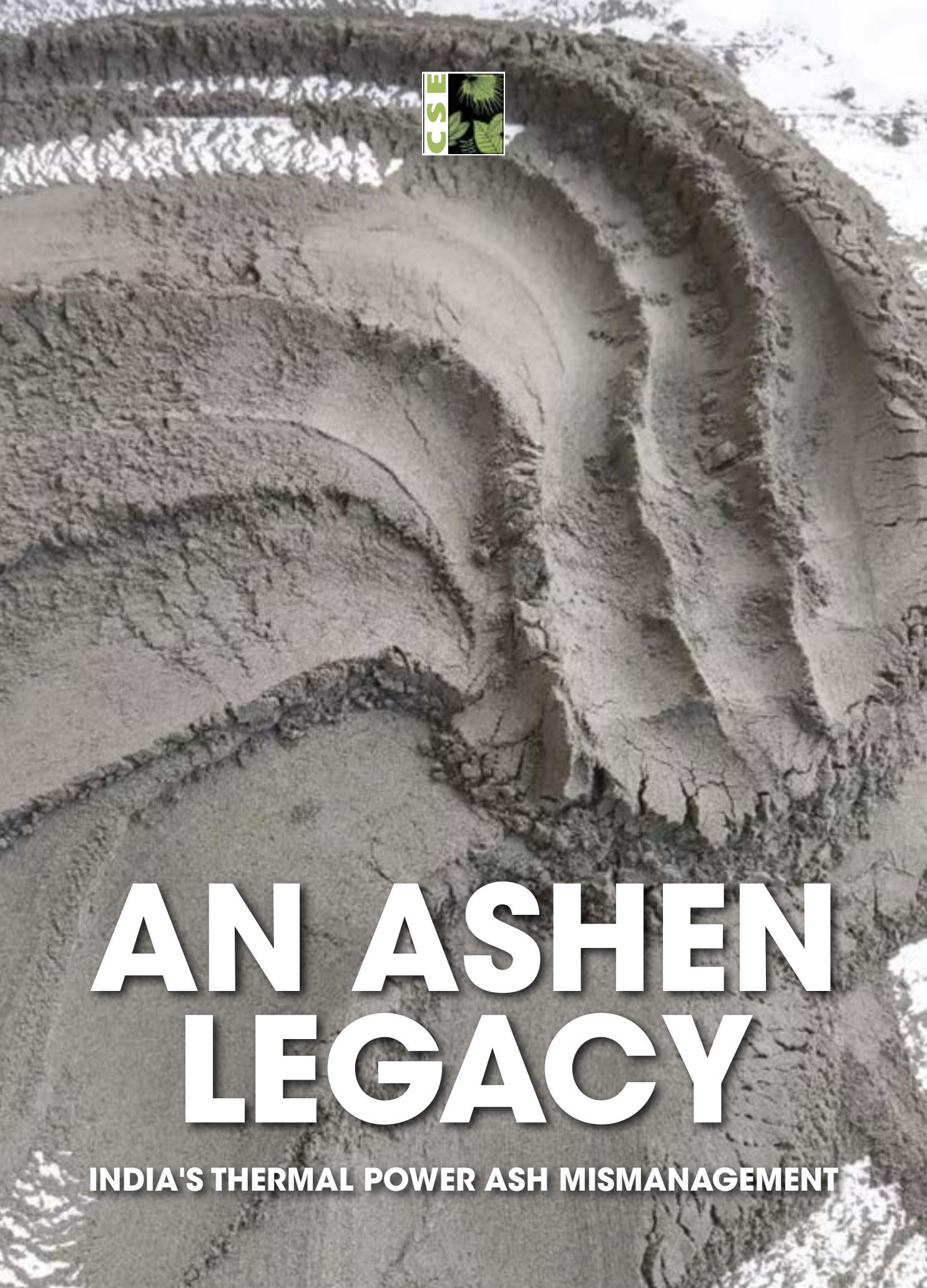

AN ASHEN LEGACY

INDIA'S THERMAL POWER ASH MISMANAGEMENT

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1. Background

Coal-based power is one of the most resource-intensive and polluting industries, and contributes significantly to ambient air pollution in India. Currently, coal- and lignite-based utility power plants account for 77 per cent of the country's total electricity generation.[1] The sector consumes about 65 per cent of the total coal consumed in India. In order to meet the growing electricity demand, a huge capacity addition has occurred to the Indian coal-based power sector in the past 10 years. Around 64 per cent (132 GW) capacity was added in the last 10 years, which has also led to a surge in coal consumption in the sector. Between 2009–10 and 2018–19, annual coal consumption rose from **367 million tonnes** to about **629 million tonnes**, an increase of almost 71 per cent.

Fly ash is the byproduct or unburnt residue formed during combustion of coal in a furnace. It is emitted along with the flue gases and collected either by mechanical separators or electrostatic precipitators in the dry form. The collected fly ash is normally stored in silos. Heavier unburnt ash, collected at the bottom of the furnace, is called bottom ash and constitutes around 20 per cent of the total ash generated at a power plant. Unused fly ash and bottom ash from plants is generally transferred in the wet slurry form to ash ponds with the help of ash slurry supply lines.

A rise in coal consumption naturally increases the production of fly ash as a byproduct or residue, which not only requires large tracts of land for disposal but also leads to significant pollution. This problem is particularly severe in India, because Indian coal is low-grade, with high ash content (of the order of 30–45 per cent) and low calorific value (3,500–4,000 kcal/kg). Annual fly ash generation from Indian coal power plants rose from **123 million tonnes** in **2009–10** to **217 million tonnes** in **2018–19**, an increase of almost **76 per cent**.[2]

123 million tonnes

Fly ash generated by Indian coal power plants in 2009–10

217 million tonnes

Fly ash generated by Indian coal power plants in 2018–19

