Working paper 538

India's stranded assets: how government interventions are propping up coal power

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Key messages

- The five major (current and future) drivers of asset stranding in India's coal power value chain are: the cost competitiveness of renewable energy alternatives; financial distress in distribution companies; air pollution regulation; water scarcity; and coal shortages.
- A number of these drivers are already significantly impacting India's power sector: 40 gigawatts of commissioned and under construction coal-fired power capacity are already 'stressed', which presents an ongoing systemic financial risk for the government and the financial system dominated by the Indian public sector.
- The Government of India is intervening in coal power (across the value chain from coal mining to power production and distribution) in several ways, which include support in the form of an estimated ₹74,114 crore ($11.3 billion) in public finance, ₹13,960 crore ($2.1 billion) in national subsidies, and support equivalent to ₹24,724 crore ($3.8 billion) through policy postponement.
- The Indian government is counteracting a number of the drivers of asset stranding by delaying the pass-through of market signals and the costs of environmental and wider climate impacts to coal power project developers and investors.
- Experts find similar patterns of government intervention to the coal power value chain elsewhere – e.g. European Union, United States, China, South Africa, Indonesia and South Korea. It will be critical for governments in these countries and regions to carefully manage their interventions in the power sector to avoid fossil fuel subsidies and support their wider commitment to energy access, and a transition to low-carbon energy sources.

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Acronyms

CEA	Central Electricity Authority
CTI	Carbon Tracker Initiative
DISCOM	distribution companies
GDP	gross domestic product
GST	Goods and Services Tax
GW	gigawatts
IEA	International Energy Agency
IISD	International Institute for Sustainable Development
IRENA	International Renewable Energy Agency
kWh	kilowatt hours
NDC	Nationally Determined Contribution
NEP	India's Third Draft National Electricity Plan
ODI	Overseas Development Institute
OECD	Organisation for Economic Co-operation and Development
PLF	plant load factor
PPA	power purchase agreement
TPP	thermal power plant
UDAY	Ujwal Discom Assurance Yojana
UNDESA	United Nations Department of Economic and Social Affairs
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization
WRI	World Resources Institute
WTO	World Trade Organization

1 Introduction

In 2015, under the United Nations Framework Convention on Climate Change's (UNFCCC's) Paris Agreement, governments committed to keeping global temperature increases to 2°C and to pursuing efforts towards a more ambitious 1.5°C target. Global decarbonisation efforts may increase the risk of asset stranding – that is, loss of value, revenue or return on investment – in fossil fuel production assets (see Table 1 for definitions of asset standing). This is particularly relevant to coal assets, as it is estimated that the phasing out of inefficient coal power plants alone could contribute to halving power sector emissions globally (OECD/IEA, 2015).

Government interventions play a major role in power sector development around the world, including in coal-fired power. Despite this, there has been limited analysis on the role of these incentives in the transition to low-carbon energy and, in particular, to asset stranding.

In this paper, we develop a broad framework for understanding the links between government interventions and wider drivers of asset stranding and apply this to India's coal power sector as a first case study. We do this by focusing on three key questions:

- What are the recent and current government interventions in the coal power value chain?
- What are the wider drivers of coal power asset stranding?
- What are the linkages between the government interventions and the drivers?

This work builds on a detailed inventory of India's energy subsidies, compiled by the Global Subsidies Initiative, and a detailed data set on coal power assets in India, compiled by the Vasudha Foundation (see Annex 1 and 2) (Garg et. al, 2017; Vasudha Foundation, 2018). Chapter 2 presents an overview of India's electricity transition, Chapter 3 sets out the framework and Chapter 4 findings, then Chapter 5 concludes and provides recommendations on next steps. Overall, we find that government interventions are counteracting the drivers of asset stranding in India's coal power sector.

2 India's electricity transition

India is currently the world's third largest economy (in gross domestic product, purchasing power parity terms) with a population expected to reach 1.7 billion people by 2050 (World Bank, 2017; UNDESA, 2015).

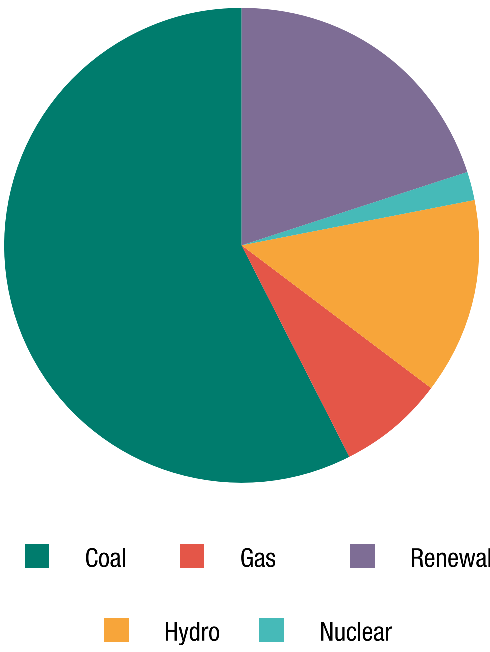
Improving access to modern energy services is a key policy objective in India: 15% of the population has no access to electricity (IEA et al., 2018). One justification for further coal power development is that it would improve electricity access (see Box 1). However, this poses a challenge under the Paris Agreement, as the energy sector accounted for 68% of India's total CO_2 equivalent emissions in 2010 (Ministry of Environment, Forests and Climate Change, 2015).

In March 2018, coal made up 57% of India's installed power capacity (see Figures 1 and 2; Ministry of Power, 2018). In January 2018, an estimated 47 gigawatts (GW) of coal power was still under construction, and 88 GW was under development (i.e. announced, pre-permit and permitted plants)[1] (Coal Swarm, 2018). And India's Nationally Determined Contribution (NDC) under the Paris Agreement currently outlines that 'coal will continue to dominate power generation in [the] future' (Federal Government of India, 2016).

Despite apparent consensus on an ongoing role for coal, different parts of the Indian government are sending mixed signals on the likely level of coal power expansion:

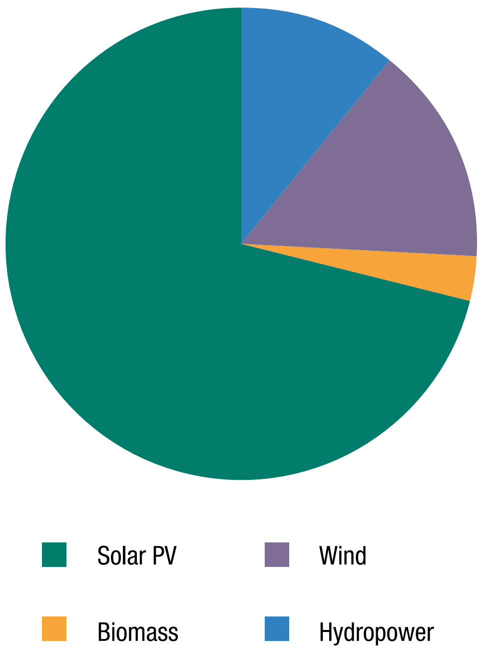
- In late 2016, the Central Electricity Authority estimated India would not require any new coal capacity until at least 2027, beyond the 50 GW already in pipeline (Singh and Upadhyay, 2018).
- In 2017, the Government of India announced plans to double coal-based electricity generation by 2040 (Government of India, 2017).
- In 2017, the Third Draft National Electricity Plan (NEP) forecast a net expansion of 57 GW in thermal power capacity in the decade to 2026/27. The same policy sets out to reach 175 GW of renewable energy capacity by 2022 (NITI Aayog, 2017).

