Controlling emissions in India's electricity sector: An analysis of options

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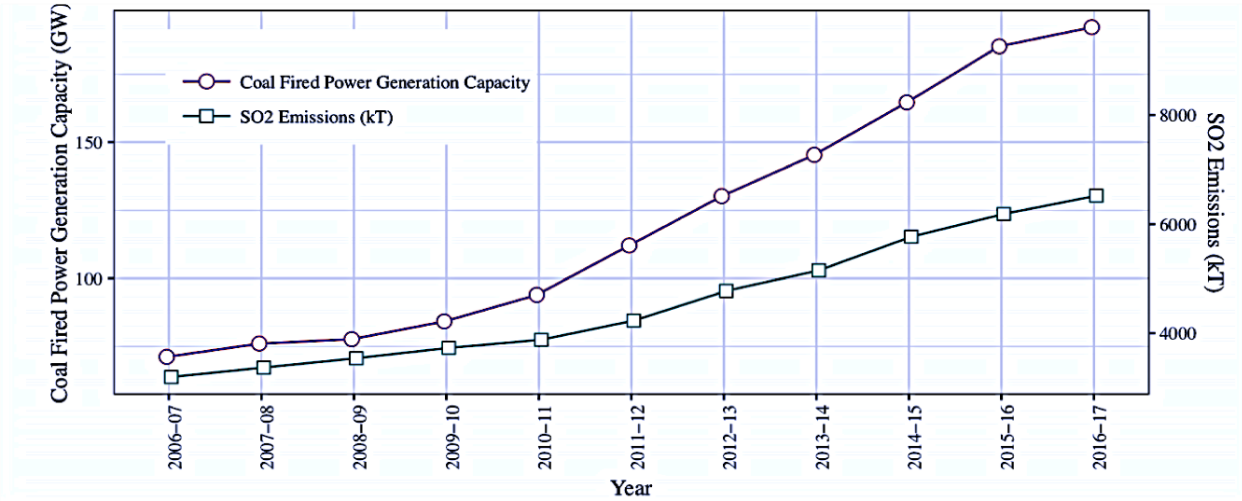
Introduction

India is currently in a state of "air crisis" that is unprecedented in the history of the country. A March 2019 ranking of world cities by AirVisual and Greenpeace lists 22 Indian cities in the worst 30 for worrying levels of $PM_{2.5}$.[2] According to Lancet Public Health, 1.24 million deaths in India can be attributed to air pollution in 2017 alone.[3]

There is a lack of sufficient evidence-based literature to guide policymakers in prioritising resources and efforts to control an identified source of air pollution. The problem is further accentuated by a weak monitoring and enforcement mechanism.[4] Thermal power plants are a major source of particulate matter (PM_{10} and $PM_{2.5}$), SO_X and NO_X emissions – along with identified sources such as vehicles, agriculture stubble and waste burning, and other miscellaneous sources such as dust. Figure 1 illustrates the relationship between coal power plant capacity addition and related SO_X emissions.[5]

Figure 1: Coal-fired power generation capacity and related SO2 emissions[6]



[2] IQ Air Air Visual. (n.d.). World most polluted cities, 2018 (PM2.5). [Website.] Retrieved from https://www.airvisual.com/world-most-polluted-cities.

[3] Balakrishnan, K.,Dey, S., Gupta, T., Dahliwal, R.S. Brauer, M., Cohen, A. et al. (2018). The impact of air pollution on deaths, disease burden, and life expectancy across the states of India: the Global Burden of Disease Study 2017. *The Lancet Planetary Health*. 3. 10.1016/S2542-5196(18)30261-4. Retrieved from https://www.researchgate.net/publication/329450659_The_impact_of_air_pollution_on_deaths_disease_burden_and_life_expectancy_across_the_states_of_India_the_Global_Burden_of_Disease_Study_2017.

[4] For issues and violation concerns in a command-and-control approach for environmental regulation in India, see Greenstone, M., Harish, S., Pande, R., and Sudarshan, A. (2017). *The solvable challenge of air pollution in India*. India Policy Forum 2017. Retrieved from https://scholar.harvard.edu/files/rpande/files/ipf_2017_greenstone_harish_pande_sudarshan_submittedmanuscript.pdf.

[5] Sugathan, A., Bhangale, R., Vishal, K., and Hulke, U. (2018). How can Indian power plants cost-effectively meet the new sulfur emission standards? Policy evaluation using marginal abatement cost-curves. *Energy Policy*, 121(C),124-137. Retrieved from https://ideas.repec.org/a/eee/enepol/v121y2018icp124-137.html.

[6] Sugathan, A. (2018). Technology options and marginal abatement costs curves for SO_2 emissions from Indian coal-fired power plants. Submitted to *Applied Energy*.

Thermal power plants are among the 17 highly polluting industries that are required to install continuous emissions monitoring systems (CEMS) with real-time data transfer to state pollution control boards (SPCB) and the Central Pollution Control Board (CPCB) servers. Researchers note that thermal power plant CEMS data is neither in the public domain nor is it fully reliable, and therefore is not useful for regulatory and policymaking purposes.[7]

Setting thermal power plant emissions standards is one of the important functions of the India's Ministry of Environment, Forests and Climate Change (MoEF&CC). The ministry revised emissions standards in late 2015 and established a December 2017 deadline for compliance. For the first time ever, the 2015 revisions established emissions standards for SO_X, NO_X, Mercury and water consumption.[8] See the Appendix for further details on the historical context of emissions regulation and current landscape for monitoring and enforcement of standards.

In July 2018, the Supreme Court of India[9] reprimanded the ministry for its inability to enforce compliance of the new standards.[10] In its defense for delay, the MoEF&CC along with the Ministry of Power (MoP) and the Central Electricity Authority (CEA) expressed reservations and asked for an extension of the original deadline to December 2024. A principal reason for the extension was the inability of generation companies to take up additional capital and operating expenditure to meet the new standards along with the lack of availability of space, water and other input materials such as limestone.[11] After considering the views of various parties, the court granted a five-year extension (i.e., compliance by December 2022).

The significance of this case is far-reaching from the perspective of the time lost when it comes to improving the health of Indian citizens. Ideally, policymakers would have diagnosed the reasons for non-compliance by the original deadline (December 2017) and articulated why they believe those same reasons will not be prevalent for meeting compliance by the new deadline (December 2022). This is an important step, in the absence of which the possibility of some thermal power plants slipping the new deadline remains, and therefore delays the expectations for

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[7] Bhati, P., and Pathania, R. (2018). *No room for delay: Analysis of CEA plans to implement new norms for coal power plants*. New Delhi: Centre for Science and Environment. Retrieved from https://shaktifoundation.in/report/no-room-delay-analysis-cea-plans-implement-new-norms-coal-power-plants/.

[8] Water stress caused approximately 14 TWh of less electricity generation from India's coal power plants according to a WRI (2018) study. See Luo, T., Krishnan, D., and Sen, S. (2018). *Parched power: Water demands, risks, and opportunities for India's power sector*. Washington, D.C.: World Resources Institute. Retrieved from https://www.wri.org/publication/parched-power.

[9] Writ Petition(s) (Civil) No(s). 13029/1985 M.C.Mehta (Petitioner) Versus Union of India & Others (Respondents).

[10] Monitoring and enforcement of emissions standards within a state boundary is the responsibility of State Pollution Control Boards (SPCBs), which are guided by the Central Pollution Control Board (CPCB).

[11] Chemical reagent used in FGD systems.

improved health.

Interestingly, neither MoEF&CC nor the Supreme Court of India suggested that alternative policy mechanisms could be developed that would make it easier and cheaper to achieve the emissions reduction targets relative to the MoEF&CC's "command-and-control" approach. MoEF&CC's current approach requires (command) each thermal power plant to install equipment to reduce emissions (control). Evidence from both India and elsewhere indicates that emissions reductions can be achieved at significantly lower costs and with an improved probability of success by pursuing market-based alternatives such as emissions trading systems or emissions portfolio obligations.[12]

We present several of these options for consideration by Indian stakeholders. This short framing paper provides an overview of the main alternatives and a comparison of the advantages and disadvantages of each alternative. Our goal is to stimulate a robust discussion of the merits of these options for meeting India's public health and economic development goals.

Menu of options

Drawing on international experience and knowledge of India's policymaking environment, we offer three alternatives to the current command-and-control approach. These include an emissions trading system, emissions portfolio obligation, and an emissions reduction surcharge. In this section, we describe each mechanism and offer a brief overview of how such an approach could be implemented in India. In the following section, we highlight the advantages and disadvantages of each approach.

In the discussion of each mechanism, we assume that the total emissions reductions are identical across all of the options. The primary difference among the options in achieving those emissions reductions is with respect to the total cost of compliance across the sector. There are several other differences in terms of the policy framework under each option. However, it needs to be emphasized that the outcome sought – i.e., quantum of emissions reductions from the power sector – is the same across all options.

[12] Some SPCBs are increasingly accepting these limitations and opening up to the concept of market-driven approaches to reduce and control pollution. For example, the Gujarat Pollution Control Board launched a pilot emissions trading scheme on 5 June 2019 for industries (except for thermal power plants) in the industrial cluster surrounding the city of Surat. The pilot envisions trading particulate matter emissions among 300 industries, mostly in the chemicals sector. The Board is supported by a team of experts from J-PAL South Asia, University of Chicago Trust and the Institute for Financial Management and Research. For more details of the scheme, see Gujarat Pollution Control Board. (2019). *Emissions Trading Scheme (Pilot Project)* [Website]. Retrieved from https://gpcb.gujarat.gov.in/webcontroller/page/emissions-trading-scheme-pilot-project.

The total cost of compliance is a crucial variable to consider given the overall dire fiscal situation that exists within the power sector. The power sector, despite the UDAY intervention (implemented in 2015, wherein states agreed to take over 75% of discom debt), has been racking up losses that are expected to be back at the pre-UDAY levels by early next year.[13,14] The banking sector continues to reel under the non-performing asset crisis in which the power sector continues to be a key element. Both national- and state-level budgets already have deficits larger than what the law allows.

Both the national- and state-level governments are under enormous pressure to address multiple concerns, such as slowing economic growth, high unemployment, rural agrarian distress, protectionist policies of other nations that are restricting Indian exports, poor quality infrastructure, and exposure to volatile global oil prices, among others. Consequently, we explore options that can reduce the overall cost of compliance with the required emissions reductions.

Command-and-Control

The incremental expenses required to meet emissions standards depend on the control equipment already in place and the age of the thermal power plant. Plant owners' willingness to invest in emissions control technologies depends on the cost of the upgrades and useful life of the plant. Establishing this administratively may be difficult due to the lack of good quality data on plant operations and emissions.

Yet that administrative approach is the one being used today. There are three sets of emissions standards prescribed for thermal power plants that differ with plant vintage – i.e., pre-2003 (~58 GW), 2003-2016 (~130 GW) and post-2016 (~9 GW). Plants installed after 2016 have to follow the most stringent standards and may already have invested in some control equipment as required by their environment clearance permissions. See the Appendix to this paper for an overview of the old and new standards, and how they compare with standards applicable in other countries.

There is a high level of uncertainty about the costs of compliance – both one-time capital expenses (capex) and recurring operating expenses (opex) – involved in installing and operating emissions control technologies. For example, CEA estimated the total capex cost to be approximately 644 INR bn, while the Ministry of Power's

[13] For more details on UDAY: Government of India Ministry of Power. (2019). Salient Features of the Scheme. [Website.] Retrieved from https://www.uday.gov.in/Salient-Features.php.

[14] CRISIL. (2019, 6 May). *Square one: Discom debt to reach pre-UDAY levels this fiscal* [Press Release]. Retrieved from https://www.crisil.com/en/home/newsroom/press-releases/2019/05/square-one-discom-debt-to-reach-pre-uday-levels-this-fiscal.html.

funding request amounts to 835 INR bn.[15, 16] A back-of-the-envelope levelised cost of electricity calculation suggests this would mean a tariff increase of 0.25 INR/kWh to 0.32 INR/kWh.[17]

Following the court orders, thermal power plants owned and operated by the central government (~58 GW capacity, out of a total of ~200 GW of coal-fired capacity), along with some state government-owned and private generators have initiated the process for selection of vendors for flue gas desulfurisation (FGD) installation for SOx removal.[18] Table 1 shows the current progress of FGD installation.[19]

Table 1: Status of FGD installation (MW)

Sector	FGD planned	Feasibility Study Completed	Notice Inviting Tender	Bids awarded	FGD Commissioned
Central	53,350	51,510	43,260	13,540	-
State	51,885	35,980	3,630	-	-
Private	61,737	42,220	19,750	1,820	1,820
Total	**166,972**	**129,710**	**66,640**	**15,360**	**1,820**

Some of these companies have approached the respective regulatory commissions for clarity on an in-principle approval of costs, and for pass-through of these costs in the generation tariff. Although the central regulator (CERC, July 2018) and state regulators (MERC, 2019) have maintained that the tariff regulations do not provide for any "in-principle cost approvals" and therefore, while the commission agrees that such additional costs shall be treated as a pass-through, the quantum of allowable costs can only be determined post-facto – i.e., after the costs have been incurred and a detailed scrutiny of such costs has been undertaken.