Fly ash is ultra-fine, prone to becoming air borne in the dry state. This significantly affects air quality near coal-based plants. Long-term exposure to fly ash in the air can lead to serious pulmonary illnesses like bronchitis, silicosis, fibrosis, pneumonitis, etc. The ash contains toxic heavy metals that are known carcinogens. Ash disposed of in the wet form in ash ponds can be equally harmful if not handled in an environmentally sound manner. Several cases of contamination of nearby surfacewater bodies and groundwater due to ash pond overflows or leakages have been reported. This may even lead to accumulation of heavy metals beyond permissible limits in the contaminated water bodies.

Naturally, fly ash has been under the regulatory scanner for quite some time now. The effort has been to convert potentially harmful waste into a resource. The notification on fly ash utilization first came into force in 1999. Over the

1,647 million tonnes

Quantity of legacy fly ash in India as of 31 March 2019

years, it has gone through several amendments in 2003, 04, 09 and 16, in order to move towards the goal of 100 per cent utilization of fly ash produced by all coal- and lignite-based plants. As the quantity of coal consumed in India increased, and fly ash generated increased proportionally, Ministry of Environment, Forest and Climate Change (MoEF&CC) brought in several other policy measures and reforms to increase utilization of residual ash. Currently, fly ash is utilized in India in cement, brick and tiles manufacturing, filling up abandoned mines, reclamation of low-lying areas and construction of roads and flyovers. The ministry has also set certain limits, in terms of geographical area, within which fly ash is to be compulsorily used for manufacturing bricks or in the construction industry.

Yet, 21 years after the notification first came into force, many plants have still not been able to achieve the target. As per a December 2019 report submitted to the National Green Tribunal (NGT), the quantity of unused ash from the coal power sector is 1,647 million tonnes (as on **31 March 2019**). This is almost **eight times** the current annual ash generation. Ash is piling up in the wet form as slurry in ash ponds and in the dry form in open fields. Fugitive emissions and leakages have increased substantially. The severity of the problem was exemplified by the major coal ash pond accidents that occurred between 2010 and 2020.[3]

This risk of overabundance of ash has been further aggravated with the recent government orders of doing away with **mandatory coal washing** and opening the coal sector for **commercial mining** by private players, which will lead to increase in ash generation. Improper maintenance and lining of ash ponds continues to be a problem. This particular area does not have any regulatory oversight.