Figure 1 India's electricity capacity mix (%)



Note: As at 31 March 2018. Oil and diesel represent 0.2%.
Source: CEA (2018)

Figure 2 Renewable energy potential in India by 2030 (GW)



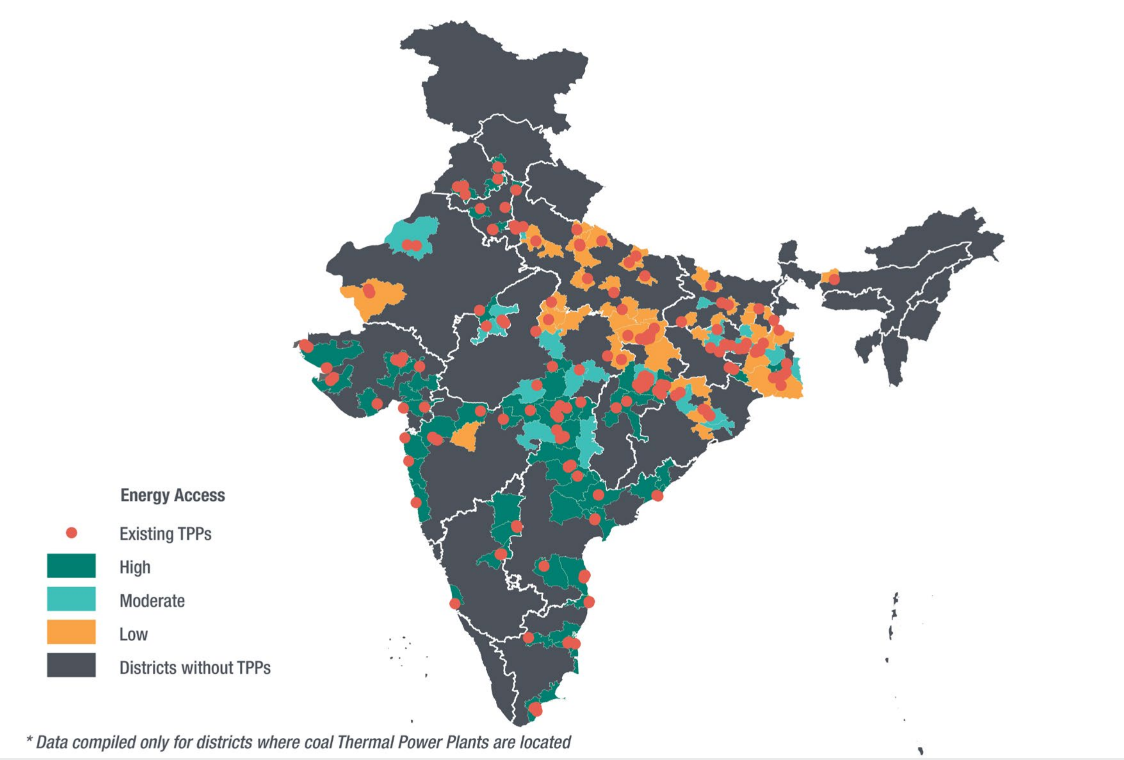
Source: IRENA (2017)

1 Coal power plants usually come online between five and seven years after receiving a permit.

Box 1 Is India's coal power serving the electricity poor?

In its NDC, the Government of India notes coal's continuing role in helping 'to secure reliable, adequate and affordable supply of electricity' and efforts to universalise electricity access (under the NEP) (Federal Government of India, 2016). In fact, there is little correlation between the density of coal power plants and rates of access to the electricity grid. Many thermal power plants are in regions with low rates of electricity access (see Figure 3). Moreover, with wind and solar power now out-competing the cost of coal power in many recent auctions, it is questionable what role coal has to play in future electrification (Sushma and Anand, 2018).

Figure 3 Distribution of coal thermal power plants (TPPs) and energy access in India



Source: Vasudha Foundation (2018)

- In 2017, India's Minister of Finance lowered the expectation of new thermal capacity to 50 GW, within the mid-year macroeconomic assessment (Buckley and Shah, 2017).
- In January 2018, the updated NEP outlined the closure of 48 GW of end-of-life subcritical coal fired power capacity by 2027 as an offset to coal plants under development but yet to be commissioned (Buckley and Shah, 2018).

In addition to questions about the future role of coal in the energy mix, India's Standing Committee on Energy finds over 40 GW of commissioned and under-construction coal power capacity is already 'stressed' (see section 3.1 for a definition) – with ₹174 crore ($25 million)[2] in outstanding loans (Standing Committee on Energy, 2018). In June 2018, the Central Electricity Authority indicated this might be as high as 70 GW (in conversation). This presents an ongoing systemic financial risk for the government and the financial system dominated by the public sector.

At the same time, the electricity transition in India has clearly begun. There has been massive surge in renewable energy in India and installed capacity nearly doubled between March 2016 and March 2018, increasing from 39 GW to 69 GW (CEA, 2016; 2018). In May 2018 alone, more than 10 GW of solar was tendered (Prateek, 2018). According to the Ministry for New and Renewable Energy, India has the potential for 1,050 GW of renewable energy capacity by 2030 (see Figure 2; IRENA, 2017; see also section 4.2).

2 Values are in INR and converted to USD using the Royal Bank of India reference rate of $1:₹68.6573 (as at 9 July 2018) (https://www.rbi.org.in/scripts/BS_DisplayReferenceRate.aspx).

3 Frameworks and definitions

3.1 Framework for analysis

There is no one definition of 'stranded assets' in the international literature, nor literature specific to India or the coal power sector (see Table 1). The term can vary with respect to the type of impacts, the extent to which impacts affect asset value, and whether impacts are on past or future investments.

For our analysis we develop a framework to examine how government interventions might shape stranded asset risk (see Table 2). This framework allows us to examine government interventions that might potentially affect stranded asset risk – in new investments, extending the lifetime of existing assets at risk of stranding, or that 'bail-out' owners of assets that have become stranded.

Government interventions identified and analysed in this paper are as follows:

1. Government interventions driving new investments in 'non-economic' high-carbon assets. This examines new investments in coal power assets at risk of under-performance or future stranding. Such interventions encourage investments that would not have been made otherwise – and often take place at the **project appraisal, preparation and construction stage.**

2. Government interventions extending the life of high carbon assets at risk of stranding. This includes operational, but under-performing coal power plants, where revenues or profits are below financial forecasts and where there is high financial risk (e.g. loan default). Such interventions extend the lifetime of an asset that would otherwise become stranded (e.g. maintenance and retrofitting costs) – and often take place at the **operation stage.**

3. Government interventions provided to those holding stranded assets. This includes coal power plants that have become stranded before the end-of-life (typically 25 years), which have not yielded forecasted financial returns. Government interventions can lead to the recovery of closure costs (e.g. decommissioning and environmental remediation costs) – and often take place during the **closure stage.**

Table 1 Definitions of stranded assets in the literature

Definition	Source
Past investments	
Assets that have suffered from unanticipated or premature write-downs, devaluations or conversion to liabilities.	Caldecott (2015)
Foregone revenue, where actual revenues are lower than the expected revenues. This includes rent losses, as a result of lower volumes and lower prices.	Climate Policy Initiative (2014)
Loss in intrinsic value. Where, following valuation, a percentage of firm reserves are identified as non-monetisable.	IHS Energy (2014)
Focus on 'stressed/non-performing assets'. Accounts where there has been delay in payment of interest/principal by a stipulated date, as against the repayment schedule on account of financial difficulty faced by the borrower.	India's Standing Committee on Energy (2018)
Future investments	
Investment in fossil fuel-based assets, as a result of changes brought about by climate policy … that do not recover all or part of their investment during the time that they are operational.	IEA (2014)
The misallocation of finance (based on a future scenario). For example, exploration finance for 'unburnable' resources under a 2°C global temperature scenario.	CTI (2013)
Stressed assets – or special mention accounts – result from overdue principal/interest payments (whether in part or whole) of between 1 and 90 days.	Reserve Bank of India (2018)

For our analysis, we have developed a table to show the incidence of government support and of drivers of asset stranding linked to these three stages of the project life cycle, from appraisal to operations, to project closure – and across the coal power value chain from coal mining to transmission and distribution.

3.2 Defining government interventions

We also develop definitions for three of the main categories of government interventions that can influence asset stranding.

- **Public finance.** Any support provided by a majority government owned (i.e. more than 50%) financial institution. This includes support provided through government loans or loan guarantees for coal mining or coal power projects. For project investors and developers, public finance can create confidence in project feasibility, reducing risk perceptions and so reducing costs.
- **Subsidies.** This includes budgetary transfers, fiscal incentives such as tax expenditures, the government provision of goods or services below market value (e.g. land and water) and regulated prices or other measures of market or price support.
- **Policy postponements.** This includes delays in the implementation of policy frameworks that have been passed by Parliament or Cabinet and resulting in the extension of timelines or non-implementation of policy. Delays in the introduction of environmental standards is one example. Such postponements can defer project costs (both of a capital and operational nature) at any point in the coal power value chain.