The distribution utilities, on whom the burden of a pass-through tariff will fall, have expressed their inability to raise consumer tariffs to reflect true costs. For many distribution utilities, their average tariff is lower that their average cost of supply –

[15]. Central Electricity Authority. (2019, 21 February). Norms for Installation of FGD for new environmental regulations 7th December-2015. Author. Retrieved from http://www.cea.nic.in/reports/others/thermal/umpp/fgd_newnorms.pdf

[16] Finance Commission. (2019, 5 February). *Finance Commission meets the Ministry of Power* [Press Release]. Retrieved from http://pib.nic.in/newsite/PrintRelease.aspx?relid=188646.

[17] Assuming a useful life of 15 years for the emissions control technology installed, opex at the rate of 10% of the capex, and a discount rate of 11%.

[18] Other technologies will be needed to address the remaining pollutants and reduce water consumption. For example, in order to reduce NOx, technologies such as low NOx burners, selective catalaytic and non-catalytic reduction equipment; for PM, technologies such as electro-static precipitators; and for water, closed-loop cycles or even air-cooling are being considered. We are presenting data only for FGDs in this paper to illustrate how the process of compliance is playing out in India today.

[19] Gupta, A. (2018). Picking up Pace: Progress in FGD implementation at TPPs. *Power Line*. Retrieved from https://powerline.net.in/2018/12/29/picking-up-pace-2/.

with some states having gaps as high as 1.96 INR/kWh (Jammu & Kashmir), 1.85 INR/kWh (Jharkhand), and 1.61 INR/kWh (Manipur).[20]

With the above regulatory context, and the dire financial status of distribution utilities, power plant owners as well as lenders are increasingly concerned about the viability of investments in emissions control technologies. The Ministry of Power has asked for viability gap funding support from the Finance Commission.[21] Experts say that such support can potentially be provided from the National Clean Energy Fund.[22]

In the absence of enough regulatory clarity on the amount of pass-through coupled with the limited appetite of distribution utilities to raise tariffs, this option runs into the risk of further delays or total non-compliance by the thermal power plants.

Emissions Trading System (ETS)

An emissions trading system (ETS) caps the total system emissions by explicitly making a specified number of allowances available, establishes a market for trading emissions allowances, and establishes emissions standards for each emitting generator. Unlike the command-and-control option, under the ETS, each generator does not have to invest in emissions control technology in order to comply with the emissions standard. Instead, each generator can decide either to invest in emissions controls or purchase allowances from the market to comply with the standards. The generators then demonstrate compliance by presenting emissions allowances equal to their actual total emissions in that period. Generators use the allowance price from the market as a key benchmark to decide their optimal compliance strategy.

Newer, more efficient and cheaper generators that expect to run a lot and for a longer period of time may find it cheaper to install emissions controls that enable them to go well beyond the emissions standard set for them. They can convert excess emissions reductions into allowances to sell to older, less efficient and expensive generators that run seldom and may retire soon. Consequently, the overall cost of achieving the same aggregate emissions reductions may be significantly lower under the ETS as compared with the command-and-control option because only a sub-set of plants are installing emissions controls.

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[20] For an overview of financial stress in the distribution business, see Kaur, A., and Chakraborty, L. (2018). *UDAY power debt in retrospect and prospects: Analyzing the efficiency parameters* [Working Paper]. New Delhi: National Institute of Public Finance and Policy. Retrieved from https://www.nipfp.org.in/media/medialibrary/2018/11/WP_244_2018.pdf.

[21] Finance Commission. (2019, 5 February). *Finance Commission meets the Ministry of Power* [Press Release]. Retrieved from http://pib.nic.in/newsite/PrintRelease.aspx?relid=188646

[22] This fund was collected through a cess on the sale of coal which was introduced in 2010 and was in operation until the introduction of the Goods and Services Tax in mid-2017. Since then it has been rechristened as GST Compensation Cess.

Three crucial factors for successful implementation of this option include:

- Transparency in data collection and dissemination.
- Effective monitoring and audit of allowances.
- Improvement in administrative capabilities of the institutions involved.

Lack of any of these factors could lead to improper compliance and failure in enforcing accountability. Meta-analysis studies on the design and effectiveness of ETS systems globally indicate that institutional learning, administrative prudence, appropriate allowance revenue management, and stakeholder engagement policy are crucial for ETS performance.[23]

The institutions and platforms are largely in place to implement such a market-based trading program in India. Thermal power plants are part of the 17 controlled industries that have to install CEMS and share continuous emissions data with their respective SPCB as well as the CPCB.[24] The PCBs can issue emissions allowances, while the Power System Operation Corporation Limited (POSOCO), which today maintains the renewable energy certificate (REC) registry, could manage allowance trading.[25] Alternately, the exchanges which provide a platform for REC trading could also manage allowance trading.[26]

More importantly, India has prior experience with an ETS-type program with the Perform Achieve Trade (PAT) scheme.[27] PAT aimed to promote energy efficiency by setting up energy reduction targets for the included industries (referred to as designated consumers). Companies had the freedom to perform better than their targets, earn energy savings certificates (ES Certs), and trade those ES Certs with other companies who underachieved on their energy savings targets.

PAT Cycle-I was launched in March 2012 for eight sectors, including thermal power plants (see Table 2 for list of sectors included along with the energy savings targets)

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[23] See Haites, E. (2018). Carbon taxes and greenhouse gas emissions trading systems: What have we learned? *Climate Policy*, 18:8, 955-966. Retrieved from https://www.tandfonline.com/doi/full/10.1080/14693062.2018.1492897; and Easwaran Narassimhan, E., Gallagher, K., Koester, S., and Alejo, J. R. (2018). Carbon pricing in practice: A review of existing emissions trading systems. *Climate Policy*, 18:8, 967-991. Retrieved from https://www.tandfonline.com/doi/full/10.1080/14693062.2018.1467827.

[24] Central Pollution Contraol Board, Ministry of Environment, Forest and Climate Change, Government of India. (2019) Online Monitoring of Industrial Emission & Effluent. [Website.] Retrieved from http://cpcb.nic.in/Online-Monitoring-Industrial-Emission-Effluent/.

[25] Renewable Energy Certificate Registry of India. (2019) Renewable Energy Certificate Registry of India homepage. [Website.] Retrieved from https://recregistryindia.nic.in.

[26] Indian Energy Exchange. (n.d.). *Renewable Energy Certificates*. Author. Retrieved from https://www.iexindia.com/products.aspx?id=5%2fPXgqPnjo0%3d&mid=IT8b%2bZM5cBA%3d.

[27] Bureau of Energy Efficiency. (n.d.). *PAT*. Author. Retrieved from https://beeindia.gov.in/content/pat-3.

and ended in March 2015.[28] Experience from the PAT Cycle-I suggests that the scheme exceeded its goals, achieving an additional savings of 30%, which are valued at 95 INR bn.[29] However, the thermal power plant sector was the only sector out of the eight selected which missed its targets (by 5%), even though in terms of savings contribution it is one of the biggest sectors with registered savings of 3.06 MTOE.

Table 2: Sectors and targets under PAT Cycle-I

Sector	Number of Designated Consumers	Energy saving targets (million toe)	Energy saving achieved (million toe)
Thermal power plants	144	3.211	3.06
Iron and steel	67	1.486	2.10
Cement	85	0.816	1.48
Fertilizer	29	0.478	0.78
Aluminum	10	0.456	0.73
Pulp and paper	31	0.119	0.29
Textile	90	0.066	0.13
Chlor-Alkali	22	0.054	0.09
Total	**478**	**6.686**	**8.67**

Lessons from PAT Cycle-I suggest that the program must have enough flexibility to adjust targets in response to market dynamics. A cap set too low will lead to a glut in the allowance market, removing the incentive to save energy. The supply of ES Certs (30,00,000) outweighed the demand (14,50,000), leading to a crash in prices from an expected price of 10,000 INR to an actual realised price of less than 200 INR per ES Cert. Further, a clearly set out enforcement mechanism (nature of penalties, timelines, etc.) brings more clarity and therefore leads to better compliance;[30] see PwC-Shakti 2014 for more details.[31]

[28] PAT Cycle-II started in April 2016 and ended in March 2019, while PAT Cycle-III started in April 2017 and will end in March 2020. Three new sectors (railways, electricity distribution companies and refineries) have been added in these two cycles.

[29] Bureau of Energy Efficiency. (2017). *PAT Scheme Booklet*. Authior. Retrieved from https://beeindia.gov.in/sites/default/files/Final%20Booklet%2029-9-2017.pdf.

[30] Kajol, Jairaj, B., and Krishnan, D. (2018). PAT's path to energy efficiency. *The Hindu BusinessLine*. Retrieved from https://www.thehindubusinessline.com/opinion/pats-path-to-energy-efficiency/article23751019.ece.

[31] PwC-Shakti Sustainable Energy Foundation. (2014). *The PAT scheme: Analysis, insights and way forward*. Author. Retreived from https://shaktifoundation.in/report/pat-scheme-analysis-insights-way-forward/.

However an ETS program will likely have certain limitations, including:

- A major limitation stems from the fact that it is focused solely on the ability of the emitting generators to reduce emissions and does not incentivise any other emissions reducing activities, such as increasing renewable energy generation and implementing demand-side measures (i.e., energy efficiency and demand response). Consequently, the ability of the ETS to reduce emissions is limited to the availability of emissions control technologies.
- The generators that end up purchasing an allowance (i.e., not actual emissions reductions) may not be seen favorably by politicians and bureaucrats who tend to prefer something more substantive rather than notional – as has been seen in India's experience with the renewable portfolio standard-renewable energy certificate (RPO-REC) mechanism which is discussed in more detail below.

Emissions Portfolio Obligation (EPO)

Unlike the command-and-control and the ETS options, an emissions portfolio obligation (EPO) puts the responsibility of compliance with the emissions reduction target on the power procurer – i.e., the distribution utilities (discoms). Unlike the command-and-control but similar to the ETS, the EPO is a cap-and-trade program which focuses on the performance of the discoms to manage their emissions portfolio.

Under the EPO, discoms are given an emissions standard which they can meet by deploying various strategies, such as reducing their overall electricity procurement by deploying energy efficiency and demand response programs, purchasing more electricity from renewable generators, or purchasing power from cleaner thermal power plants. Similar to the ETS, those discoms that reduce their emissions below the standard can sell the excess in the form of emissions certificates to discoms that are unable to meet their emissions standards. Again, similar to the ETS, the emissions certificates are traded on a market platform. Unlike the command-and-control and the ETS, the EPO would go a long way in supporting both renewable energy and demand-side measures such as energy efficiency and demand response programs which are still in their nascent stages in India.

India's RPO-REC program provides important lessons that can inform an EPO option. The RPO-REC has had a mixed response, with some discoms abiding by the set targets and several others falling behind. One of the primary factors behind the discoms' limited interest (during 2008 to 2014) in the RPO-REC program was the relatively higher cost of renewable energy compared with the cost of their existing supply portfolio. Whether they bought renewable energy or RECs, their net supply

costs would increase. Worse, since procurement of RECs is a financial transaction alone, many discoms found it difficult to justify politically as they were always short in procuring sufficient power to meet their demand. Even though the State Electricity Regulatory Commissions (SERCs) have the power to levy penalties for non-compliance, they have seldom used it given the financially stressed position of discoms. Uttarakhand and Madhya Pradesh are the only states to levy a penalty for non-compliance.[32] Lack of effective monitoring and enforcement of the program by the SERCs led to a weak accountability structure. A 2015 central government audit report notes that, "RPO mechanism designed as a policy instrument to demonstrate commitment and create a demand incentive for the development of renewable energy resources in India had not been effectively enforced" (CAG 2015). Given the poor enforcement and therefore lower demand for REC purchases, many renewable energy generators struggled with revenue realisation and financial losses. For the EPO to be successful, there has to be strict enforcement by the relevant authority (for example, the SERC) with harsh penalties for failure to meet any obligation.

The cost of renewable energy relative to the cost of many utilities' supply portfolios continues to decrease and, hence, choosing to buy renewable energy will effectively reduce the cost of the supply portfolio. The need for an RPO-REC program will diminish as this trend strengthens over time.