In recent years, National Green Tribunal (NGT) has passed several orders pertaining to non-compliant plants for depositing environmental compensation towards damage caused by ash accidents. However, after pleas filed by power producers stating that NGT had not analyzed the situation on a plant-to-plant basis and end users like cement plants and other agencies that can utilize ash should also be made accountable for it, Supreme Court put a stay on a few such orders. This has been continuing, derailing the regulations and the enforcement system. While end users like cement and construction agencies should be made accountable to some extent, it is primarily the responsibility of the power producers to make efforts for effective utilization of waste generated by them, whether it be coal ash or any other hazardous waste. Power producers must ensure disposal of ash in an environmentally sound manner that does not cause harm to the surrounding areas. With so many ash breach incidents, it is clear that power plants have been negligent on their part and must be dealt with strictly by regulatory bodies.

Therefore, in order to tackle the growing concerns and impacts associated with overabundance of ash, and to clear the huge stockpile of legacy ash, urgent interventions—in terms of policy measures, technologies and practices—are needed to enhance fly ash utilization.

2. Coal consumption, ash generation and utilization in the power sector

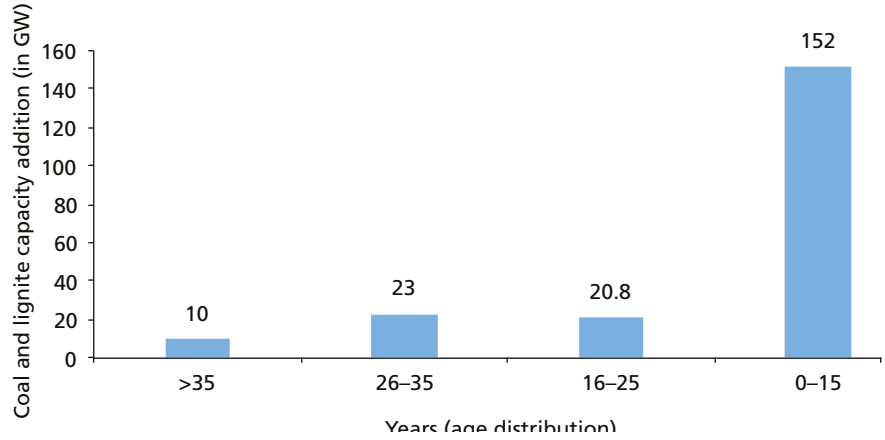
India's total power generation capacity (as on 31 March 2020) stood at 370 gigawatt (GW),[4] of which thermal power capacity alone is about 230 GW. Coal- and lignite-based power stations continue to be the bulk energy providers, making up 205 GW (89 per cent) of the total thermal power capacity. Significant coal-based capacity has been added in the last 15 years. Around 64 per cent (132 GW) of the capacity is less than a decade old. About 74 per cent (152 GW) is less than 15 years old. Huge capacity additions have led to a gradual increase in coal consumption over the years, thereby also leading to an increase in fly ash generation. Moreover, Indian coal has high ash content (about 30–45 per cent), which leads to generation of large quantities of fly ash at coal- and lignite-based thermal power stations.

Trends in coal consumption and ash generation

In a span of ten years (i.e., from 2009–10 to 2018–19), coal consumption in the power sector increased by almost 71 per cent and the corresponding ash generation increased by almost 76 per cent. At present, the power sector currently consumes about 623 million tonnes of coal and generates about 217 million tonnes of ash, 94 million tonnes up from the 2009 ash generation figures. This is a significant increase.