An inventory of interventions along the coal value chain, and estimates of the scale of support or impacts of policy postponements, was collated for financial year 2016/17 (1 April 2016 to 31 March 2017), using publicly available resources (e.g. government documents and public datasets) and builds on a recent inventory of India's energy subsidies by Garg et al. (2017) (see Annex 1). Values are in Indian rupees and converted to US dollars at annually average exchange rates as per Reserve Bank of India notified rates for each year. Our analysis did not include government interventions to the transmission and distribution sector, which for the purpose of our analysis is considered to be technology agnostic.

3.3 Identifying key drivers of asset stranding

We identify the major drivers of coal power asset stranding in India during 2017 to March 2018, using publicly available literature (e.g. research, media articles and government sources identified through Google searches of 'India' 'coal power' and 'stranded assets'). We found 65 citations of drivers in the literature and analyse the top-five drivers in order of incidence (see Annex 3). More details are provided in Chapter 4.

Finally, this paper has benefitted from interviews (in person and via Skype), and an online webinar with international experts on asset stranding in coal power, on 1 June 2018. A workshop was also conducted with Indian stakeholders on asset stranding in India's coal power sector in Delhi on 22 June 2018 (see interviewees and workshop participants lists in Annex 4).

Table 2 Framework to examine how government interventions might shape stranded asset risk

Coal fired power value chain					
	Coal mining	Transport and storage	Power plants	Transmission and distribution	Cross-cutting
Project appraisal, preparation and construction					
Operation (maintenance, retro-fitting)					
Closure, decommissioning and rehabilitation					

4 Findings

4.1 Government interventions

We found 28 government interventions to support coal power in financial year 2016, including 6 different types of public finance, 19 subsidies, and 3 examples of policy postponement (see Table 3). The highest value of support is provided to coal power plants. Although there are gaps in data availability, we estimate the value of interventions in financial year 2016 to be: for public finance, ₹74,114 crore ($11.3 billion); for subsidies, ₹13,960 crore ($2.1 billion); and, for policy postponements ₹24,724 crore ($3.8 billion).

We then sought to do a basic assessment of the relative 'importance' of these government interventions in terms of how they might shape stranded asset risk, according to two criteria. To be classified as 'high' importance, a subsidy had to have a strong impact on both criteria, while a 'low' importance subsidy had a low impact on both criteria. To be considered of 'medium' importance it could either have a moderate impact on both criteria, or a strong impact in one of the two criteria. The two criteria are as follows:

1. An estimate of the impact on the delivered cost of energy. The impact was determined according to two key components of the delivered cost of energy from coal power plants: fuel input costs (assumed to account for up to 50% of costs), and capital costs (assumed to account for up to 25% of costs) (Nalbandian-Sugden, 2016).
2. A general estimate on the impact of the intervention on the perception of financial risk (to investors or project developers). This was assessed based on whether the government intervention had either a disproportionate impact on the cost of individual project financing or impacted on a larger absolute number of coal power projects.

Six measures were identified as having 'high' importance across these two criteria (Table 4). This includes domestic public finance for new coal plants estimated at ₹73,845 crore ($11.2 billion) in financial year 2016 (CIL, 2016; PFC and REC data). Subsidies were provided through: pay-outs in investor state disputes (scale of support not available (n/a)); payment of fixed charges when a plant is operating at low plant load factors (n/a); re-negotiated power purchase agreements (PPAs) for power plants (n/a); and concessional excise duty rates on coal production estimated at ₹6,886 crore ($1.1 billion) in financial year 2016 (CIL, 2016). Also, one policy postponement through non-compliance with sulphur dioxide standards introduced in 2015, estimated at ₹23,660 crore ($3.6 billion) in financial year 2016 (Sethi, 2017; Patel, 2017).

Table 3 Government interventions along the coal power value chain (₹crore, and US$ millions in brackets), FY16/17

Coal-fired power value chain					
	Coal mining	Transport and storage	Power plants	Transmission and distribution	Cross-cutting
Number of government interventions	**14**	**3**	**8**	**0**	**3**
Project appraisal, preparation and construction	- - -	- - -	n/a¤ 73,845 (11,281)* -	- - -	- - -
Operation (maintenance, retro-fitting)	7,196 (1,099)¤ 182 (28)* 24,724 (3,777)†	6,452 (986)¤ 88 (13)* -	67 (10)¤ - -	- - -	245 (37)¤ n/a* -
Closure, decommissioning and rehabilitation	- - -	- - -	- - -	- - -	- - -

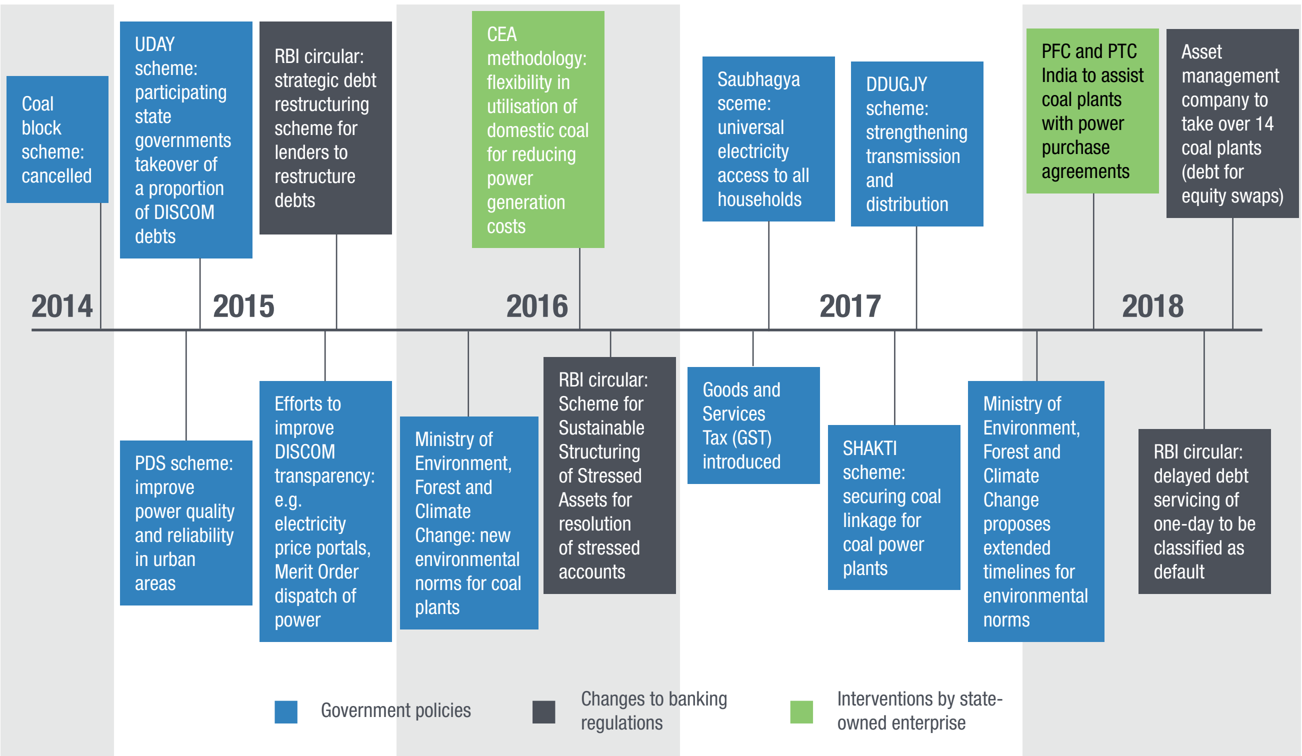
*Note: Key: ¤ = Subsidies; * = public finance; † = policy postponements. n/a indicates that an intervention exists but has not been calculated or published. For public finance the number of interventions is not available but six different types or sources of public finance were found. Technology agnostic transmission and distribution interventions are excluded. Sources: see Annex 1.*

Table 4 High importance government interventions along the coal power value chain (₹ crore and USD billions), FY16

Coal-fired power value chain					
	Coal mining	Transport and storage	Power plants	Transmission and distribution	Cross-cutting
Project appraisal, preparation and construction			National public finance for coal power plants (₹73,845 crore ($11.2 billion))*		
Operation (maintenance, retro-fitting)	Concessional excise duty rates on coal production (replaced with GST) (₹6,886 crore ($1.1 billion))¤		Payouts in investor-state disputes (value n/a)¤ Payment of fixed charges even when a plant is operating at low PLF (value n/a)¤ Re-negotiated PPAs for thermal power plants (value n/a)¤ Non-compliance with SO2 environmental standards (₹23,660 crore ($3.6 billion))†		
Closure, decommissioning and rehabilitation					

*Notes: Key: ¤ = Subsidies; * = public finance; † = policy postponements. Some estimates are missing (n/a). Sources: see Annex 1. GST = Goods and Services Tax. PLF = plant load factor.*

Figure 4 Timeline of policy regulatory changes in the coal power sector (2014–2018)



Note: DISCOM = distribution companies.
Source: Garg et al. (2017); Standing Committee on Energy (2018)

In addition to the more direct interventions already outlined, coal-fired power has been further impacted by a shifting policy and regulatory environment for coal and interventions by state owned enterprises (see Figure 3).