From an emissions perspective though, the lower cost of renewable energy relative to the supply portfolio can be leveraged to provide discoms compliance flexibility where the EPO doesn't necessarily lead to a net increase in costs. If the discom chooses to procure renewable energy or energy efficiency as a means for complying with the EPO, then its compliance costs may very well be negative relative to their existing supply costs. The major challenge with this option will be the discom's capability to optimise an emissions portfolio along with their existing responsibilities.

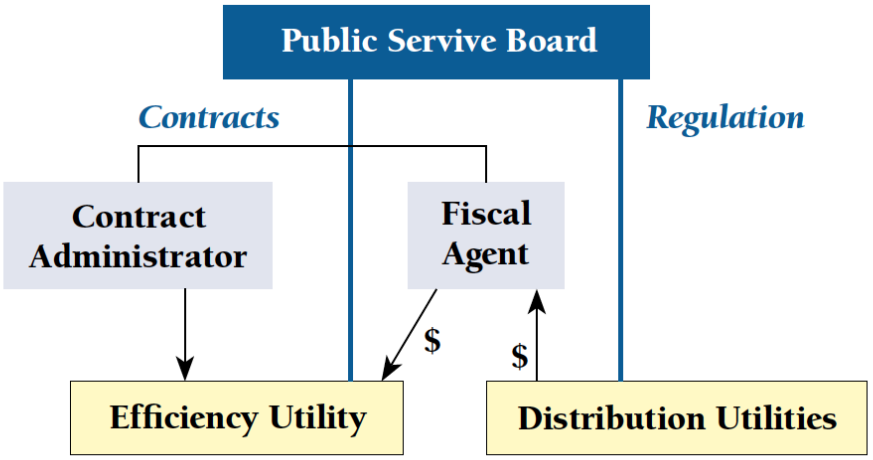
Emissions Reduction Surcharge (ERS)

The third option — the emissions reduction surcharge (ERS) — is similar to an "emissions-tax" on consumers, where a surcharge is levied on all consumers which can either be a flat rate or a progressive rate similar to the existing electricity tariff tiers. Discoms could collect the surcharge and remit the funds to a third-party, independent agency. This agency disburses the funds to appropriate emissions reduction proposals, which are least-cost and the most effective in meeting emissions standards. This method is used in the United States with third-party adminsitrators

[32] Adebare, A. (2016). India: Assessment of renewable power purchase obligations In India. *Mondaq*. Retrieved from http://www.mondaq.com/india/x/546712/Renewables/Assessment+Of+Renewable+Power+Purchase+Oblgatons+In+Inda.

for energy efficiency programs. Figure 2[33] illustrates how this works in Vermont with a third-party energy efficiency administrator, and is akin to how it would work in this instance.

Figure 2: Illustrative third-party administrator structure



The surcharge could be used to fund programs, projects and technologies which reduce the total emissions from the power sector. The agency will have to build sufficient understanding of the available technologies, develop monitoring mechanisms, ensure the effectiveness of investment decisions, and collect, analyse and disseminate data across state boundaries.

Among the three options – ETS, EPO, and ERS – one of the main differences is who makes the decisions about how to meet emissions standards. Under an ETS, the generators decide what to do. Under an EPO, the discom decides. Under an ERS, a third-party decides how to achieve the emissions targets.

Under this approach, each electricity consumer explicitly sees this line item in their electricity bill and, hence, has an opportunity for greater awareness of the cost of reducing emissions. Consequently, consumers are more likely to take an active role in questioning the relevant authority about emissions since they are paying a distinct surcharge for lowering them.

This could be the most flexible approach as funds could be allocated for the widest range of emissions reduction strategies. For example, a national-level energy efficiency program similar to the Unnat Jyoti by Affordable LEDs for All (UJALA)

[33] Sedano, R. (2011). *Who should deliver rate-payer funded efficiency? A 2011 update.* Montpelier, VT: The Regulatory Assistance Project. Retrived from: https://www.raponline.org/knowledge-center/who-should-deliver-ratepayer-funded-energy-efficiency-a-2011-update/.

scheme[34] could be part of the emissions reduction strategy under this option, but would be hard to consider and implement under the ETS and EPO approaches. Further, having an independent agency decide the best use of money removes the natural barriers in technology and approach selection, which would otherwise creep in if the funds are to be managed by the discoms or the generators.

Over the years, various state governments as well the central government have imposed taxes or "cess" on the consumption of certain good and services to raise funds for particular purposes. Some examples include Education cess, Swachh Bharat (Clean India) cess and Krishi Kalyan (Farmer's Welfare) cess. Maharashtra government has very recently hiked the state tax on electricity sale to raise funds for installing solar pumps.[35]

One of the challenges with this option is the risk of governments – either central or state – diverting these funds either temporarily or permanently to meet other social objectives. A case in point is the Clean Energy Cess on coal, which was introduced in 2010 but later abolished and rechristened as Goods and Services Tax (GST) Compensation Cess in mid-2017 and is now used to meet state indirect tax deficits. Such a diversion would delay achieving the core objective of reducing emissions.

The institutional capacity of the agency – including staff skills to evaluate various investment options and balance between size of the organisation and administrative overheads - is a challenging aspect of this option. An accountability mechanism would have to be established to ensure that the designated agency is making appropriate investments in reducing emissions.

Evaluation of options

Capturing and disseminating emissions data in a reliable and transparent manner is paramount to the success of each of these options. So are timely and independent audits of the emissions inventory and the accompanying financial books that record payments between various parties. With that context, a high-level comparison of the advantages and disadvantages of the options is presented in Table 3.

[34] Energy Efficiency Services Limited. (n.d.). *About UJALA*. Author. Retrieved from https://eeslindia.org/content/raj/eesl/en/Programmes/UJALA/About-UJALA.html.
[35] Sen, S., and Jain, B. (2019). Maharashtra hikes tax on electricity by 10 paise/unit, eyes. *The Times of India*. Retrieved from https://timesofindia.indiatimes.com/city/mumbai/maharashtra-hikes-tax-on-electricity-by-10-paise/unit-eyes-rs-90-crore-a-month/articleshow/67533530.cms.

Table 3: Evaluation of options

	Advantages			**Disadvantages**	
Command-and-Control	No changes required to the administrative and governance structure			Risk of further delays and/or total non-compliance by financially stressed gencos	Not an optimal utilisation of limited financial resources available for power sector interventions
Emissions Trading System	Gencos free to explore emissions reduction strategies including but not limited to reducing generation, fuel substitution, emissions control technology, buying permits, etc.	Likely to be lower in cost compared to command-and-control as emissions reduction optimisation happens across all thermal power plants		Setting of caps should be revised in a time-bound manner to ensure emissions reductions grow over time	Gencos may not be well prepared/lack ability to take up additional responsibilities of emissions optimisation and therefore may omit considering least-cost options outside of their scope
Emissions Portfolio Obligation	Discoms free to explore emissions reduction strategies beyond thermal power plants, including more renewable energy, demand-side measures (e.g., energy efficiency and demand response)	Likely to be lower in cost compared to ETS as emissions reduction optimisation happens across all options spanning both supply- and demand-side		Setting of caps should be revised in a time-bound manner to ensure emissions reductions grow over time	Discoms may not be well prepared/lack ability to take up additional responsibilities of emissions optimisation and may not pay attention to other least-cost options outside of their scope
Emissions Reduction Surcharge	Provides freedom to explore broadest set of options even beyond decision-making space of discoms	Likely to be lower in cost compared to EPO and all other options as emissions reduction optimisation considers all options spanning both supply- and demand-side across the entire country	Consumers demand higher accountability of direct payment – consumers feel more involved in decision-making process	Accountability of 3rd party agency will need to be enforced from the perspective of ensuring use of funds to effectively reduce emissions. This also requires that the agency be staffed with people bringing the right skill set and expertise	Governments will be tempted to re-assign collected funds for other objectives, thereby limiting emissions reduction potential

Next Steps

The electricity sector in India is already in financial doldrums and, while air quality improvement is a top priority, it's also critical to achieve it through least-cost means. Within that context, it is important to understand the stakeholders' perspective on how the options rank in terms of cheapest, fastest, operationally easiest and politically most acceptable.

Operationally, a key first step here is to assess what is possible within the existing jurisdictional powers of the MoEF&CC, and the second step is to assess the agency's willingness to explore solutions together with other ministries – in this case with the MoP – to achieve objectives at least-cost and in least amount of time.

With that understanding and an indication from the stakeholder about their preferences, a more rigorous analysis of each of the short-listed options will need to be undertaken with the objective of designing a detailed roadmap for implementation.

Appendix: Policy and regulatory environment

Key takeaways

Summary and key messages:

- This paper summarises the legislative and governance structure for the control of air pollution caused by thermal power plants in India. The paper provides a brief discussion of the various laws, rules and administrative policies and programs related to air emissions that are to be followed by thermal power plants.
- Setting thermal power plant air emissions standards, as well as monitoring them, are important functions of the Ministry of Environment, Forest and Climate Change (MoEF&CC) and require dedicated determination for improvement and enforcement. Global examples, especially from China and the U.S., offer hope for such improvement.
- Standards setting, which is a periodic activity, should be carried out with better coordination between other concerned ministries and departments; for thermal power plants, this means coordination with the Ministry of Power, the Central Electricity Agency and regulatory commissions.
- Monitoring thermal power plant emissions, which is a recurring activity, should be carried out with better use of available technology. This would not only make the process and results more transparent, but would also lead to faster interventions and cost savings. It is imperative that emissions data are made available easily and frequently to ensure that progress is sustained.
- Recent intervention by the Supreme Court of India on matters related to non-compliance of emissions standards by thermal power plants shows insufficient urgency in action even though air quality is proven to be one of the key contributors to poor public health as well as lower economic prosperity.

Chapter 1: Policy and regulatory environment governing air pollution

"From the affidavits filed by the Union of India through the Ministry of Power, it seems quite clear that the Ministry of Power has absolutely no intention of doing anything to reduce the air pollution generated by coal based thermal power plants.

...the Union of India will realize that air pollution is a very serious matter which concerns the health of everybody in India and their health cannot be put to ransom because the Union of India does not want to take any steps to reduce the air pollution caused by coal based thermal power plants."

- The Supreme Court of India, 25 July 2018

Coal-based thermal power plants are viewed as the primary source of energy that supports economic development and are also one of the major sources of air pollution. The objective of this paper is to understand the policy and regulatory environment governing air quality regulation and monitoring – primarily in the context of thermal power plants in India.

1.a. Past and present legislation

The 7th Schedule of the Constitution of India provides for the distribution of powers under three different categories: those subjects falling under the Union List (List I) are governed by the central government; those subjects falling under the State List (List II) are governed by state governments; and those subjects falling under the Concurrent List (List III) are governed by both the central government as well as state governments. *Public health and sanitation* as well as *water supply* are part of List II, while *protection of forests* and *electricity* (generation, transmission and distribution) form part of List III.

There is a residuary provision under Article 248 of the Constitution, which directs that the central government has exclusive power to make any law with respect to any matter not enumerated in the State List and the Concurrent List. There is no mention of *air* or *climate* in any of the three lists, and thus they are treated as residual matters.

The Ministry of Environment, Forest and Climate Change (MoEF&CC), functioning under the administrative structure of the central government, is the nodal agency for regulating air quality in India. It is responsible for planning, promoting, co-ordinating and overseeing the implementation of India's environmental and forestry policies and programs. In its original form, it was established as the central government's Department of Environment in 1980. It was renamed the Ministry of

Environment and Forests in 1985, and again renamed as the MoEF&CC in 2014. It is the cadre controlling authority of the Indian Forest Services.[36]

One of the earliest regulations governing air quality in India is **The Air (Prevention and Control of Pollution) Act, 1981**.[37] The Act expanded the role and functions of the Central Pollution Control Board (CPCB) and state pollution control boards (SPCBs), which were constituted as statutory organisations under the Water (Prevention and Control of Pollution) Act, 1974.[38] The key responsibility of the CPCB is to (a) advise the central government in matters relating to the improvement of air and water quality, and (b) plan and execute nationwide programs for the prevention of air and water pollution. Likewise, the SPCBs are supposed to perform similar functions for their respective state governments.

The CPCB is a multidisciplinary technical organisation working under the MoEF&CC. It plays the role of an advisor and coordinator for the various SPCBs (at the state level) and the Pollution Control Committees [(PCCs), at the Union Territory level]. It has the power to resolve any disputes between two or more SPCBs/PCCs. A directory of 29 state pollution control boards and six pollution control committees can be found on the CPCB's web page.