Graph 1: Coal- and lignite-based capacity addition in India

Significant coal-based capacity (about 152 GW) has been added in the past 15 years, leading to substantial increase in coal consumption in the power sector



Source: Coal-based power norms—Where do we stand today?, CSE 2020

Table 1: Trends in coal consumption and ash generation by the thermal power sector

Annual coal consumption has increased by 71 per cent and ash generation by 76 per cent within a decade

Year	Coal consumption (million tonnes)	Fly ash generation (million tonnes)	Per cent ash in coal
2009–10	367	123.54	33.6
2010–11	387	131.09	33.9
2011–12	417.56	145.42	34.8
2012–13	454.6	163.56	35.9
2013–14	489.4	172.87	35
2014–15	530.4	184.14	34.7
2015–16	545.9	176.74	32.4
2016–17	574.3	169.25	29.5
2017–18	608.0	196.44	32.3
2018–19	628.9	217.04	34.5

Source: Executive summary on the power sector, Central Electricity Authority[5&6]

Trends in ash utilization and residual ash generation

Tremendous increase in coal consumption by the power sector in the past decade has ballooned fly ash generation and resulted in large quantities of unused ash. As per Central Electricity Authority's (CEA) 2018–19 annual report on fly ash, 103 thermal power stations were able to achieve the target of 100 per cent ash utilization. However, 83 power stations have not been able to achieve this target. Though the all India average fly ash utilization percentage from TPPs has jumped from 63 per cent (77 million tonnes) in 2009 to 78 per cent (168 million tonnes) now, the major cause of concern is the amount of residual or unutilized ash that has gradually accumulated over the past many years due to the low utilization percentage. For about five years (between 2012–13 and 2016–17), the quantity of fly ash utilized has remained stagnant at around 100 million tonnes; however, during the same period, annual generation has been above the 150 million tonne mark, which indicates a huge pile up. Only in the last two years (i.e., 2017–18 and 2019–19) has there been an additional 30 million tonnes increase in utilization each year.