4.2 Drivers and key indicators of risk of asset stranding

A total of 22 drivers of the stranding of coal-fired power assets were identified in the literature (see Annex 2).[3] Most drivers impact directly on coal plants (11), with the others impacting on the wider coal power value chain – from transmission and distribution of electricity (5), to coal mining (4) and the transport and storage of coal (1), or being cross-cutting in nature (1).

Five drivers were determined to be of 'high' importance as they were cited in the literature with the highest incidence (see Table 5). These are the cost competitiveness of renewable energy alternatives, the financial distress of distribution companies (DISCOMs), air pollution regulation, water scarcity, and coal shortage. These are each discussed in more detail in the following sections. The qualitative analysis draws connections between these drivers and underlying policy or market failures (including failure to price externalities). DISCOMs' financial distress was commonly cited as a major driver of coal power plant stranding and so is included in this section to reflect this.

In addition to the five more specific drivers outlined below, electricity generation overcapacity is having an overarching role in accelerating asset stranding in India's coal power sector. In between March 2017 and March 2018, electricity generation capacity exceeded demand by 8.8%, dropping to 6.8% at peak demand (and is particularly pronounced in Western regions – see CEA, 2017a). Total electricity demand is lower than expected, in part due to slow growth in industrial demand. Meanwhile, electricity supply has been impacted by poor electricity planning, the de-regulation of the electricity sector in 2003, aggressive bank lending and excessive risk taking by promoters (Standing Committee on Energy, 2018; Vasudha Foundation et al., 2018). In future, increased demand might reduce this gap, particularly through rural or transport electrification and 'Made in India' enterprise development (e.g. OECD/IEA, 2015).

The result of this disparity is declining plant load factors – the ratio between the actual output of a power plant compared to the maximum output it could produce. In the last decade, plant load factors declined by 12% on average (from 77.5% in 2009/10 to 65.1% in 2018/19) (Ministry of Power, 2018). Though not a direct focus of this paper, load factors have been declined more significantly in state government owned and privately-owned plants (see Figure 5). The Institute for Energy Economics and Financial Analysis argues the central-government-owned NTPC (formerly the National Thermal Power Corporation) plants have priority in coal linkage and power purchase agreements with DISCOMs, which means they are protected from some of the drivers that might affect load factors at state and privately-owned plants (Buckley, 2018).

Driver 1: cost competitiveness of renewables

India's levelised renewable energy costs are among the lowest in the world (IRENA, 2018). Solar and wind technologies are cost competitive with the cheapest fossil fuel option (coal), while hydropower is even cheaper (IRENA, 2018). The costs of utility-scale solar

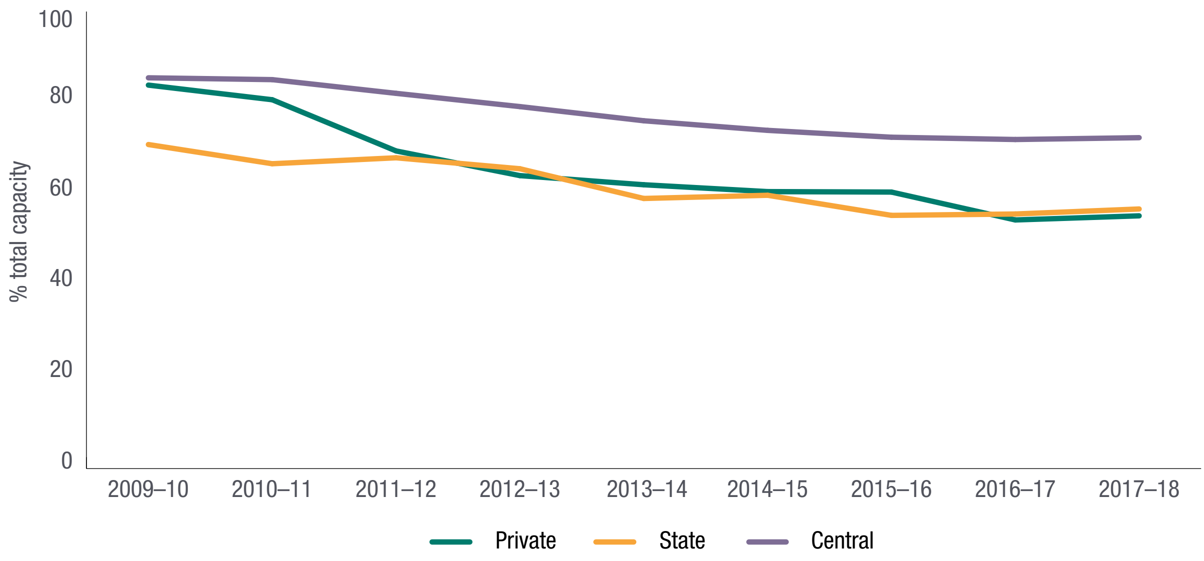
Table 5 High-importance drivers of coal power asset stranding in India (January 2017–March 2018)

Coal-fired power value chain					
	Coal mining	Transport and storage	Power plants	Transmission and distribution	Cross-cutting
Project appraisal, preparation and construction			3. Air pollution regulation (also impacts on operations)	1. Cost competitiveness of renewable energy alternatives	
Operation (maintenance, retro-fitting)	5. Coal shortage		4. Water scarcity	2. DISCOMs financial distress	
Closure, decommissioning and rehabilitation					

Note: number indicates order of importance (i.e. incidence in the literature).
Source: See Annex 2.

3 The cost competitiveness of renewable energy alternatives, financial distress in DISCOMs, air pollution regulation, water scarcity coal shortage, plant efficiency, carbon taxation, coal taxation, energy efficiency, transport, mandated plant closures, favourable rules for energy alternatives, technical failures, coal price fluctuations, labour disruptions, cost competitiveness of newer coal plants, cost competitiveness of gas plants, land issues, water costs, favourable permitting for alternatives, new coal discoveries, declining plant load factors.

Figure 5 Load factors of coal plants by ownership (central government, state government and private) (financial years 2009-10 to 2017-18)



Source: Vasudha Foundation (2018), based on data from the Central Electricity Authority

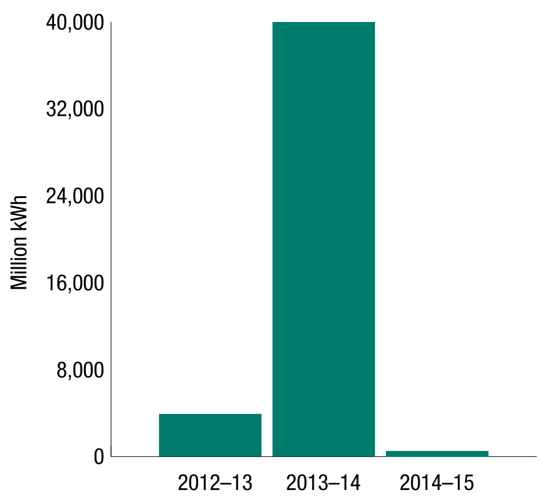
declined by 75% between 2010 and 2017 to less than \$0.1 per kilowatt hour (kWh), and onshore wind costs declined by 16% to between \$0.04 and \$0.05 per kWh on average (IRENA, 2018). In addition, the lowest solar tariff bid declined fivefold to ₹2.44 (\$0.035) per kWh between 2010 and 2017 (Bridge to India, 2017). By 2017, solar and wind project bids were 20% cheaper than the average price of existing thermal power generation (Buckley and Shah, 2017).