The CPCB has six zonal offices (one each in Bangalore, Kolkata, Shillong, Bhopal, Vadodara and Lucknow, along with a project office in Agra) which undertake field investigations and report to the head office in New Delhi. The primary function of the zonal offices is coordination between the various state governments and SPCBs/PCCs for implementation of standards at the state level.

Administratively, Pollution Control Implementation-II is the division that is responsible for thermal power plant air emissions at the CPCB. This division also deals with nine other sectors: aluminum, copper, zinc, integrated iron & steel, dust (particulate matter) emitting industries, mining, cement, coal mining, and non-coal mining/asbestos.

As part of its functions, CPCB may promulgate or establish standards for air quality, and may collect, compile and publish technical and statistical data related to air pollution. It may prepare manuals and codes relating to the prevention, control and abatement of air pollution. The SPCBs, in consultation with the CPCB, may establish state-specific standards for emissions of air pollutants from industrial plants and

[36] The government of India has three All India Services, which include: the Indian Administrative Services (IAS), the Indian Police Services (IPS) and the Indian Forest Services (IFS).
[37] The Act's preamble recognises its need as an outcome to India's participation in the United Nations Conference on Human Environment, held in Stockholm in 1972. Henceforth referred to as the Air Act, 1981.
[38] Henceforth referred to as the Water Act, 1974.

automobiles and other sources, except for ships and aircraft. Enforcement and compliance under the various standards and directives are the primary responsibility of the SPCBs.

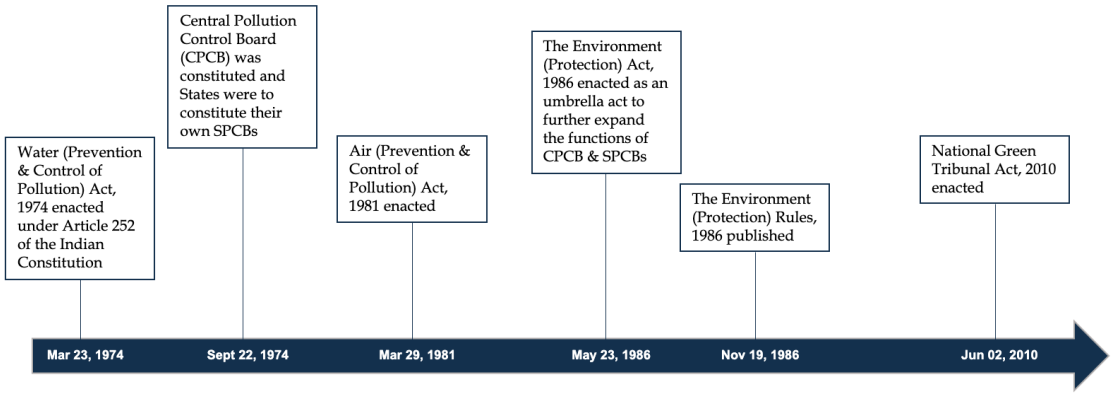
The Air Act, 1981 allows the SPCBs to declare control areas within the state boundary, with restrictions on setting up a new industrial facility, or running an existing industrial facility. Imprisonment and fines can be imposed on persons and companies found to be in noncompliance with set standards. The Air Act, 1981 also directs state governments to create state air laboratories.

In the aftermath of the Bhopal Gas Tragedy (on the night of 2 Dec 1984), another important piece of legislation — **The Environment (Protection) Act, 1986** — was introduced. This Act empowers the central government to take appropriate measures to protect and improve the environment and ensure the prevention of hazards to other living creatures, plants and property. It allows the central government to make appropriate rules to regulate environmental pollution and grants it the powers to inspect and monitor equipment and plants as necessary. Search or seizure of equipment or plants is to be governed under the provisions of the Code of Criminal Procedure, 1973. The central government has the power to take samples of air, water, soil or other substances from any factory or premises and analyse or inspect the sample(s) collected. This Act, too, prescribes imprisonment and fines for persons or companies found to not adhere to the standards prescribed. The scope and powers of the CPCB were further expanded under this Act. It was further amended in 1991 to expand the scope. Since the Environment Act, 1986 is general legislation enacted under Article 253 (legislation for giving effect to international agreements), it allows the parliament to create laws for any part, or the whole of the country, to meet India's international obligations.

A third piece of legislation is the **National Green Tribunal Act, 2010** which calls for the establishment of a National Green Tribunal (NGT) to effectively and expeditiously address cases relating to the environmental protection and conservation of forests and other natural resources. The NGT is a specialised body with the expertise to handle environmental disputes involving multidisciplinary issues. The Principal Bench of the NGT is situated in New Delhi, and there are four regional benches: one each in Kolkata (eastern bench), Pune (western bench), Bhopal (central bench) and Chennai (southern bench). The NGT is not bound by the procedure laid down by the Code of Civil Procedure, 1908 or by the rules of the evidence contained in the Indian Evidence Act, 1872 – both of which may make it easier for citizens and civil society organisations to participate. Figure 1 summarises key environmental governance legislation enacted to date. Note: As the focus of this

paper is the environmental rules and regulations governing the operation of power plants, regulations governing the siting and environmental clearance for new power plants are not included.

Figure 1: Introduction to key environment legislation



1.b. Notifications governing pollution by thermal power plants

Industries in general, and more specifically thermal power plants, are usually recognised as significant sources of air pollution. It should be noted here that, while there are have been several source apportionment studies performed by various researchers for the city of Delhi and the National Capital Region (NCR), there has not been a single source apportionment study for the whole of India. According to a recent study for NCR conducted by the Automotive Research Association of India and The Energy and Resources Institute (TERI), power plants contribute 7% of PM_{10} emissions, 8% of $PM_{2.5}$ emissions, 15% of NO_X emissions, and 33% of SO_2 emissions.[39]

The very first notification issued by CPCB as a result of powers granted to it under the 1981 and 1986 Acts (Section 3 and Section 25), were the **Environment (Protection) Rules, 1986**. This was the flagship document which established, for the very first time, standards for emissions or discharge of environmental pollutants. Factors that guide the prohibition or restriction of certain industries in certain areas are provided in the rules. Operational guidance for the procedure to follow for submitting samples, for laboratory analysis, for submitting reports, etc. is also provided in the rules. The rules require every industry, operation or process requiring the consent of the MoEF&CC in any manner to submit a yearly

[39] The Energy Resources Institute and the Automotive Research Association of India. (2018, August). Source Apportionment of PM2.5 & PM10 Concentrations of Dehli NCR for Identification of Major Sources: Executive Summary. Author. New Dehli, India. http://www.teriin.org/sites/default/files/2018-08/AQM-SA_0.pdf.

environmental report to the respective SPCB (by 30 September).[40] Section 26 of The Environment (Protection) Act, 1986, requires that any rule or modification to any rule made under the Act shall be brought before both Houses of the Parliament to be agreed upon before taking effect.

The original rule, followed by various amendments, provides for industry-specific standards for emissions or discharge of environmental pollutants, including from thermal power plants. The most recent amendment was made on 28 June 2018.

- Air Emissions – details of original and modified standards for emissions by thermal power plants are provided in Annexure I. Another amendment (effective 1 June 2002) required coal-based power plants (located beyond 1000 kms from pit-head or in urban, sensitive or critically polluted areas) to use raw, blended or beneficiated[41] coal with an ash content not exceeding 34% on an annual average basis.[42] By a further amendment in January 2014, this requirement was mandated for plants located between 500-749 kms from pit-head. The coal supplier is responsible for supplying beneficiated coal. The average ash content found in Indian coal is close to 40%.[43]
- Stack height prescription – details in Annexure II.
- Wastewater emissions – details in Annexure III.
- Temperature limit for cooling water discharge – details in Annexure III.
- Fly ash – notification issued by the central government in 1999 under the powers conferred by The Environment (Protection) Act, 1986. Details in Annexure IV.

The CPCB also created **National Ambient Air Quality Standards (NAAQS)** in 1994. These standards were most recently revised on 18 November 2009. The revised standards aim to provide uniform air quality across the country, irrespective of land

[40] It is difficult to say whether these yearly reports are filed or not. The SPCB web pages do not provide such information.
[41] Coal containing a higher calorific value but lower ash content than the original ash content in the raw coal, obtained through physical separation or a washing process.
[42] TPPs using Circulating Fluidised Bed Combustion, Atmosphere Fluidised Bed Combustion, Pressurised Fluidised Bed Combustion, Integrated Gasification Combined-Cycle technologies, or other clean technologies are exempted from this requirement.
[43] "India is unique among nations that use coal for power generation in that it hauls coal over much greater distances than most others, from mine to power station. Besides the detrimental effect of coal ash on the environment, the extra load which the railway system carries means greater cost to the economy, as well as added air pollution through the transport system. These issues favoured the introduction of the policy reducing ash to 34% for power plants situated over 1,000 km from the coal mines." Powell, L. and Sati, A. (7 July, 2017). Coal beneficiation: Policy priorities for India. New Dehli. Observer Research Foundation. Retrieved from https://www.orfonline.org/research/coal-beneficiation-policy-priorities-for-india.

use pattern. These standards note a time-weighted average (annual, 24 hrs, 8 hrs and 1 hr) concentration for a dozen recognised pollutants, along with methods of measurement.[44]

In January 2019, the MoEF&CC announced that controlling particulate matter remains a major challenge under the **National Clean Air Program** (NCAP). According to NCAP, particulate matter concentrations exceed the NAAQS standards all over the country, with very high concentrations in the urban areas of the Indo-Gangetic Plain, i.e., cities in the states of Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal and the Union Territory of Delhi – a region with significant population numbers. A study by IIT-Delhi and TERI (Pal et.al., 2018) captured satellite data over an 18-year period, from 1998-2015, to report the $PM_{2.5}$ levels for 109 cities across India. The study suggests there is a wide range across cities, from a low $PM_{2.5}$ level exposure in Thiruvananthapuram (15 ug/m^3 Kerala) to a maximum exposure in Aligarh (103.8 ug/m^3 Uttar Pradesh). Forty cities were found to have an annual average $PM_{2.5}$ exposure greater than the annual permissible limit of 40 ug/m^3 (see Figure 2 for a summary of the cities with the highest concentrations). For perspective purposes, compare this with the permissible standard of 35 ug/m^3 in China, 12 ug/m^3 in the U.S., and 10 ug/m^3 per the World Health Organization.

Figure 2: Average annual PM2.5 concentrations in the most polluted cities

City	PM 2.5 concentration (ug/m3)
Aligarh	103.8
Noida	103.4
Loni	101.2
Ghaziabad	101
Merrut	98
New Delhi	97.4
Faridabad	97.3
Firozabad	95.1
Agra	91.6
Bareilly	87.1

The NAAQS standards mandate establishing a **continuous ambient air quality monitoring station** (CAAQMS) at designated places across the country. Currently, there are a total of 133 stations installed across states, with the maximum (37 stations) in Delhi. A 15-minute interval database for each of the stations can be

[44] These include Sulphur Dioxide, Nitrogen Dioxide, Particulate Matter (size less than 10mm), Particulate Matter (size less than 2.5mm), Ozone, Lead, Carbon Monoxide, Ammonia, Benzene, Benzo(a)Pyrene, Arsenic, and Nickel.

viewed and downloaded from the CAAQMS Portal. An app for Android devices (Sameer) has been developed which provides hourly updates on National Air Quality Index published by CPCB.

On 5 February 2014, CPCB directed 17 categories of highly polluting industries, including thermal power plants, to install online effluent quality and **continuous emissions monitoring systems** (CEMS) to track the discharge of pollutants.[45] The installation deadline was 31 June 2015. The online data is supposed to be transmitted simultaneously to CPCB and respective SPCB servers. In July 2017, CPCB issued a guideline document describing the benefits of various CEMS options available and proper selection and implementation. However, CSE (2018) notes that the thermal power plants' CEMS data is neither in the public domain nor is fully reliable, and therefore is not used for regulatory purposes.

1.c. Comparison of India's standards to other countries' standards

Figure 3 provides a comparison of the current air emissions standards in India and other regions. As can be seen, India's prescribed standards are closer to those of Australia[46] and the EU, whereas the standards in China and the U.S. are more stringent. It would be pertinent to note here that, in the U.S., the states can adopt more stringent emissions standards than those prescribed at the national level by the U.S. Environmental Protection Agency. Similarly, in the EU, member countries have the freedom to adopt more stringent standards than those contained in the EU Directives.

[45] Real-time online availability and monitoring of data was recognized as necessary for bringing transparency and accountability under the National Environment Policy, 2006. This would motivate self-monitoring, thus increasing cost-effectiveness by minimising the need for inspection and increasing public access to information.