100

Number of power plants utilizing 100 per cent of the ash they produce

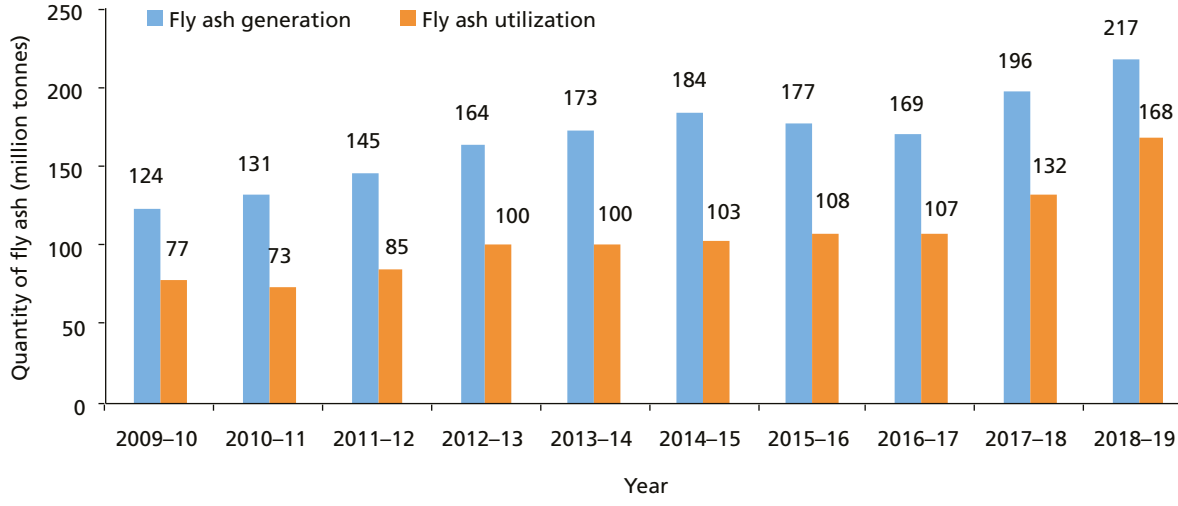
83

Number of power plants not utilizing 100 per cent of the ash they produce

Average ash utilization percentage between 2009 and 2019 has been about 62 per cent. During the period, on an average, almost **60 million tonnes** of fly ash has remained unutilized annually (see *Graph 2: Fly ash generation vs utilization*). Considering the nation-wide figures for fly ash utilization from coal-based power plants, a CSE analysis put the cumulative unused ash stock from thermal power plants in the past ten years at **627 million tonnes,** which is almost **three times** the current ash generation of **217 million tonnes**. Huge leftover stocks require more area of land or wet ash storages for disposal. This has created a burden on existing wet storage structures that do not have enough capacity to handle huge quantities of ash. As a result, ash dykes often leak or overflow due to excess slurry built up. Open storage in the dry form leads to fugitive emissions in the surrounding areas.

Graph 2: Fly ash generation vs utilization

Fly ash generation has increased from 124 million tonnes in 2009–10 to 217 million tonnes in 2018–19, but utilization has not been able to keep up



Source: CSE analysis; data sourced from CEA's annual fly ash generation reports

Table 2: Trends is fly ash utilization and accumulation of unused ash

Every year, almost 60 million tonnes of fly ash remain unutilized

Year	Fly ash generation (million tonnes)	Fly ash utilization (million tonnes)	Per cent ash utilization	Unused ash (million tonnes)
2009–10	123.54	77.33	63	46.21
2010–11	131.09	73.13	56	57.96
2011–12	145.42	85.05	58	60.37
2012–13	163.56	100.37	61	63.19
2013–14	172.87	99.62	58	73.25
2014–15	184.14	102.54	56	81.6
2015–16	176.74	107.77	61	68.97
2016–17	169.25	107.10	63	62.15
2017–18	196.44	131.87	67	64.57
2018–19	217.04	168.40	78	48.64
Total unused ash (2009–19)				627
Average ash utilization (per cent)				62
Average un-used ash (per cent)				38

Source: Centre for Science and Environment (CSE) analysis, 2020; data sourced from CEA annual reports

State-wise ash utilization and residual ash generation

Coal-based power plants are spread over 17 states in India. They are heavily concentrated in Andhra Pradesh, Chhattisgarh, Madhya Pradesh, Maharashtra, Odisha, Uttar Pradesh and West Bengal. Substantial quantities of coal are consumed in these states, generating humongous quantities of ash. CSE analysed CEA's state-wise data on ash generation and utilization from 2010–11 to 2018–19. The following inferences have been drawn:

Table 3: State-wise total unused ash from the coal power sector

Fly ash utilization rate ranges from 35 per cent to 98 per cent in different states of India

State	Year (2010–11 to 2018–19)			
	Total ash generation (million tonnes)	Total ash utilization (million tonnes)	Per cent ash utilization	Total unused ash (million tonnes)
Andhra Pradesh	152.94	98.18	64.19	54.76
Bihar	52.94	18.83	35.57	34.11
Chhattisgarh	198.66	90.93	45.77	107.74
Gujarat	54.14	42.24	78.03	11.89
Haryana	51.39	36.62	71.27	14.77
Jharkhand	56.79	51.96	91.51	4.82
Karnataka	38.57	18.64	48.34	19.93
Madhya Pradesh	126.92	55.48	43.72	71.43
Maharashtra	153.92	101.49	65.94	52.43
Odisha	112.74	61.92	54.92	50.82
Punjab	29.26	28.87	98.67	0.39
Rajasthan	53.92	52.40	97.17	1.53
Tamil Nadu	70.66	59.78	84.60	10.88
Telangana	25.48	11.94	46.86	13.54
Uttar Pradesh	211.83	108.22	51.09	103.61
West Bengal	157.74	131.64	83.45	26.11

Source: CSE analysis, data sourced from CEA annual reports

Uttar Pradesh and Chhattisgarh are the two states producing maximum fly ash in India

- **Uttar Pradesh** and **Chhattisgarh** have had the highest ash generation, followed by **West Bengal, Maharashtra, Andhra Pradesh, Madhya Pradesh and Odisha**. All these states have large coal-based power capacity.