As a result, renewable energy capacity installations are growing rapidly. From April 2017 to March 2018, renewable energy capacity installations (of 11.8 GW) were double those of net new thermal capacity installs (of 5.0 GW) (CEA, 2017b; 2018). As the government aims to increase renewable capacity to 175 GW by 2022, this trend is likely to continue. In addition, under the Indian Electricity Grid Code, wind and solar projects receive 'must-run' status over thermal power and free interstate grid transmission (Buckley and Shah, 2017).[4]

Driver 2: DISCOMs' financial distress

In India, electricity distribution companies (DISCOMs) are facing collective debt burden worth billions of dollars (Mukherjee and Tripathy, 2017). Reasons for this include: heavily subsidised rural and residential electricity prices that fail to recover full production costs; electricity theft; non-payment or inability to pay for electricity by certain categories of end consumers; the lack of capacity to measure electricity consumption and to bill based on actual energy usage; unfunded state subsidies; as well as excessive lending to finance ongoing operations (Bharadwaj, 2017; Buckley, 2018). As a result, DISCOMs are increasingly attempting to achieve profitability.

Figure 6 Generation losses due to DISCOM low demand and associated reserve shut down (million kWh), financial years 2012–13 to 2014–15



Source: Vasudha Foundation (2018), based on data from the Central Electricity Authority

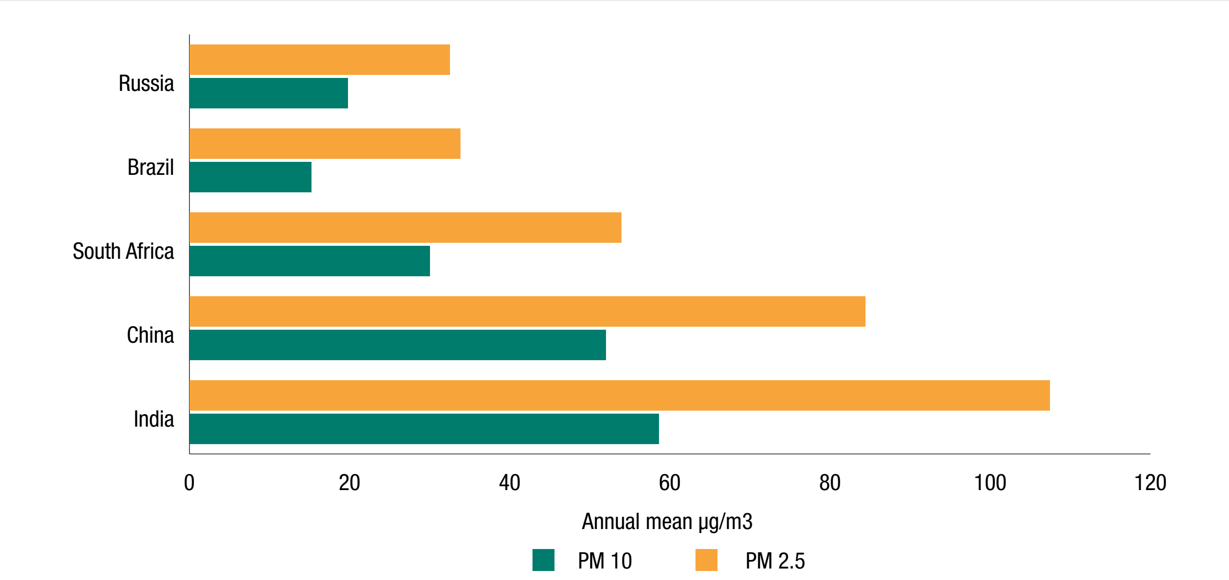
4 This is despite some evidence that states such as Tamil Nadu and Rajasthan have been curtailing renewables.

Under efforts to reduce costs, certain DISCOMs are suppressing demand for coal power, extensively delaying payments to electricity producers, and renegotiating coal power PPAs (Singh, 2018a; Mukherjee and Tripathy, 2017). From 2012 to 2015, coal power generation losses due to low DISCOM demand and associated reserve shutdown reached nearly 15 billion kWh a year on average (see Figure 6; Vasudha Foundation, 2018). Reserve shutdown is where generators and distributors agree to take a plant (or unit) offline for a period due to

Box 2 Health and environmental costs of coal power in India

India's cities are among the most polluted globally. Ten of India's cities rank among the 20 most polluted for particulate matter (PM) 2.5, and all exceed the World Health Organization's standard for PM 10 (20 μg/m³) (see Figure 7) (WHO, 2016; Greenpeace, 2018). Coal power is a major contributor. By 2050, coal power alone is expected to become the single largest source of PM 2.5 emissions (Health Effects Institute, 2018). Coal power also releases sulfur oxide and nitrogen oxide emissions, mercury, soot and fly ash into the atmosphere (Landrigan et al., 2017; Shearer, Fofrich and Davis, 2017).

Figure 7 Outdoor air pollution in BRICS urban areas (cities average, annual mean μg/m3) (2010–2014)



Note: Russia's estimate is based solely on one city, Moscow. The other countries are averages for between 13 and 210 cities. Some city estimates are for 2013 and other estimates for 2014, based on latest available data.
Source: WHO (2016)

Air pollution is one of the largest contributors to premature deaths in India, with PM 2.5 alone being responsible for 1.3 million premature deaths a year (Health Effects Institute, 2018). It also has a direct effect on the economy from reduced productivity: it is estimated to cost India's economy around 3% of India's GDP (Zulqarnain Zulfi, 2016). By 2030, the implementation of coal power norms could avoid 3.2 lakh (320,000) premature deaths, and 5.2 crore (52 million) respiratory-related hospital admissions (Center for Study of Science, Technology and Policy, 2018).

Coal mining and coal power are extremely water-intensive processes (see also the following section on driver 4), and also have negative impacts on water bodies. Ash from power stations is stored in ponds and poses a hazard to surface water sources from runoff and to groundwater from percolation (Cropper et al., 2012). Discharges from power stations must be treated, and zero discharge to water is proposed for some coal plants (CEA, 2016).

The effects on land are felt mainly through coal mining and the coal power waste disposal. In 2014, over 280,000 hectares of land were mined for coal, of which 27% was forest land (Garg, n.d.). The use of forest land is expected to increase with associated impacts on biodiversity, ecosystems and forest-related livelihoods. In 2014/15, approximately 184 million tonnes of ash was generated by coal plants (CEA, 2015). The land required to store this waste is estimated at 82,000,000 hectares a year (based on an estimated 0.6 hectare of land per MW installed capacity; Tiwari, Umesh and Dewangan, 2016).

Source: Garg et al. (2017)

low system demand or payment issues. This procedure was particularly prevalent in financial year 2013-14 (Vasudha Foundation, 2018).

Driver 3: air pollution regulation

In December 2015, the Ministry of Environment, Forest and Climate Change issued revised environmental standards for thermal power plants to be implemented by the end of 2017. As per the revised standards, particulate emissions would decline by 40% and nitrogen and sulphur oxides by 48%, as well as working to reduce or eliminate fly ash waste (Scroll.in, 2018a). In October 2017, 89% of the coal power fleet were in breach of these limits (Buckley and Shah, 2017). In that same year, following pressure from the Ministry of Power, the orders were revised to apply from 1 January 2023 (a five-year delay) (Scroll.in, 2018b). The Ministry argued to the Supreme Court that a phased retrofitting plan is required so as to not jeopardise the country's power supply (Scroll.in, 2018a). It also argued that the standards should not apply to those plants under construction which had achieved environmental clearance before the regulation as this would create significant costs and delays (Scroll.in, 2018a). More positively at the state level, in July 2018, the Gujarat Pollution Control Board suspended imports to combat air and water pollution from the incorrect storage and handling of coal and bauxite (TNN, 2018; Balan, 2018).

