an SPC resembles most closely will likely affect the potential it has to execute the decarbonisation of its own asset base. An SPC's ability to drive power sector-wide decarbonisation (i.e., beyond the limits of its corporate structure) is partly a function of its operational efficiency (captured by Capacity), but also of its market share and degree of vertical integration (captured by Exposure to Competition). Thus, a Grinding Behemoth may not be as operationally efficient or possess the same technical capabilities of a Competitive Player, but because of its dominant role in the power sector, any success it has in decarbonising its asset base will drive decarbonisation in the power sector more broadly. By comparison, an under-resourced and financially weak Depleted Provider in a similarly dominant market position may be nonetheless unable to undertake the transition to a low-carbon production base, even if it is in principle motivated to do so.

The mapping of intervention effectiveness to SPC archetypes in **Error! Reference source not found.** can help to guide a policymaker in identifying the interventions most likely to successfully influence the behaviour and strategy of SPCs that resemble one or another archetype. The attributes of strong profit motives, high exposure to competition and financial and technical capacity are not always present, such that the efficacy of market-wide interventions in promoting low-carbon action by SPCs is likely to depend on how closely their attributes resemble those of Competitive Players. Similarly, for Grinding Behemoths, Statist Caterers, and Depleted Providers, market-wide interventions are unlikely to have the desired impact, and targeted direct measures may be much more effective.

6. Conclusion

SPCs are major sources of greenhouse gas emissions, and dominate power markets in a range of large developing economies. They are also major investors in low-carbon power generation across renewables, hydropower and nuclear. The toolbox of market-wide policies widely referenced in the climate policy literature is designed to incentivise private sector companies and does not explicitly consider SPCs. In this report, we expand the toolbox of policy interventions to include those targeting SPCs, and evaluate which of them may be most suited to different contexts and SPC characteristics. We identify four key conclusions.

1. Making effective use of SPCs as agents of decarbonisation can require the use of tailored policy tools. The governance and incentive structures of SPCs are generally very different from those of a typical private firm. This affects how responsive they are to climate policy measures. Applying conventional market-wide tools to SPCs may not yield the results policymakers seek or expect.
2. SPCs can be more effective drivers of decarbonisation than their private sector counterparts in some circumstances. SPCs' influence over the power sector in their jurisdictions can be channelled towards low-carbon electricity generation and investment. SPCs that are well-resourced and enjoy monopolistic control over one or more components of the electricity value chain could, if correctly incentivised to do so, pursue decarbonisation with greater speed and impact than a private utility could.
3. Traditional market-wide mechanisms, particularly those focused on carbon pricing, may catalyse more limited responses from SPCs than from private sector firms. This may be especially true when price signals are not the only factor, or even the most important one, in determining SPCs' investment and generation profile. SPCs are typically charged with fulfilling complex and overlapping mandates. Combined with protections from market competition, these act to lessen the influence of market-based mechanisms on SPCs' operations and planning. For all but the most profit-driven SPCs, the standard toolbox of climate policy interventions may not be enough to deliver on ambitious national transition strategies.
4. Developing a generalised approach to climate policy design for SPCs can help identify the most appropriate tools to deploy in different contexts. The four archetypes developed in this paper are intended to serve as inspiration for further analysis.

In summary, most of the world's economies will need to dramatically accelerate the pace of decarbonisation in their respective power sectors in order to meet their climate mitigation goals. In countries where SPCs are major market places, they can – and indeed, must – assume a central role in driving this process, guided by appropriate and effective interventions adapted to their specific circumstances.

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Notes

[i] For example, State Grid of China, one of the largest companies in the world according to the Forbes Global 2000 list, has about 1 billion customers. Similarly, in France, the power system operator is a public sector company, distinct from generation. In the petroleum sector, Mexico's PEMEX is responsible for shipping most of the country's oil to local gasoline stations.

[ii] It is worth noting that SPCs generally differ in this regard from national oil companies (NOCs) created for the specific strategic and financial purposes of not only giving governments direct control over the development, marketing, and monetization of the country's natural resources, but also to generate large revenues for the government, through exports, royalties and taxes. NOCs often serve a parallel function of supplying cheap petroleum products to the local market.

[iii] More recently, this view is changing as technological and business innovations are separating out the hard wires in T&D from the ability to transmit along those wires, and have opened the latter to competition.

[iv] Numerous private sector utilities also operate with similar regulatory protections, pricing environments, and service obligations, for example, in highly regulated electricity distribution markets where natural monopoly conditions may be viewed as justifying various protections for private sector operators. However, in contrast to an SPC, these companies are ultimately in business to generate financial returns for their private sector shareholders in addition to meeting their regulatory obligations. As a result, a regulated private sector company is likely to be more sensitive than its service-oriented SPC counterpart to, for example, the type of pricing changes engendered by carbon pricing mechanisms because of their potential to impact the company's overall profitability and stock value and, by extension, the financial interests of its private shareholders.

[v] This could be the case, for example, if there are requirements regarding independent directors and staggered terms.

[vi] This challenge of fossil fuel asset overhang could benefit from more examination of how governments can more directly reduce this asset base, as well as drive an increase in renewables. This might involve the creation of bad banks or similar structures that can take bad assets off the books of SPCs and put them under more direct government control. In general, this problem needs more emphasis as building renewables can be less of a problem than retiring fossil fuel assets.

[vii] Regulations represent in essence a legislative/administrative variation on the informal direction or more formal directives discussed above. It may be most appropriate for certain environmental standards (e.g., for emissions or effluent standards) where regulatory pronouncements, including the sanctions they carry, are important. It should also be noted that governments adopt regulations and pricing mechanisms that target the economy more broadly, including private sector actors. These are not typically viewed as SPC-specific, but at times the mode of adoption and implementation of this type of action may be influenced by government ownership of key companies (e.g., simplified consultations with industry). Government/SPC consultation can potentially help to design more effective regulations to support a low-carbon transition, provided that both parties are committed to the goal (see, for example, earlier discussion about aligning mandates). It may also be appropriate in a context in which the SPC is not the only economic actor in the sector; there, the use of sectoral regulations can push SPC behaviour while also maintaining a level playing field with its other competitors. In cases where the SPC is the only party, it may

also be preferable (from transparency and sustainability perspectives), but one that can also be more burdensome.

[viii] The OECD Guidelines on Corporate Governance of State-owned Enterprises (OECD, 2015a, Recommendations II and VII.B) state that governments should ensure that: (a) “the state ... act as an informed and active owner, ensuring that the governance of SOEs is carried out in a transparent and accountable manner, with a high degree of professionalism and effectiveness;” (b) “SOE boards ... effectively carry out their functions of setting strategy and supervising management, based on broad mandates and objectives set by the government;” and (c) any redefinition of SOE objectives – for example, to incorporate low-carbon corporate goals – is not made “in a non-transparent manner.” The OECD also advises under Recommendation III, “State-owned Enterprises in the marketplace”, that: “Consistent with the rationale for state ownership, the legal and regulatory framework for SOEs should ensure a level playing field and fair competition in the marketplace when SOEs undertake economic activities.”