[46] Australia does not have a national standard. Each of the 10 states set their own standards. Likewise, the U.S. national standard is the least stringent and individual states set their own stringent standards.

Figure 3: Comparison of standards[47]

Prescribed Emission Standards All figures are in mg/m3		China*	USA*	EU*	AUS**	Indonesia**	India***	
Particulate Matter	Existing Plants	20/30#	19	20	80	150	Installed before 31 Dec 2003	100
							Installed after 1 Jan 2004 & before 31 Dec 2016	50
	New Plants	10	12	10		100	Installed after 1 Jan 2017	30
Sulfur Dioxide (SO2)	Existing Plants	50/100/ 200#	185	200	200	750	Installed before 31 Dec 2003	600 (units < 500 MW) 200 (units > 500 MW)
							Installed after 1 Jan 2004 & before 31 Dec 2016	600 (units < 500 MW) 200 (units > 500 MW)
	New Plants	35	136	150		750	Installed after 1 Jan 2017	100
Oxides of Nitrogen (NOx)	Existing Plants	100	135	200	800	850	Installed before 31 Dec 2003	600
							Installed after 1 Jan 2004 & before 31 Dec 2016	300
	New Plants	50	95	150		750	Installed after 1 Jan 2017	100
Mercury (Hg)^		0.03	0.0017	0.03 Germany	None	None		0.03

[47] Hart. M., Bassett, L. and Johnson, B. (2017, 15 May). Everything you think you know about coal in China is wrong. Washington, D.C. Center for American Progress. Retrieved from https://www.americanprogress.org/issues/green/reports/2017/05/15/432141/everything-think-know-coal-china-wrong/; Zhang, X. (2016, July) Emission standards and control of PM2.5 from coal-fired power plant. London. IEA Clean Coal Centre. Retrieved from https://www.usea.org/sites/default/files/Emission%20standards%20and%20control%20of%20PM%202.5%20from%20coal%20fired%20power%20plant%20-ccc267.pdf; Ministry of Environment, Forests and Climate Change, Government of India. Environment (Protection) Amendment Rules, 2015 dated 7 Dec 2015; and subsequent corrigendum dated 7 Mar 2016; vary by province and installation year; and Natural Resources Defense Council. (2012, April). Summary of recent mercury emission limits for power plants in the United States and China. Washington, D.C. Author. Retrieved from https://www.nrdc.org/sites/default/files/china-us-mercury-limits-FS.pdf.

- * Everything You Think You Know About Coal in China Is Wrong, Center for American Progress, May 2017
- ** Emission Standards and control of PM2.5 from coal-fired power plant, IEA Clean Coal Centre, July 2016
- *** MoEF&CC Environment (Protection) Amendment Rules, 2015 dated 7 Dec 2015; and subsequent corrigendum dated 7 Mar 2016
- # vary by province and installation year
- ^ Summary of Recent Mercury Emission Limits for power plants in the United States and China, NRDC, April 2012

Chapter 2: Monitoring and enforcement mechanism

Rules and standards alone are insufficient to ensure that pollution prevention and control goals are met. These standards must be enforced, at regular frequency, along with an imposition of fines and other non-monetary measures proportional to the seriousness or recurrences of violations. The clear definition and distinction of roles and responsibilities for the various monitoring agencies is one of the key requirements to achieving an effective monitoring and enforcement mechanism. Thermal power plants fall under the list of 17 highly polluted industries and are therefore subject to rigorous scrutiny by the SPCBs — whose performance, in turn, is regularly verified by the CPCB and reported to the MoEF&CC.

2.a. Role of CPCB

The CPCB mandates and formulates national programmes for the prevention and control of pollution. Its role includes (a) establishing a nationwide monitoring network, (b) setting up national standards for water and air quality, (c) preparing source-specific standards for effluents and emissions, and (d) creating action plans for critically polluted areas and highly polluting categories of industries.
Enforcement of mandated standards is the responsibility of the SPCBs.

However, CPCB does undertake manual monitoring as well as online monitoring of thermal power plants and the other highly polluting industries (list of 17). It is not known whether the manual monitoring is a scheduled or surprise inspection activity (carried out by the Environmental Surveillance Squad). For online monitoring, CPCB had directed plants to install CEMS in early 2014. The actual status of compliance with this directive is hard to establish as CPCB neither publishes a summary of the status, nor provides the emissions data online.

Section 5 of The Environment (Protection) Act, 1986, gives overarching powers to the central government to intervene and issue directions.[48] This section establishes that the central government's powers are far-reaching, as it can, if required, give directions to shut down any industry or business and halt the supply of services; this

[48] Parliament of India. (1986, March). The Environment (Protection) Act, 1986, Section 5. Author. Retrieved from https://indiankanoon.org/doc/191236316/. "Section 5. Power to give directions: Notwithstanding anything contained in any other law but subject to the provisions of this Act, the Central Government may, in the exercise of its powers and performance of its functions under this Act, issue directions in writing to any person, officer or any authority and such person, officer or authority shall be bound to comply with such directions.
Explanation--For the avoidance of doubts, it is hereby declared that the power to issue directions under this section includes the power to direct--
(a) the closure, prohibition or regulation of any industry, operation or process; or
(b) stoppage or regulation of the supply of electricity or water or any other service."

may include additional services than those mentioned in clause (b), such as telecommunications. The central government, vide Notifications No. S. O. 157(E) of 27th Feb 1996, and S. O. 730(E) of 10 July 2002, has delegated the powers vested under Section 5 to the chairman of the CPCB to issue directions in case of violations.

Notices issued under Section 5 – which range from show cause notices and modified directions to closure directions – are posted for public viewing on the CPCB's website. A few examples of such notices and the type of decisions made are detailed in Figure . Between 1 January 2017 and 30 September 2018, the CPCB issued a total of 2,063 notices under Section 5 to all types of industries. Of these, 47 show cause notices, 87 modified directions, and 38 closure directions were issued to thermal power plants.

Section 18(1)(b) of the Air Act, 1981 and Water Act, 1974, gives powers to the CPCB to issue specific orders to SPCBs and PCCs. This section has seldom been used by the CPCB to give orders related to the control and monitoring of thermal power plants. In one such instance of using Section 18(1)(b), on 3 November 2016, CPCB directed SPCBs/PCCs to submit and upload the status of consent to operate for thermal power plants (and all other plants under the list of 17 identified industries) on CPCB's website. To summarise, Section 5 gives the CPCB powers to directly issue orders to thermal power plants; Section 18(1)(b) allows the CPCB to intervene and order a SPCB/PCC to take compliance action if the CPCB deems necessary.

The CPCB reviews the performance of the SPCBs in a joint meeting held every quarter. The agenda or meeting minutes of these review meetings are not available in the public domain. The CPCB used to publish an annual report, but has stopped the practice as of late; the latest annual report published was for FY 2015-16.

Figure 4: Type of actions taken by CPCB under Section 5

SHOW CAUSE NOTICE	MODIFIED DIRECTIONS	CLOSURE DIRECTIONS
26 September 2018 to Anpara TPP Uttar Pradesh (State Genco) Notice post manual monitoring by Lucknow zonal office on 2 August 2018 **"TPP is directed to show cause as to why the plant should not be closed in view of violation of PM and ash pond effluent treatment, in fifteen days time period."** Findings • Plant is found to be operating without a consent to operate under the Air Act, 1981 and Water Act, 1974 • PM concentration far exceeding allowed limit (623 mg/Nm^3 versus 100 mg/Nm^3) • Deviation observed between	24 September 2018 to Gandhinagar TPP Gujarat (State Genco) Notice post manual monitoring by Vadodara zonal office on 21 June 2018, and show cause notice dated 2 August 2018, and TPPs reply to the same **"TPP is directed to submit action taken report on suggested directives, in fifteen days time period."** Directives • Plant to submit PM emission monitoring report to CPCB and GPCB from an EPA recognized lab on quarterly basis for one year as evidence of compliance • Obtain amended consent from GPCB to include zero water discharge condition	30 July 2018 to Koradi TPP Maharashtra (State Genco) Notice post directive issued on 5 February 2014, and show cause notice dated 21 July 2018, and TPPs no-reply to the same **"TPP is directed not to operate Unit 8-10 without installation of CEMS and providing connectivity to CPCB server."** Observations • TPPs problems in installing CEMS were heard in joint meeting held on 19 April 2017 under Chairman of CPCB. Justifications provided were not enough to explain reasons for non-compliance. • Subsequently prosecution was launched against 45 non-complying plants at

2.b. Role of SPCBs

The role of SPCBs and PCCs is to monitor and enforce the standards prescribed by the CPCB. Any industry discharging effluents or emissions is required to obtain consent from the SPCB under the Water Act, 1974 and the Air Act, 1981, which include:

- Consent to establish (CTE): to be obtained prior to establishing an industry, which is similar to a no objection certificate. This is a one-time activity undertaken before construction begins.
- Consent to operate: post establishment, a consent to operate is required for functioning and needs to be renewed periodically, and is termed as consolidated consent and authorization (CCA). This is essentially an operating permit that must be renewed periodically.

SPCBs have their own processes for granting these consents, which are documented on their respective web pages.

Depending upon the categorisation of a particular industry,[49] the consent approval process, timeline and fee structure differs.[50] Thermal power plants are classified within the red category and have to renew their consent to operate every year; however, by paying a higher fee, such consent can be obtained for a maximum period of five years at one time. The delegation of authority for consent approval and the fees to be paid are dependent upon the total capital investment by an industry. For instance, the Maharashtra Pollution Control Board (MPCB) has defined the delegation of authority (Figure 5) and fees required (Figure 6) for industries operating in the state.

[49] In order to bring uniformity to the processes, the CPCB along with various SPCBs has developed a criterion of categorisation of industrial sectors based on the Pollution Index, which is a function of emissions (air pollutants), effluents (water pollutants), hazardous wastes generated, and consumption of natural resources. Accordingly, it is decided:
Red category – Industrial sectors with a pollution index score of 60 and above
Orange category – Industrial sectors with a pollution index score of 41 to 59
Green category – Industrial sectors with a pollution index score of 21 to 40
White category – industrial sectors with a pollution index score including and up to 20

[50] A similar approach is followed in the UK. An Operational Risk Appraisal Scheme score is calculated for each industry based upon the environmental risks involved, and a suitable permit fee is determined. For more details, see http://ec.europa.eu/environment/waste/framework/pdf/BPE%20Permitting/3.%20Permitting_Operational%20Risk%20Appraisal%20Scheme%20(UK).pdf

Figure 5: Delegation of powers to grant consent by MPCB

Authority	Red Category	Orange Category	Green Category	Consent and authorisation to Urban Local Bodies	Infrastructure projects such as SEZ, IT Townships, Highways etc.
Sub Regional Officer	-	-	Up to Rs.500 mn	-	-
Regional Officer	Up to Rs. 100 mn	Up to Rs. 1.5 bn	Above Rs.500 mn up to Rs.5.0 bn	B & C - Class Municipal Councils and cantonment Boards	Up to Rs.250 mn
Head of Departments	Above Rs.100 mn up to Rs.250 mn	Above Rs. 1.5 bn up to Rs.2.5 bn	Above Rs. 5.0 bn up to Rs.10.0 bn	A- Class Municipal Councils and Cantonment Boards	-
Consent Committee	Above Rs.250 mn up to Rs.750 mn	Above Rs.2.5 bn up to Rs.7.5 bn	Above Rs.10.0 bn up to Rs.20.0 bn	-	Above Rs.250 mn up to Rs.3.5 bn
Consent Appraisal Committee	More than Rs.750 mn	More than Rs.7.5 bn	More than Rs.20.0 bn	All Municipal Corporations	More than Rs.3.5 bn

Figure 6: Consent fees as per Govt. of Maharashtra circular dated 25 August 2011

Capital Investment by Industry (including land, building, machinery w/o depreciation)	Consent to Establish	Consent to Operate
More than Rs.1.0 bn	0.02% of capital investment	0.02% of capital investment
More than Rs.750 mn to Rs.1.00 bn	Rs.1,25,000	Rs.1,25,000
More than Rs.500 mn to Rs.750 mn	Rs.1,00,000	Rs.1,00,000
More than Rs.250 mn to Rs.500 mn	Rs.75,000	Rs.75,000
More than Rs.100 mn to Rs.250 mn	Rs.50,000	Rs.50,000
More than Rs.50 mn to Rs.100 mn	Rs.25,000	Rs.25,000
More than Rs.10 mn to Rs.50 mn	Rs.15,000	Rs.15,000
More than Rs.6 mn to Rs.10 mn	Rs.5,000	Rs.5,000
More than Rs.1 mn to Rs.6 mn	Rs.1,500	Rs.1,500
Below Rs.1 mn	Rs.500	Rs.500

CPCB has introduced a web-based online consent management and monitoring portal, wherein a consolidated view of all state-level consent applications and authorisations can be seen for all of the 17 highly polluting industries, including thermal power plants. On the portal, the "India e-track industries" dashboard provides a statewide compliance status table. While the portal information is fairly exhaustive for some states (for e.g., Gujarat, where one can click on each type of industry to see such details as the name of the plant, its location, CCA validity date, and any immediate action taken by the SPCB), for others it provides only a table of industries in compliance without revealing further details.