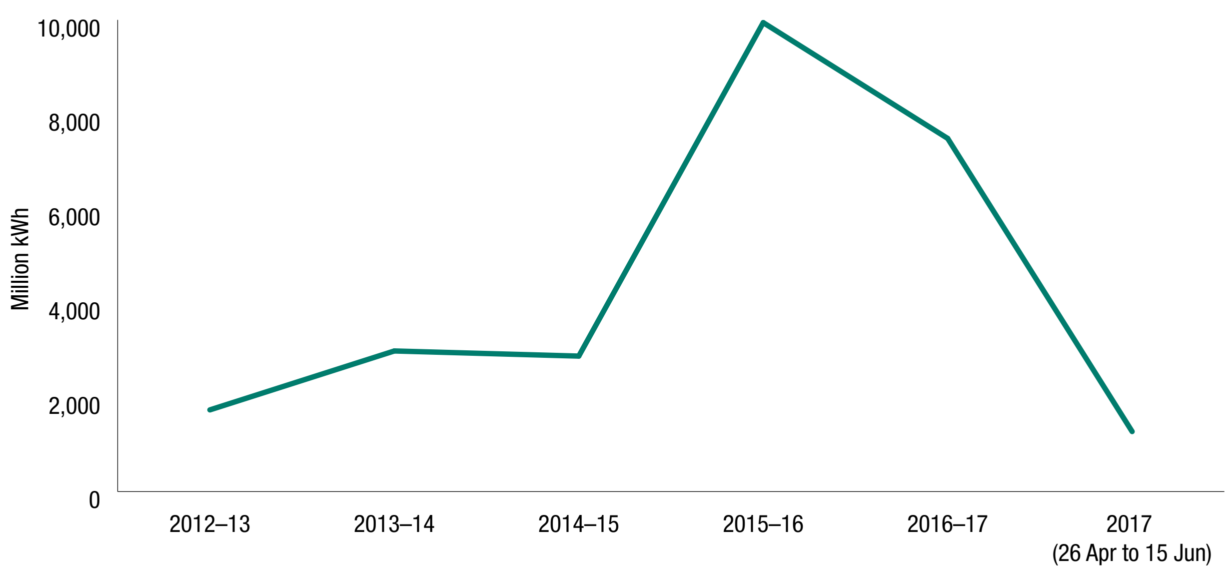
The effective enforcement of these standards would significantly increase capital costs (Dash, 2018). The Central Electricity Authority has estimated these costs at between ₹88 lakh and ₹1.28 crore (between $0.1 million and $1.9 million) per megawatt (MW). In the meantime, the failure to enforce these standards is receiving increasing attention because of the rising health burden of emissions (see Box 2).

Driver 4: water scarcity

Thermal power plants use water to cool steam for electricity production and for the disposal of ash waste (Scroll.in, 2017). The Ministry of Environment, Forest and Climate Change's 2015 environmental regulations include water usage limits of 2.5 cubic metres of water per MWh for coal plants; revised upwards to 3 cubic metres per MWh in October 2017 (Scroll.in, 2017). Water scarcity is increasingly likely in the context of climate change, as well as economic growth and population expansion (Garg et al., 2017; Buckley and Shah, 2017). By 2050, WRI and IRENA (2017) estimate coal power will account for 9% of India's domestic water consumption (under a business as usual energy scenario).

Between 2012 and 2017, water scarcity was reportedly responsible for coal power generation losses of 5 billion kWh a year, with strong annual variation (see Figure 8) (Vasudha Foundation, 2018). In 2015/16 and 2016/17, India experienced particularly severe drought, affecting water availability to coal power plants (Vasudha Foundation, 2018). This creates a strong incentive for water efficiency in the electricity sector. In this, renewables hold an advantage. While India's coal power plants use 3.8 cubic metres of water per MW, solar uses 0.1 cubic meters and wind nearly zero per MW (Buckley and Shah, 2017).

Figure 8 Generation losses due to water scarcity (million kWh) (financial years 2012/13 – June 2017)



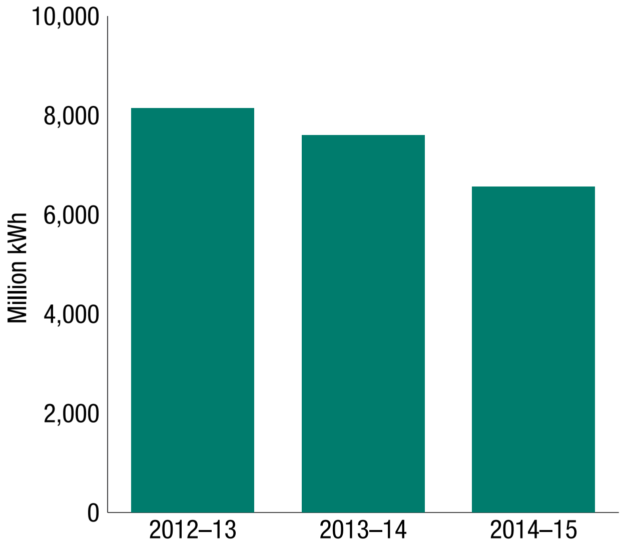
Source: Vasudha Foundation (2018), based on data from the Central Electricity Authority

Driver 5: coal shortages

In June 2018, 9 GW of coal plants were idle due to coal shortages (Shaikh, 2018). Coal shortages experienced by plants are the result of many factors including low domestic production efficiency, long distances between the mine and power plant, inefficient railway logistics, the absence of coal linkages (between mines and plants), or the disruption of coal linkages following a failure to pay for coal inputs (see Annex 2 for references). India's major coal producer's (Coal India Limited) efficiency remains low, despite some improvement (e.g. 27 percent increases in coal production in the past 5 years despite fewer employees) (Buckley and Shah, 2017). The government has announced plans to increase domestic coal production, however coal linkages remain an issue as in 2014 the government cancelled the allocation of coal blocks to plants with a memorandum of understanding leading to coal shortages (CTI, 2018).

Coal shortages are also impacting plants relying on imported coal. Tata Power, Adani Power and Essar Power collectively own 9.8 GW of coal power capacity entirely reliant on coal imports, which are at risk of stranding due to rising international prices, fuel import costs and currency depreciation (Mishra, 2018; Buckley and Shah, 2017; Singh, 2018b.[5] Operations are becoming

Figure 9 Generation losses due to coal shortage (million kWh) (2012/13 to 2014/15)



Source: Vasudha Foundation (2018), based on data from the Central Electricity Authority

Box 3 Links between coal power and government interventions in India's wider banking sector crisis

The declared bad debts of Indian banks rose significantly in 2017 and 2018, reaching $130 billion at the end of March 2018, and prompting a $32 billion recapitalisation plan for the dominant state-controlled banks (FT, 2018). India's power sector is responsible for $38 billion of this 'bad debt' burden (Singh and Antony, 2018).

In February 2018, the Reserve Bank of India issued a circular on new lending rules classifying delayed debt servicing of even one day as default (Reserve Bank of India, 2018). These rules classify defaulters as any stressed power plants without PPA agreements and without coal linkages that are unable to service debts – and in turn, loan defaulters cannot access PPAs and associated coal supplies (Kondratieva, 2018; Shetty, 2018) . A legal dispute arising from the new rules has led the Allahabad High Court to grant a reprieve for power projects facing 'severe' financial distress until the finance ministry meets with stakeholders on a possible solution (Financial Express, 2018). The Ministry of Power is also exerting pressure on the Reserve Bank to amend the rules (Singh, 2018c). This is particularly important for publicly owned banks that have the highest investment exposure to the coal sector (based on new investments in 2017; PTI, 2018a). For example, in June 2018, a consortium of banks led by the State Bank of India wrote off three-quarters of outstanding loans from a Jharkhand coal power project (Singh and Antony, 2018).

A consortium of banks led by the State Bank of India were also proposing to form a stranded asset management company to take over 14 'stressed' coal power plants (Dhillon, 2018).[1] Under the so-called National Infrastructure Investment Fund, a debt burden of ₹2 lakh crore ($29.2 billion) will be taken over (Ab, 2018). The banks involved are the main project creditors for these assets, with individual bank commitments based on project-level exposure (Dhillon, 2018). The aim is to restore the project's financial health using debt for equity swaps and concessional interest rates, with unsustainable debt converted to long-term bonds and sustainable debt sold to investors (Dhillon, 2018; Ab, 2018). This runs the risk of DISCOMs reneging on existing, more expensive coal power PPAs to prioritise these discounted PPAs, thereby pushing a new wave of coal plants into financial distress while more positively reducing the cost of power supply (Buckley, 2018).

1 At the time of writing

5 Due to machinery constraints these plants rely on imports for up to 70% of their coal inputs.

increasingly uneconomic as despite rising coal input prices, they remain bound by PPAs with a purchase price of between ₹2 and ₹3 (between $0.03 and $0.04) per kWh (ibid).

Of the 189 power plants included in Vasudha Foundation (2018) database, between 2012 and 2015, generation losses due to coal shortages reached 7 billion kWh a year on average (see Figure 9). Coal power plants in Punjab, Haryana and Rajasthan in particular are facing an increasing risk of critically low coal stocks due to waterlogging in open-cast coal mines (Sirhindi, 2018).