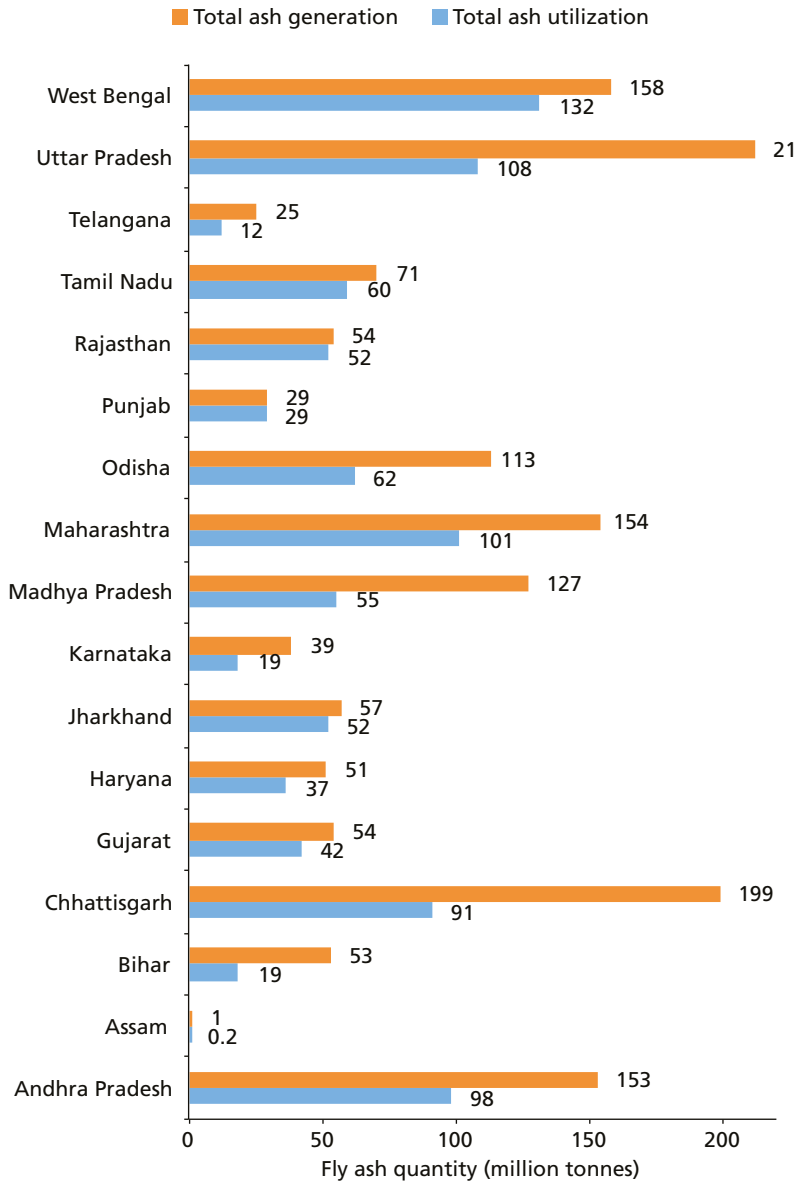
- High generation and low utilization percentage in many states indicate pile up of unused ash in those states. **Chhattisgarh** and **Uttar Pradesh** have accumulated the most ash in this decade. **Madhya Pradesh, Andhra Pradesh, Maharashtra and Odisha** also have a huge ash backlog. States with large coal-based capacity and limited ash demand in nearby areas have low ash utilization rates.

- **West Bengal** is the only state that produces a sizeable quantity of ash but manages to clear the stock. It has utilized 131 million tonnes out of the total of 157 million tonnes of ash it produced in the past decade. Fly ash is used extensively in cement manufacturing in the state. It is also used in construction of roads and highways. Some fly ash is even exported to Bangladesh for manufacturing Pozzolana Portland Cement (PPC) cement. Ash is transported pneumatically through pipelines to silos located on jetties by the riverside. Ash from the silos is loaded into covered barges and exported to Bangladesh.[7]

A few states, notably **Haryana, Gujarat, Punjab and Rajasthan,** utilized as much ash in 2018–19 as they produced in that year, but no state has been able to completely utilize its accumulated stock of legacy ash. **Jharkhand, Punjab and Rajasthan** are the only states that have achieved an average fly ash utilization rate of 90–100 per cent. In fact, Gujarat, Haryana, Punjab and Rajasthan do not have any plants with a poor ash utilization rate.