The consent fees and enforcement penalties collected are kept by the SPCBs and used for administrative and other expenses. It is difficult to assess the percentage of revenues met by such fees and penalties.

Continuing with the example of Maharashtra, the PCB was asked by the NGT in 2014 to frame an enforcement policy to integrate various aspects including inspections, monitoring, standards, compliances, directions, and remedial measures including forfeiture of bank guarantees.[51] Figure 2 depicts the sequence of actions followed in a

[51] MPCB notified its Enforcement Policy on 29 February 2016.

case of noncompliance as per the enforcement policy.

Figure 2: Maharashtra Pollution Control Board actions in case of noncompliance by industry

Action 1, after a site visit and inspection or surprise check and sampling, if noncompliance is less than 25% or not having serious impact, a Warning Letter is to be issued pointing out observations.

Action 2, where noncompliance exceeds 25% but is not having serious impact, a Show Cause Notice is to be issued pointing out observations.

Action 3, post Show Cause Notice if no rectification within prescribed period is undertaken, then a Proposed Directions notice is to be issued.

Action 4, post issuance of Proposed Directions, and in case of reply/no reply and subsequent to grant of opportunity of hearing, a Conditional Directions notice can be issued with timeframe to comply with conditions imposed;
where serious noncompliance exceeds 75% then directions for closure/disconnection of electricity/water supply/essential services can be issued until remedial steps are undertaken.

Action 5, in case of continuous and serious noncompliance, an action for Filing of Prosecution at NGT may be initiated.

As a measure to ensure compliance, the applicant for consent to operate has to furnish bank guarantees as defined by the SPCB. The logic of bank guarantees is based on the "polluter pays principle," whereby consequences of noncompliance are meant to be more expensive as compared to compliance, thereby leading to corrective actions. The bank guarantee, if revoked, can be reinstated to its original amount within a stipulated time period.[52] The MPCB policy states that amounts collected via such forfeiture are to be deposited in an "Environment Improvement & Environment Compliance Fund" and utilised for intensive monitoring and data management activities, etc.

However, even with the presence of such *ex-ante* and other *ex-post* approaches, the effectiveness of control agencies have been found to be limited. Public perception of the effectiveness of the SPCBs is poor.[53] Effective monitoring is a function of capital resources, technological resources and most importantly human resources deployed to ensure processes and standards are followed. Because many SPCBs are under-resourced, it is wishful to think that monitoring is effective.

[52] Excerpts from MPCB Enforcement policy: "In case, the compliance is not secured within stipulated time provided to concern industry, the Board shall initiate action for forfeiture of Bank Guarantee and whenever there is evidence of substantial compliances provision for considering extension of time for securing complete and thorough compliance by forfeiting proportionate bank guarantees only. Wherever there is continual non-compliance, in spite of sufficient opportunities and with extension of time is given by the Board (not more than 3 times), after third extension, further stringent actions such as refusal/revocation of consent and further final directions of closure etc. shall be initiated. However, in cases of serious violations, no second opportunity and extension of time will be granted. The refusal/revocation order will be issued as may deem fit in the circumstances of particular case." Maharashtra Pollution Control Board. (2016, February 29). Implementation of the Enforcement Policy. Retrieved from http://mpcb.gov.in/consentmgt/pdf/Circular_Enforcement_Policy.pdf.

[53] Centre for Science and Environment. (2009). Turnaround: Reform Agenda for India's Environmental Regulators.

A study by researchers at University of Chicago notes that, given the population density, economic damages, and health costs associated with air pollution, India does not spend enough on environmental regulation and enforcement.[54] The study notes: "*Central and state expenditures on environmental governance in India are extraordinarily low. For instance, the total annual budget of the CPCB in India was just INR 74.3 crores (USD 11 million) in 2017. This number is simply inadequate to carry out the mandate of the apex environmental regulator, which includes standard setting, new research, policy guidance to states, and a limited amount of enforcement activity*."

Inadequate staffing has often been cited as a challenge and the number of employees range from as few as 75 (Bihar SPCB), to 200 (Delhi SPCB), to 1,000 (Maharashtra PCB).[55] An undated study by the erstwhile Planning Commission (circa 2000[56]) finds that the number of staff personnel vary widely. For example, it notes there is gross staffing inadequacy in the North Eastern SPCBs; that one technical staff person is responsible for monitoring 100 units in Andhra Pradesh; and that 14 technical staff members monitor 100 units in Kerala.

The qualifications of board members and staff have been found to be insufficient. Appointment of board members has been found to be a decision influenced by state governments. In a June 2017 order, the NGT terminated the tenures of the chairmen of 10 SPCBs (Himachal Pradesh, Sikkim, Tamil Nadu, Uttarakhand, Kerala, Rajasthan, Telangana, Haryana, Maharashtra and Manipur) because they lacked the technical skills necessary for the role and/or their appointment was temporary, demonstrating a lack of seriousness on the part of the state government on an issue of public concern.

The Planning Commission study also notes that, in terms of finances, the SPCBs of Manipur, Meghalaya, Tripura, Jammu and Kashmir are almost entirely dependent upon grants and aid from the Central Government, while the SPCBs of Maharashtra, Tamil Nadu, Uttar Pradesh and Andhra Pradesh generate the majority of their finances from their own resources (water cess, consent fees, sample testing fees and receipts from fines and forfeitures). The study further notes that a "paradoxical situation" has been found at many SPCBs in which the boards, although having a huge cash surplus, do not invest in technology upgrades, training, etc., due to the

[54] Greenstone, M., et al. (2017, July). *The solvable challenge of air pollution in India*. India Policy Forum. NCAER.
[55] Tongia, R. and Seligsohn, D. (2017, 21 February). Challenges, recommendations for meeting the upcoming 2017 standards for air pollution from thermal power plants in India. Washington, D.C. The Brookings Institution. Retrieved from https://www.brookings.edu/research/challenges-recommendations-for-meeting-2017-norms-for-air-pollution-from-thermal-power-plants-in-india/.
[56] Planning Commission, Government of India. (n.d.) Evaluation study on functioning of state pollution control boards. PEO Study No.180. Author. Retrieved from http://planningcommission.nic.in/reports/peoreport/cmpdmpeo/volume1/180.pdf

limited autonomy they have to make expenditure decisions.

Collaboration with independent technical research institutions has been found to be low, especially with respect to studies for the power sector. Most of the studies awarded to research organisations, such as TERI and the Indian Institutes of Technology in Bombay and Kanpur, have dealt primarily with vehicular sources of pollution.[57]

Intervention by other state government officials is another hurdle faced by SPCB staff in accomplishing their work. For instance, under the CTE granted by MPCB in 2015, two 660 MW units commissioned at the Koradi thermal power plant were required to install flue-gas desulfurization (FGD) technology. However, the owners of the power plant did not make the required FGD investment and lobbied other state officials for relaxation of the requirement. However, due to public resistance no relaxation of the rule was allowed and the plant owners had to install a FGD.

Some SPCBs are increasingly accepting that these hindrances exist and that they limit their functioning. As a result, they are showing interest in exploring other solutions or approaches – namely, market-based ones such as emissions trading. The Gujarat Pollution Control Board (GPCB) on 5 June 2019 launched a pilot emissions trading scheme for an industrial cluster in and around the city of Surat.[58] The pilot envisages the trading of PM emissions by 300 industries, mostly in the chemicals sector and excluding power plants, and is supported by a team of experts from J-PAL South Asia, University of Chicago Trust and Institute for Financial Management and Research.

[57] Chandra, S. (2018, August). Poor Science Contributes to Delhi's Air Pollution Crisis. The Scientist. Retrieved from https://www.the-scientist.com/news-opinion/opinion--poor-science-contributes-to-delhis-air-pollution-crisis-64714.
[58] Gujarat Pollution Control Board. (2019). Emissions Trading Scheme (Pilot Project) [Website]. Retrieved from https://gpcb.gujarat.gov.in/webcontroller/page/emissions-trading-scheme-pilot-project.

Chapter 3: Challenges in the current context

At an installed capacity of 223 GW, thermal power plants constitute about 64% of the total capacity of the India electricity grid.[59] A significant majority of this capacity is made up of coal-fired generating plants (88%), with the balance coming in from gas-fired stations and a very small percentage from diesel-fired plants. Also note that significant capacity additions have been made in the last decade alone; India's total thermal power plant capacity was 94 GW at the end of FY09.

Coal is globally recognised as the number one source responsible for climate change, and a major source of several conventional air pollutants (including SOx, NOx, PM and Hg) that directly impact public health.[60] How we use coal as a source of electricity generation, today and in future, and how we regulate and try to minimise the adverse effects of burning coal on human health and the economy,[61] is therefore a pertinent question in the Indian context.[62] This problem will be exacerbated if India continues to build new coal plants in order to electrify homes that currently don't have access to electricity.

As discussed in the previous section, the present administrative structure has raised several issues and challenges regarding emissions monitoring of thermal power plants. Environmentalists have used the public interest litigation (a constitutional right which allows citizens the freedom to file suits in the Supreme Court and High Courts on matters of interest to the larger public) route to approach the judiciary, get citizens' voices heard and create change.[63] In the next section we discuss the current ongoing case in which the Supreme Court of India reprimanded the central government (Ministry of Power [MoP] and MoEF&CC) as well as the national generation company, NTPC, for not doing enough to abide by the 2017 targets set for emissions standards.

3.a. Environmentalists find their way through the courts

[59] India's total installed capacity at the end of October 2018 was approx. 346 GW. Ministry of Power, Government of India. Central Electricity Authority [Website]. Retrieved from http://www.cea.nic.in.

[60] Rice, D. (2019). Coal is the main offender for global warming, and yet the world is using it more than ever. *USAToday*. Retrieved from https://www.usatoday.com/story/news/nation/2019/03/26/climate-change-coal-still-king-global-carbon-emissions-soar/3276401002/

[61] Ministry of Finance, Government of India. (2018, 23 March). The Economic Survey 2016-2017, Volume 2. Oxford University Press. The survey states that the annual number of deaths linked to coal-based power plants pollution is estimated to be around 115,000 and the total monetary cost is around 27,600 Rs.Cr.

[62] According to the Centre for Science and Environment (CSE), TPPs in India are responsible for 70% of the total freshwater withdrawal by all industries; over 60% of the particulate matter emissions; 50% of SO2 and NOx emissions, and more than 80% of mercury emissions by the industrial sector in the country.

[63] A PIL can be filed against central government, state government, municipal authorities, but not against a private entity. However, a private entity can be included as a respondent in a PIL. See Holladay (2012) for a thorough analysis of the history of PIL in India and its advantages as an instrument for addressing rights disparities in other developing countries.

To understand the present case and the roles of the various stakeholders involved, it is worthwhile to look at the timeline of key events that have unfolded since notification of the revised emissions standards in 2015.

- In April 2015, MoEF&CC issued a new set of stringent standards for public comments – almost 15 years after the last notification. These standards, for the very first time, introduced norms for SO_2, NO_X and water consumption.[64]
- MoEF&CC notified the Environment (Protection) Amendment Rules, 2015 on 7 December 2015. Thermal power plants were required to ensure compliance within two years.
- In September 2016, Central Electricity Authority (CEA) asked the regional power committees (RPCs) to formulate a phasing plan for installing emissions control technologies.
- RPCs submitted their phasing plans to CEA and MoP in April 2017.[65]
- CEA asked the RPCs to submit revised plans, such that the phasing should be completed by the end of 2022. They submitted the revised plans in September 2017.
- Supreme Court issues a notice to MoEF&CC on 17 November 2017 asking for its reply on the status of compliance with the revised standards.
- MoEF&CC submitted its response to the Supreme Court on 7 December 2017. It said that, as per discussions with MoP, the retrofitting of emissions control technologies will require significant shutdowns at coal power plants, which is not feasible given the country's electricity demands. Therefore, the earliest feasible plan shall run up to the end of 2022.
- The very same day, i.e., on 7 December 2017, which was also the original deadline for compliance, the MoEF&CC sent a letter to CPCB asking it to exercise its powers under Section 5 to direct all thermal power plants (those not in a position to comply with revised standards), to work with the revised plan submitted by MoP dated 13 October 2017.
- On 10 February 2018, advocate Ritwick Dutta submitted suggestions (see below) to the Surpeme Court for ensuring emissions control and reduction

[64] Due to low sulfur content and high ash content, till 2015 emphasis was on control of particulate matter and disposal of ash.