4.3 Cross-cutting findings

Drawing together these findings, we find that many of the government interventions identified in section 4.1 are counteracting the drivers of asset stranding in the coal power sector identified in section 4.2 (see Table 6). The drivers of asset stranding in India's coal power sector are collectively increasing capital expenditures and operating costs, while government interventions are reducing capital expenditures and operating costs. Except for recent policy postponements, and proposals by the State Bank of India to directly support stressed coal power plants in the context of India's wider banking crisis (see Box 3), we find that most government interventions identified were introduced before asset stranding risks became widely recognised. Rather than considering asset stranding a factor, these interventions are delaying the impact of the drivers identified in section 4.2 on asset stranding.

We find that most government interventions are acting on the operational stages of coal power plants – reducing operating costs (e.g. fuel inputs) and capital expenditures (e.g. retrofitting to comply with environmental standards). Different types of government interventions are acting on different stranded asset drivers. Subsidies are counteracting most of the high-importance drivers through various means, including lowering the cost of coal inputs and operation, and providing public finance, which is acting to increase investor confidence and direct investments to coal power and coal mining – an opportunity cost for renewable alternatives. Finally, policy postponements are deferring the capital cost of retrofits and delaying the cost impacts of complying with air pollution regulation. Each driver is discussed in more detail below Table 6.

Focusing on the **cost competitiveness of renewables**, government interventions to support the coal power value chain are creating an uneven playing field for renewables, particularly at project appraisal and operational stages. For example, subsidies to coal are much higher than subsidies to renewables (see Garg et al., 2017).

In July 2017, the Federal Government of India replaced a number of central and state-level taxes with the Goods and Services Tax (GST), which resulted in alterations to the net tax burden for a number of energy products and services. The coal power sector benefitted from this shift , through a slight reduction the cost of coal power per kWh (on average) (IISD, 2018 forthcoming). The possible exception is coal plants dependent on coal imports because of a separate tax reform that removed preferential rates on import duties (Garg et al., 2017). At the same time, the shift in tax burden for solar and wind increased, pushing up project costs (IISD, 2018 forthcoming; Straisth, 2018). The government also eliminated a special fund for renewable energy—the National Clean Energy and Environment Fund (NCEEF)—and reallocated the revenues into a new fund for compensating state-level losses associated with the GST. Given the ongoing trend for a decline in the levelized costs of renewables, it is unclear to what extent these changes will affect the renewable energy market.

The Indian government has undertaken several interventions and policy measures to address **DISCOM financial distress** – particularly through public finance – and the renegotiation of PPAs . In 2015 the government established the Ujwal Discom Assurance Yojana (UDAY) scheme, which aimed to improve DISCOMs' financial performance (Buckley and Shah, 2017) (see Figure 3).[6] However, under the UDAY scheme, central and state governments alongside public finance institutions have taken over up to 25% of DISCOM debts in participating states (Ministry of Power, 2016). This has materially reduced financial pressure and lowered funding costs by up to 300 basis points (Buckley, 2018). Linked also to the cost competitiveness of renewables as already outlined, India's distribution companies (DISCOMs) may also increasingly look to opportunities in lower-cost renewable solutions to help remedy their deteriorating financial position.

More recently in 2018, the government and state-owned enterprises have also initiated processes to alleviate financial distress in coal plants and DISCOMs. In January 2018, the Power Finance Corporation Limited (Consulting) agreed with PTC India (formerly Power Trading Corporation of India Limited) to assist 12 GW of commissioned thermal power plants to formalise PPAs (PTI, 2018). In June 2018, the government received 2.2 GW worth of PPA bids from 'stressed' coal plants under another government scheme (against a 2.5 GW limit) (Shetty, 2018; Singh, 2018d).

With regards to **air pollution**, postponements in the implementation of new environmental standards are causing avoided capital expenditure costs for coal plants in the medium-term, at both construction or operational stages. This driver is closely linked to additional health costs of air pollution (see Box 3). However, the Health and Environment Alliance (2017) find that fossil fuel subsidy reform would reduce premature deaths from

6 By transferring debts onto state balance sheets, lowering interest rates, increasing transparency in disclosure, reducing transmission losses, and narrowing the gap between the average cost of electricity supply and rents (Buckley and Shah, 2017).

air pollution by 65% and help to improve national productivity.

On **coal shortages and water scarcity**, while markets can signal the availability of resources through price, government interventions can mask price signals or increase resource availability. For example, despite huge water requirements, the cost of water is not charged to coal power plants, except for the costs of treating and distributing the water (Vasudha et al., 2018). This is regarded as subsidy in the provision of goods below market value (WTO, 1994). Several other subsidies and public finance interventions are supporting coal production and transport activities, and alleviating coal shortages in India (see Table 4) (CIL, 2016; PFC and REC data). In particular, the 2017 Scheme for Harnessing and Allocating Koyala Transparently in India (see Figure 3) is aiming to improve coal linkages for coal plants with PPAs (Buckley and Shah, 2017).

Table 6 Government interventions in FY16/17 (INR/USD) counteracting the high importance drivers

Drivers	Government interventions (see Annex 1)	
	Appraisal, preparation and construction stage	**Operation stage**
1. Cost competitive-ness of renewable energy alternatives	National and international public finance for coal power plants (₹73,845 crore / $11.3 bn)* Land at concessional rates for setting up power plants (value n/a)¤	Concessional custom duty rates on coal imports (₹6,452 crore/$986 million)¤ **Payment of fixed charges even when plants are operating at low plant load factors (value n/a)¤** Unclaimed return on equity for thermal plants (value n/a)¤ **Re-negotiated PPAs for thermal plants (value n/a)¤** Ministry of Power research and training support (₹67 crore/$10 million)¤ **Payouts in investor-state disputes (n/a)¤**
2. DISCOMs financial distressi		Loan forgiveness and financial restructuring of DISCOMs (debt takeover and issuance of bonds) (₹73,690 crore/ $11.3 billion) ‡
3. Air pollution regulation		Support for environmental measures and subsidence control (₹1 crore/$0.08 million)¤ Non-incurrence of costs due to non-compliance with mandates on coal washing/ beneficiation (₹1,064 crore/$163 million) † **Non-compliance with sulphur dioxide environmental standards, introduced in 2015 (₹23,660 crore/$3.6 billion) †** Lack of coal regulator (value n/a) †
4. Water scarcity	Water at zero or low cost for coal power plants (value n/a)¤	
5. Coal shortage		National and international public finance for coal mining (₹182 crore/$28 million)* Budget transfers for detailed drilling or regional exploration ₹256 crore/$39 million)¤ Compensation for land acquired for coal mining purposes (value n/a)¤ Concessional royalties (value n/a)¤ R&D in coal mining sector (₹18 crore/$3 million)¤ National finance for coal transportation (₹88 crore/$13 mn)* Concessional duty rebates on coal mining equipment (₹6,452 crore/$986 million)¤ Concessional railway freight rates on long distance coal transportation (value n/a)¤ Conservation and safety in coal mines and development of transport infrastructure (₹245 crore/$37 million)¤

*Notes: Key: ¤ = Subsidies; * = public finance; † = policy postponements; ‡ = public finance and subsidies.* High importance government interventions **are in bold.** *Where estimates are missing, these are not publicly available. This table excludes government interventions that have been phased out since FY 2016. There are many more indirect links not included here, for example public finance (related to insurance) and subsidies (related to concessional land and research and development) that are cross-cutting in the coal power value chain.* [i] *This draws on government interventions to transmission and distribution identified in Garg et al. (2017). Some of these are technologically agnostic but were included as a result of the driver literature identifying transmission and distribution dynamics as an important consideration, under the financial distress of DISCOMs.*
Source: Annex 1.

5 Conclusions and next steps

5.1 Conclusions

Though not necessarily their primary policy objective, we find that government interventions are counteracting the wider drivers of asset stranding in India's coal power sector (and thereby risk delaying the transition to low-carbon energy).

We find that a number of government interventions – in the form of public finance, subsidies and policy postponements – are encouraging new capital investment in coal fired power, which might otherwise be considered uneconomic, during the project appraisal, preparation and construction stage. The majority of government interventions are encouraging investments in the operational stage to extend the life of assets, by directly (or indirectly) increasing operational revenues and prevent them from becoming stranded. These interventions include policy postponements that mean plant owners and investors can delay capital expenditures to adhere to air pollution regulation, or subsidies that are reducing the costs of coal inputs to power plants.