[65] See CSE (2017) for a list of identified plants, that would need ESP upgradation and FGD installation.

in water consumption by thermal power plants.

  - Creating firm retirement plans and deadlines for thermal power plants which cannot comply with the original 2015 standards.
  - Creating compliance plans for existing units and plants.
  - Creating compliance plans for new units and plants.
  - Ensuring that thermal power plant standards are enforceable.

- The Environment Pollution (Prevention & Control) Authority for the National Capital Region (EPCA) was asked by the Supreme Court to provide its expert review of submissions made by various stakeholders. EPCA submitted its Report No.81 on 14 February 2018.
- By letter dated 30 May 2018, the MoP advised CERC to allow for capex (capital expenditures) and opex (operating expenditures) costs as a result of the installation or upgrading of emissions control systems to meet new environmental norms, as a pass-through in tariff under the change in law provision.[66]
- Additional standards (for stack height post FGD installation and water consumption) were prescribed by MoEF&CC by a notification dated 28 June 2018. This notification also clarified that all monitored values for SO2 and NOx shall be corrected to 6% Oxygen on dry basis.
- Supreme Court, in its record of proceedings dated 25 July 2018, directed the Union of India to file an affidavit indicating the list of thermal power plants with more than 500 MW capacity and located where population density is more than 400 persons per sq.km., along with a timeline for steps to be taken for the reduction of air pollution in line with the 2015 standards.[67]
- Supreme Court in its record of proceedings dated 7 September 2018, noted that it has taken on record the plan submitted by the central government

[66] Except for plants where the bid deadline for the tariff was on or after 7 December 2015, and for plants where the requirement of such pollution control systems was mandated under the environment clearance. Per MoP (Answers in Rajya Sabha on 18th Dec 2018, the capital cost estimates for emission control technologies is as follows:- FGD 4.5 Rs.mn/MW, Upgradation of ESP 1.3 Rs.mn/MW, combustion modification measures to control NOX 0.13 Rs.mn/MW, combustion modification and SNCR measures to control NOX 0.25 Rs.mn/MW, SCR to control NOX 2.5 Rs.mn/MW. The tariff impact, shall be approx. 0.09 Rs/kWh for upgradation of electrostatic precipitators, 0.32 Rs/kWh for FGD installation and 0.07 Rs/kWh for NOX control, per Association of Power Producers of India.

[67] The focus on plants with higher capacity and located in areas with higher population density was based on a recommendation report filed by the Centre for Science and Environment. See Bhati, P. and Pathania, R. (2018). *No room for delay: Analysis of CEA plans to implement new norms for coal power plants*. Centre for Science and Environment. Retrieved from https://shaktifoundation.in/wp-content/uploads/2018/06/No-Room-for-Delay.pdf

(as directed to them via record of proceedings dated 25 July 2018) for the control of air pollution from 57 TPPs under its control (48 NTPC plants and 9 DVC plants), and according to which SO_X and PM emissions shall comply with the standard by 31 December 2021, and the NO_X emissions shall comply with the standard by 31 December 2022. Supreme Court further directed that the thermal power plants not under direct control of the central government (which number 48) shall also be brought under the present proceedings henceforth. **It also asked the MoP to look at suggestions provided by EPCA regarding modifications to merit order dispatch.**

- In the last available record of proceedings in this matter, dated 11 October 2018, the Supreme Court notes that an additional four weeks of time is granted to state generating companies and independent power producers (IPPs - not under direct control of the central government) to state on affidavit their plan to comply with new environmental requirements. Further, the Supreme Court granted the since the MoP another four weeks to develop its suggestions regarding modifications to merit order dispatch.

3.b. Takeaway from the court proceedings

While on the one hand it is encouraging to know that the Indian judiciary can exert control and pressure on the government and its agencies to fulfill their duties, on the other hand it is disheartening that matters like these are settled via courts. The disadvantage of this approach is that it is ex-post (i.e., after a violation has been made or a deadline has been missed) and is time consuming. In this case, a holistic vision of thermal power plant emissions and their impact on the economy gets lost.

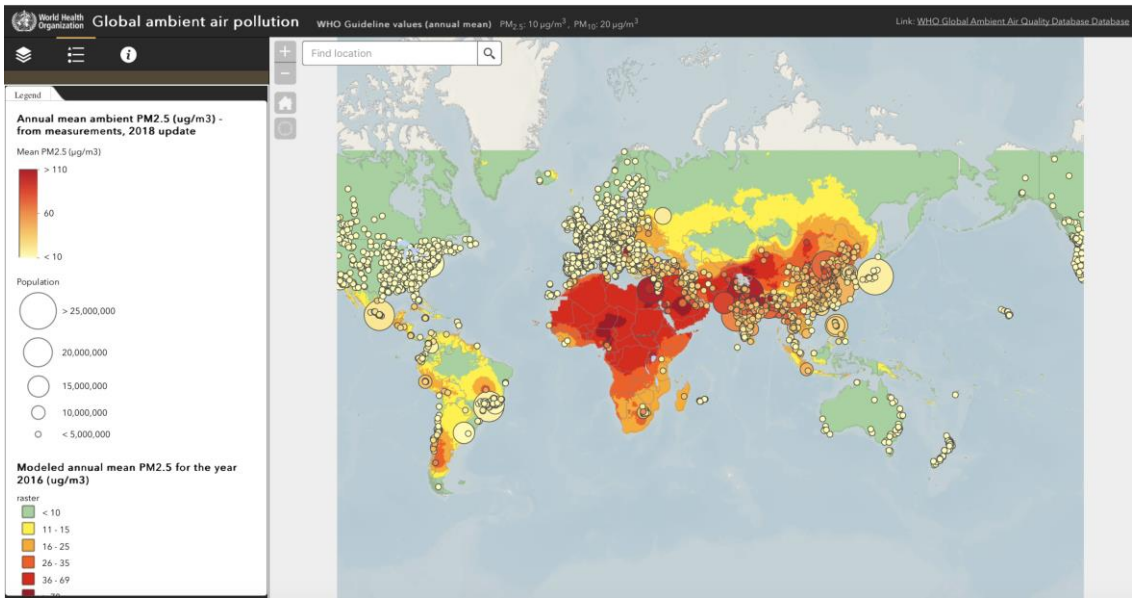
For instance, there are no discussions regarding whether the standards – which were framed in 2015 and will now not be implemented before 2022 – are sufficient and stringent enough. In addition, by the time the plants invest in emissions control technologies, the standards may be due for another revision.

Another area of concern is what happens if the same situation is repeated. The Center for Science and Environment advised that a penalty mechanism be developed to prevent repeated noncompliance. According to the Center for Science and Environment, a penalty fixed at the rate of Rs.100,000 per day per noncompliant pollutant will result in a maximum penalty of Rs.110 mn for a year. However, the Supreme Court has not yet issued any directive on this matter. All of these concerns point to the need for setting interim milestones and for midterm course correction if progress is not in sync with planning.

Chapter 4: Learnings from international experience in AQ governance

Air pollution is a big problem today for many countries in the world. It not only poses harmful effects on public health, but its negative effects on economic growth, too, have been well established by researchers and economists. The World Health Organisation (WHO) estimates that about 8 million premature deaths worldwide can be attributed to air pollution, of which 4.2 million are due to exposure to ambient air pollution and 3.8 million are due to indoor air pollution. Not all countries are on the worst-end of the spectrum and some have shown commendable political and citizen will to tackle the air pollution problem head-on. See Figure 3 for the WHO's map of ambient air pollution across the globe. This section reviews two case studies in which significant government and public action helped to curb thermal power plant emissions; emissions standards setting and monitoring functions are briefly discussed.

Figure 3: Global ambient air pollution



4.a. China

China's "war on air pollution" took an unprecedented action in early 2013. The State Council announced the Air Pollution Prevention and Control Action Plan with a series of measures including: a ten measures document to lower $PM_{2.5}$ concentrations in densely populated cities and regions, strengthening the country's environmental law, and granting authorisation to the Ministry of Environmental Protection (MEP) to adopt emissions standards and allow significant increases in pollution discharge fees. In 2013, reports of an eight-year-old child diagnosed with lung cancer as a

result of exposure to high levels of air pollution attracted people's attention. This was the very first case of its kind and highlighted the urgency of the worsening air quality situation. Even the state media took note of this case and urged the government to take action. Later in 2015, the movie *Under the Dome*, produced by Chai Jing, built further public support for the cause of fighting air pollution and especially highlighted the role of the government in controlling emissions from coal power plants.[68]

Standards Setting: The MEP adopted new emissions standards for thermal power plants in July 2011 (Figure 3). These standards were significantly stringent, not just as compared to the previously set 2003 standards but also in comparison to applicable standards in the U.S. and EU. These revisions required adherence by new plants from 1 January 2012, while existing plants were to ensure compliance by 1 July 2014. Mercury emissions standards were to be complied with by new as well as existing plants from 1 January 2015. For regions with higher populations, more stringent standards apply.

Standards Monitoring: The MEP, in 2007, had mandated CEMS for a set of highly polluting industries, including thermal power plants. By the end of 2013, MEP created an online publicly-accessible data repository where these industries can upload hourly automatically recorded emissions data. A recent study (Karplus, V., et. al., 2018) compared the SO_2 emissions data as reported by through the CEMS and with emissions time-series data captured remotely via U.S. National Aeronautics and Space Administration (NASA). The study finds that (a) there was a 14% drop in SO_2 emissions from plants after the policy deadline; (b) in the key regions with more stringent emissions standards, the reductions as reported by CEMS and as inferred based on NASA data do not necessarily match; and (c) compliance by smaller and

How China cuts its air pollution
The Economist (25 January 2018)

"The country has had draconian anti-pollution measures since 2013, when it introduced a set of prohibitions called the national action plan on air pollution. This imposed a nationwide cap on coal use, divided up among provinces, so that Beijing (for instance) had to reduce its coal consumption by 50% between 2013 and 2018. The plan banned new coal-burning capacity (though plants already in the works were allowed) and sped up the use of filters and scrubbers. These measures cut $PM_{2.5}$ levels in Beijing by more than a quarter between 2012-13, the time of the city's notorious "airpocalypse," and 2016. The measures were notable for being outright bans on polluting activities, rather than incentives to clean up production, such as prices or taxes (though China has those, too, including what will be the world's largest carbon market,

[68] The film was viewed 300 million times within four days of its release and was later ordered to be removed from the internet.

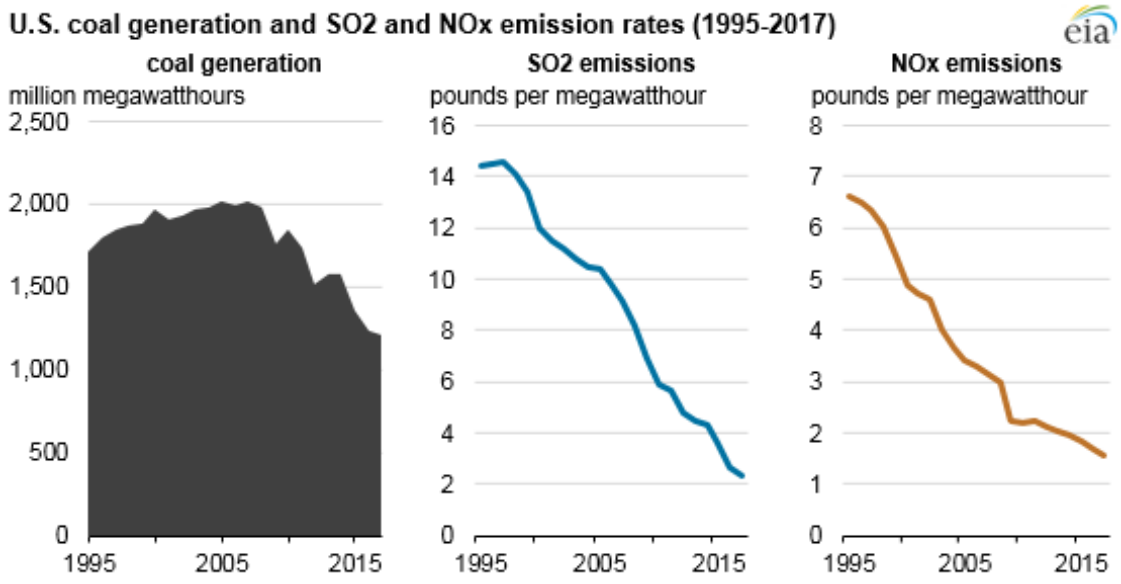
older plants has not gone so well when compared to larger, newer plants. The authors of the study note that it may be hard and costly for plant managers in key regions to meet very stringent standards, thus expressing the possibility of "incentives for plant managers to falsify or selectively omit concentration data."