With the exception of the proposals by the State Bank of India to directly support stressed coal power plants, there is currently no evidence that government interventions are providing direct support to uneconomic coal fired power plants. This is not to say, however, that as stranding and stressed assets become more common, the government will not step in – including at the point of plant closure. State-owned enterprises, though not a direct focus of this study, are already planning to do just this; for example, in 2016 the NTPC and the Power Finance Corporation made plans to bail out coal power assets to the tune of ₹100,000 crore ($15.3 billion), though this had not been implemented at the time of writing (Jha and Sahu, 2016).

We also find that similar patterns are emerging in other countries that are navigating the transition from coal to lower-carbon energy, with government interventions undermining wider drivers that could cause coal-fired power assets to become uneconomic (see Table 7). Early analysis on the topic has already been completed for China, which found that in 2015, only 12% of China's coal power capacity was subject to competitive trading, and that between 250 and 300 GW of capacity could be cancelled by 2020 following the removal of regulatory support and the implementation of environmental standards (Yuan and Weirong, 2017).

It will be critical for all governments to carefully manage their interventions in the power sector to avoid artificially extending the life of high-carbon assets, and to ensure a smooth transition from coal to clean energy.

5.2 Next steps

This paper is a first step in setting out the links between government interventions and the drivers of asset stranding in the coal power sector. Further research is required on India's coal power sector given the rapid pace of electrification, the electricity transition, and risks of high carbon lock-in. This could include modelling the removal of current interventions in the power sector (as has been undertaken in China) and of the interactions between different interventions – subsidies, public finance, and policy and regulatory interventions – and exploring some of the wider drivers of asset standing. Such work will support policy-makers to design and implement interventions – including fiscal reforms – that are needed for a deep and rapid transition to low-carbon energy.

As highlighted in Table 5, similar analysis is important for a number of countries and regions around the world that are navigating the transition away from coal, and can also be extended to other high-carbon sectors including oil and gas production, gas-fired power, and heavy industry.

Table 7 Other national and regional examples of government interventions and drivers of asset stranding

Country/ region	Coal power capacity and risks of asset stranding	Examples of government interventions	Current and future drivers
US	270 GW in total of which two-thirds is at risk of regulatory stranding	2/3 of coal capacity is regulated ($185 billion per year in regulatory support)	Removal of regulatory support, increasing uncompetitive cost structures vs low cost renewables.
EU	Two-thirds of coal capacity is losing revenue	Policy mechanisms e.g. European Union Emission Trading Scheme exemptions and derogations; as well as subsidies e.g. to support coal mining (over €3 billion) and coal power (€614 million) as well as capacity mechanisms (€601 million)[i]	Renewable energy and energy efficiency targets; new environmental standards; significantly tightened carbon pricing
China	250–300 GW of capacity is at risk of stranding following the removal of regulatory support	Coal power guarantees; preferential treatment (high renewable energy curtailment); environmental standard costs passed to consumer	Removal of regulatory support; environmental standards
South Africa	5 GW of total capacity is to be mothballed, with a further 4.8 GW under construction	The government is supporting ESKOM (utility) through government guarantees for its debt and bailouts, in financial debts (58 billion rand 'gap' in 2018); public finance for construction of new plants and coal mines	Environmental standards; water availability (climate change impacts)
Indonesia	Investment plan revised capacity downwards by 20 GW due to low demand	PPP guarantees (land, infrastructure); corporate tax incentives; capacity payments; and, a coal price regulation to be introduced soon	Lower than expected demand growth and overcapacity
South Korea	35 GW of total capacity with 7 new units in the pipeline	Power prices are kept artificially low; capacity payments ($1.5 billion/year); carbon price exemptions ($1 billion – $2 billion/year); 30-year investment guarantees	Renewable energy targets; climate mitigation targets; significantly tighter pollution control standards; higher carbon and coal taxes.

Notes: [i] Estimates based on a subsidy inventory in ten European countries: Czech Republic, France, Germany, Greece, Hungary, Italy, Netherlands, Poland, Spain, United Kingdom (see Gençsü et al., 2017).
Source: ODI et al. (2018) webinar; Europe and US data by the CTI (2017a, 2017b); Europe government interventions data from Whitley et al. (2017); South Africa data by the University of Cape Town (Burton et al., 2018; forthcoming; Steyn et al., 2017); China data by the North China Electricity Power University and Natural Resources Defence Council (Yuan and Weirong, 2017); evidence on Indonesia presented by the Institute for Essential Services Reform; and evidence on South Korea presented by For Our Climate. A webinar recording is available upon request.

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Annex 1 Government interventions in India's coal power value chain

The excel spreadsheet identifies government interventions in the coal power value chain in financial year 2016. It is avilable at https://www.odi.org/publications/11185-india-s-stranded-assets-how-government-interventions-are-propping-coal-power

Annex 2 Vasudha Foundation coal power plant dataset

The Vasudha Foundation dataset provides information on India's coal power plants, including the plant name, location, ownership and capacity, as well as parameters related to plant performance, water usage, emissions, local renewable energy potential, geographic (e.g. biodiversity and natural disaster vulnerability) and economic parameters (e.g. energy poverty). You can view the dataset at http://powerplantsv2.projectdevelopment.co/StatePlant

Annex 3 Drivers of asset stranding in India's coal power sector

Table A1 shows the incidence of drivers of coal power asset stranding in the literature reviewed from January 2017 to March 2018.

Table A1 Mentions of drivers of asset stranding in India's coal power sector (based on a literature review)

Drivers of asset stranding	Incidence (count)
Cost competitiveness of RE alternative	13
Low scheduling (from DISCOMs, low funds, PPA issues)	10
Air pollution regulation (costs)	9
Water scarcity (including blocked access)	6
Coal shortage (absence of linkages, overdue payments)	5
Plant load factor (due to overcapacity)	3
Efficiency of plant (age, technology)	3
Coal cess (and carbon pricing instruments)	3
Increasing energy efficiency or low demand (in consumers)	2
Transport costs	2
Mandated plant closure	2
Favourable dispatch for alternatives	1
Technical failures (unplanned breakdowns)	1
Vulnerability to Coal Price Fluctuation (Imports)	1
Labour disputes and disruption	1
Shifts in coal tax regime	1
Cost competitiveness of other coal plants (overcapacity)	0
Cost competitiveness of other fossil fuel (gas) plants	0
Land issues	1
Water costs	0
Favourable permitting for alternatives	0
Discoveries (new low cost sources of coal)	0

Sources: Mukherjee, P. and Tripathy, D. (2017); PTI (2018) Saurabh (2017); Singh and Upadhyah (2018); PTI (2018b, 2018c); WRI and IRENA (2018); Chawla (2018); Whiting (2018); Luo (2018); Greenpeace, 2018); Buckley and Shah (2017); Shankar (2017); Marcacci (2018); Green Tech Lead (2018); Patel (2017); Bhaskar (2018a; 2018b); Dash (2018); Sengupta (2018); IEEFA India (2018); Scroll.in (2018a; 2018b; 2018c); Kumar (2018); Mishra and Mishra (2018); Ministry of Coal (2017); Singh (2018a).

Annex 4 Interviewees and workshop participants

Interviewees (November 2017 to February 2018)

- Doug Koplow – Earth Track
- Jesse Burton – University of Cape Town
- Jiahai Yuan – North China Electric Power University
- Johnny West – Open Oil
- Mingming Liu, Han Chen and Mona Yew – Natural Resource Defence Council
- Matthew Gray and Laurence Watson – Carbon Tracker Initiative
- Pete Erickson – Stockholm Environment Institute

Workshop participants (22 June 2018, Delhi)

- Aarti Khosla – Global Strategic Communications Council
- Abhinav Soman – Council on Energy, Environment and Water
- Anirudh Bhattacharjee – Climate Trends
- Chirag Gajjar – WRI India
- Daljit Singh – Council on Energy, Environment and Water
- Geetika Singh – Vasudha Foundation
- Harneet Kaur – Vasudha Foundation
- Mohit Gupta – Environics Trust
- Parul Babbar – Vasudha Foundation
- Sanjay Vashist – Climate Action Network South Asia
- Santosh Kumar – Environics Trust
- Shreyanka Rao – Lumen Consulting
- Vikas Mehta – Growald Family Fund
- Vivek Sen – Climate Policy Initiative
- Vinuta Gopal – Asian Society for Academic Research

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