4.b. United States

The series of events which lead to legislative actions in the U.S. are very similar to what China and India have been witnessing since the early 2000s. The pollution level of the Cuyahoga River in Ohio during the 1960s, for example, was so high that locals used to joke that "anyone who falls into the river does not drown, but decays." The 1966 New York City smog is a well-documented and studied pollution event which drove public demand for air pollution control legislation. According to the U.S. Environmental Protection Agency (EPA), the Air Pollution Control Act of 1955 was the first federal legislation involving air pollution which promoted research in the area. After that, the Clean Air Act (CAA) of 1963 was the first federal legislation requiring air pollution control.

The EPA was created to implement the various requirements mandated under the CAA. Subsequent amendments in 1977 and in 1990 broadened its scope and targeted newer issues such as acid rain and ozone concentrations. The success of the EPA has been widely recognised (see Figure 4), although there have been critical discussions regarding the grandfathering provisions provided to existing thermal power plants and the judiciary imbroglio with the 2015 Clean Power Plan.

Figure 4: Trend of SO_2 and NO_X emission rates



Public support and advocacy for environmental protection has been one of the key differences between the U.S. and other countries, and can be witnessed in terms of the success it has achieved over the last several decades. Rachel Carson's 1962 book *Silent Spring*, Bill McKibben's 1989 book *The End of Nature* and Al Gore's 2006 award-winning documentary "An Inconvenient Truth" have all built mass-scale public understanding of the harmful effects of civilisation on the environment, and led to the government taking concrete steps to tackle pollution problems.

Air Pollution success stories in the United States: The value of long-term observations.
Environmental Science and Policy, Volume 84, June 2018.

"The quality of air and fresh water across much of the United States vastly improved in recent decades in response to the Clean Air and Clean Water Acts and other rules and policies. We point to recently observed decreases in air pollution and its effects attributable to policy that have been informed by environmental monitoring and research. Examples include decreased environmental lead contamination due to the elimination of tetraethyl lead from gasoline, decreases in tropospheric ozone, improved visibility from reduced airborne particulate matter, declines in atmospheric sulfur and nitrogen deposition that acidify the environment, and declines in atmospheric mercury and subsequent bioaccumulation of toxic methyl mercury. Pollutant reductions have provided environmental, social, and economic benefits, highlighting the urgency to apply these lessons to address current critical environmental issues such as emissions of greenhouse gases. These examples underscore the important role of data from long-term research and monitoring as part of fact-based decision-making in environmental policy."

Standards Setting: The 1990 CAA revisions required the EPA to set and maintain national ambient air quality standards (NAAQS) for harmful pollutants and to set emissions limits for new industrial sources, including thermal power plants. The NAAQS act as baseline limits, and depending upon the location of a thermal power plant – in an attainment or non-attainment area – further requirements are applicable, including demonstration of best available control technology and lowest achievable emissions rate. The EPA also set the New Source Performance Standards (NSPS) for any unit that commenced construction after September 1978. All plants in operation prior to this date are not subject to NSPS, except those that are classified as major sources. To tackle interstate transport of pollution, EPA has implemented several programs, such as the Acid Rain Program, NOx Budget Trading Program, Clean Air Interstate Rule, Cross-state Air Pollution Rule, and the Mercury and Air Toxics Standards program. The EPA sets the federal standard. States have the authority to set more stringent standards, thus the EPA federal standards are the floor, and states have the option to go higher. The CAA allows citizens to comment on standards before they are finalised, and also allows

them to take the monitoring agencies to court if standards are not set for a particular pollutant, are introduced but not up to the required stringency, and are introduced and stringent but are not met by industry.

Standards Monitoring: Emissions data generated under each of the above listed programs are collected and monitored by the EPA. Much of this data, along with specific analysis (such as quarterly and yearly comparisons), are posted online for public use. CEMS is required under most of the program reporting requirements, along with regular quality control and assurance of procedures used for data collection and reporting as well as the quality of data recorded. Emissions from major pollutants are required to be reported into the National Emissions Inventory and the Toxics Release Inventory, both of which are maintained by the Energy Information Agency. The 1970 CAA Amendments provide for citizen participation in enforcement and implementation. It allows "any person" to "commence a civil action on his own behalf." That means any person can sue the violator(s) as well as the EPA for its actions under the CAA. It also allows citizens to initiate review of certain EPA actions.

Chapter 5: Opportunities for intervention by various stakeholders

Here are a few opportunities for intervention that stakeholders can build upon to improve the emissions profile of thermal power plants and lead India to a low-emissions-high-economic-growth economy:

- **Technical research organisations** can explore the possibility of validation and sufficiency of the new standards for India thermal power plants.[69]
- **Civil society organisations** can examine developing public opinion[70] for transparency and availability of emissions data and impact analysis. Another area to explore is the need for third-party audits of data collected by pollution control agencies.
- **Pollution control agencies** can investigate the need for emissions as a criterion in the merit order dispatch of generating plants, especially those plants that are located in high-density population areas.
- **The environment ministry** can examine creating a city-/district-/state-level comparison of air quality standards, similar to the way the Ministry of Urban Development and CPCB publish an annual City Rating on cleanliness under the Swachh Bharat Abhiyan scheme. This may be done under the newly launched National Clean Air Program. Ratings and comparison can drive local/state action to race to the top and expose those who do nothing.
- The Central Government can examine the **role that energy efficiency and electric vehicles** can play in integrating energy policy, environment policy and transport policy for India – one that leads to a transformation in the linkages between emissions and economic growth.

[69] Claims made in some studies about the uniqueness of Indian coal (high ash and low sulfur content) should be deliberated while setting standards, given the huge population that is exposed to emissions from TPPs. Guttikunda, S., et al. (2014). Atmospheric emissions and pollution from the coal-fired thermal power plants in India. Atmospheric Environment 92, 449-460; and Cropper, M.L., Guttikunda, S., Jawahar P., et al. (2017, October). Costs and benefits of installing flue-gas desulfurization units at coal-fired power plants in India. Disease Control Priorities, Third Edition (Volume 7): Injury Prevention and Environmental Health.

[70] Annexure V lists a few social media (Twitter) accounts of institutions and individuals who are actively engaged in building public opinion for air quality improvement.

Annexure I: Standards for air emissions

<table>
<tr><th>Policy/Regulation</th><th colspan="4">Standards prescribed for thermal power plants</th></tr>
<tr><td rowspan="8">Environment (Protection) Rules, 1986
Published 19 November 1986
Inclusion under Special Order dated 3 January 1989

Environment (Protection) Amendment Rules, 2015
Published 7 December 2015

Corrigendum
Dated 7 March 2016</td><td>Particulate matter</td><td colspan="3">350 mg/Nm^3 for units < 210 MW

150 mg/Nm^3 for units > 210 MW
*The SPCB can prescribe 150 mg/Nm^3 irrespective of unit size</td></tr>
<tr><td></td><td>Installed before 31 December 2003</td><td>Installed after 1 January 2003 to 31 December 2016</td><td>Installed after 1 Jan 2017</td></tr>
<tr><td>Particulate matter</td><td>100 mg/Nm^3</td><td>50 mg/Nm^3</td><td>30 mg/Nm^3</td></tr>
<tr><td>SO_2</td><td>600 mg/Nm^3 for units < than 500 MW

200 mg/Nm^3 for units => than 500 MW</td><td>600 mg/Nm^3 for units < than 500 MW

200 mg/Nm^3 for units => than 500 MW</td><td>100 mg/Nm^3</td></tr>
<tr><td>NO_x</td><td>600 mg/Nm^3</td><td>300 mg/Nm^3</td><td>100 mg/Nm^3</td></tr>
<tr><td>Mercury</td><td>0.03 mg/Nm^3 for units => than 500 MW</td><td>0.03 mg/Nm^3 for units => than 500 MW</td><td>0.03 mg/Nm^3 for units => than 500 MW</td></tr>
<tr><td colspan="4">1 January 2003 shall be substituted as 1 January 2004</td></tr>
</table>

Annexure II: Stack height prescription

Policy/Regulation	Standards prescribed for thermal power plants	
	Size of plant	**Stack height**
Environment (Protection) Rules, 1986 Published 19 November 1986	=> 500 MW	275 M
	200/210 MW – 500 MW	220 M
	<200/210 MW	14*(Q)*0.3
Environment (Protection) Amendment Rules, 2018 Published 28 June 2018	=> 100 MW	The greater of either: 6.902 (Qx0.277)0.555 or 100 M
	< 100 MW	The greater of either: 6.902 (Qx0.277)0.555 or 30 M

* Q = emissions rate of SO_2 kg/hr

Annexure III: Water emissions

Policy/Regulation	Standards prescribed for thermal power plants*		
Environment (Protection) Rules, 1986 *P*ublished 19 November 1986	Condenser cooling waters	pH	6.5-8.5
		Temperature	Not more than 5C higher than intake water temperature
		Free available chlorine	0.5
	Boiler blowdowns	Suspended solids	100
		Oil and grease	20
		Copper	1.0
		Iron	1.0
	Cooling tower blowdown	Free available chlorine	0.5
		Zinc	1.0
		Chromium	0.2
		Phosphate	5.0
		Other corrosion inhibiting material	Case-by-case limit by CPCB/SPCB
	Ash pond effluent	pH	6.5-8.5
		Suspended solids	100
		Oil and grease	20

* Emissions standard for VOC from wastewater collection and treatment. Maximum limiting concentration, milligrammes per litre (except for pH and temperature)

Policy/Regulation	**Standards prescribed for thermal power plants**			
Environment (Protection) Amendment Rules, 2015 *P*ublished 7 December 2015	Water consumption	**Plants with once through cooling (OTC)**	**Plants with cooling towers**	**New plants installed after 1 January 2017**
		Install cooling tower (CT) and achieve maximum consumption of 3.5 m3/MWh	Achieve maximum consumption of 3.5 m3/MWh	Achieve maximum of 2.5 m3/MWh and achieve zero wastewater discharge
Environment (Protection) Amendment Rules, 2018 *P*ublished 28 June 2018	Water consumption	Specific water consumption shall not exceed maximum of 3.0 m3/MWh for new plants installed after 1 January 2017 and these plants shall also achieve zero wastewater discharge (does not apply to plants using seawater).		

Annexure IV: Fly ash utilisation

Policy/Regulation	Standards prescribed for thermal power plants	
Notification Dated 14 September 1999	**Existing thermal power plants**	**New thermal power plants**
	100% ash utilisation level in a phased manner by 2013-14 in accordance with 15-year action plan	100% ash utilisation level in a phased manner by 2007-08 in accordance with 9-year action plan
Amendment Notification Dated 27 August 2003	Extended the scope of ash utilisation by various construction agencies operating within 100km radial distance from a thermal power plant.	
	Operating within 50 km	**Operating within 50 to 100 km**
	100% ash utilisation level by August 2005	100% ash utilisation level by August 2007

Annexure V: Popular Twitter handles which discuss air quality in India

Name/Twitter Handle	Areas of work
LetMeBreathe @LetMeBreathe_In	Curate pollution stories from across India; affiliations are not known.
Sunil Dahiya @Sunil_S_Dahiya	Senior campaigner, climate and energy at Greenpeace India. Comments on all things regarding air pollution with more focus on power sector.
AQI India @AQI_India	Real-time information of air quality from India.
Air Quality in India @airqualityindia	Curation of air quality-related news in India. Maintained by Pallavi Pant, air pollution scientist and social media editor for the *Journal of Exposure Science & Environmental Epidemiology*.
Clean Air Asia @cleanairasia	Network of air quality professionals formed by Asian Development Bank, World Bank and U.S. Agency for International Development focused on cities in Asia.
CEEW @CEEWIndia	Council on Energy, Environment and Water is among South Asia's top not-for-profit independent research institutes with a special focus on power sector.
The Energy Policy Institute @EPIC_India	The University of Chicago's India office is mostly known for its recent publication of the Air Quality Life Index and industry ratings portal which the office maintains for the Maharashtra PCB and Orissa PCB.
TERI @teriin	TERI is an independent not-for-profit research institute focused on energy, environment and sustainable development.
Chintan @ChintanIndia	An NGO working toward a cleaner environment with diverse stakeholders. Affiliations are not known.
My Right to Breathe @MRTB_India	Claims to be a citizens' movement to help fight air pollution and improve public health. Affiliations are not known.

Additional resources and works cited

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