Graph 3: State-wise total ash generation and utilization

Chhattisgarh, Uttar Pradesh, West Bengal, Maharashtra and Andhra Pradesh have been the major fly ash producing states in the last decade



Note: Data for the period 2010–11 to 2018–19

Source: CSE analysis, data sourced from CEA annual reports

Power plants with poor ash utilization rates

CSE also obtained plant-wise ash generation and utilization data from CEA. Plants with poor ash utilization rates were mainly Centre- and state-owned, a majority of which belonged to NTPC Limited, Chhattisgarh State Power Generation Company Limited (CSPGCL), Madhya Pradesh Power Generation Company Limited (MPPGCL) and MahaGENCO (in Maharashtra). Most of these plants have been facing litigation due to coal ash pollution and frequent ash dyke breach incidents. A majority of these plants are either older plants or have large capacities. Some have accumulated huge amounts of residual ash (greater than 10 million tonnes each) between 2010 and 2019; most such plants belonging to NTPC (see *Table 4: Plants performing poorly in terms of fly ash utilization*).

Table 4: Plants performing poorly in terms of fly ash utilization

Most of these plants are Centre- and state-owned

State	Plants with poor ash utilization rate	Plants with significant quantities of accumulated ash
Assam	NTPC: Bongaigaon	-
Andhra Pradesh	APGENCO: Sri Damodaram	-
Bihar	NTPC: Barauni, Barh, Kahalgaon, Nabinagar and Muzaffarpur	NTPC Kahalgaon
Chhattisgarh	NTPC: Korba and Sipat CSPGCL: Dr Shyama Prasad Mukherjee,Korba (East) and Korba (West) Lanco: Amarkantak NSPCL: Bhilai II	NTPC Korba NTPC Sipat CSPGCL Korba (West) CSPGCL Dr Shyama Prasad Mukherjee
Jharkhand	DVC: Bokaro JSEB: Patratu	-
Karnataka	KPCL: Bellari, Raichurand Yermarus	-
Madhya Pradesh	UMPP (Reliance Power): Sassan MPPGCL: Amarkantak, Satpura, and Shree Singaji NTPC: Gadarwada and Vindhyachal Hindustan Power: Anuppur	NTPC Vindhyachal MPPGCL Shree Singaji MPPGCL Satpura
Maharashtra	MahaGENCO: Chandrapur, Khaparkheda, Koradi and Paras	MahaGENCO Chandrapur
Odisha	NTPC Talcher OSPGCL: IB valley	NTPC Talcher
Tamil Nadu	TanGEDCO: North Chennai	-
Telangana	TSGENCO: Kothagudem I-V, Ramagundem and Ramagundem B	Kothagudem I-V
Uttar Pradesh	NTPC: Meja, Rihand and Singrauli UPRVUNL plants: Anpara A&B and Obra Lanco: Anpara-C	NTPC Singrauli NTPC Rihand Anpara A&B
West Bengal	DVC: Durgapur; Mejia and Raghunathpur NSPCL: Rourkela WBPDCL: Santaldih	-

Source: CSE analysis, data sourced from annual ash generation reports (2010 to 2019); CEA

Possible reasons for low ash utilization rates

Key factors determining ash utilization rate of any region include coal power capacity—addition, location and number—and presence and proximity of cement or brick manufacturing units or other agencies involved in construction activities, including road construction.

Ash utilization is low in some regions either due to scarcity of ash consuming businesses like cement or brick manufacturing units in the nearby areas, or overabundance of fly ash in the area due to presence of multiple thermal power stations.

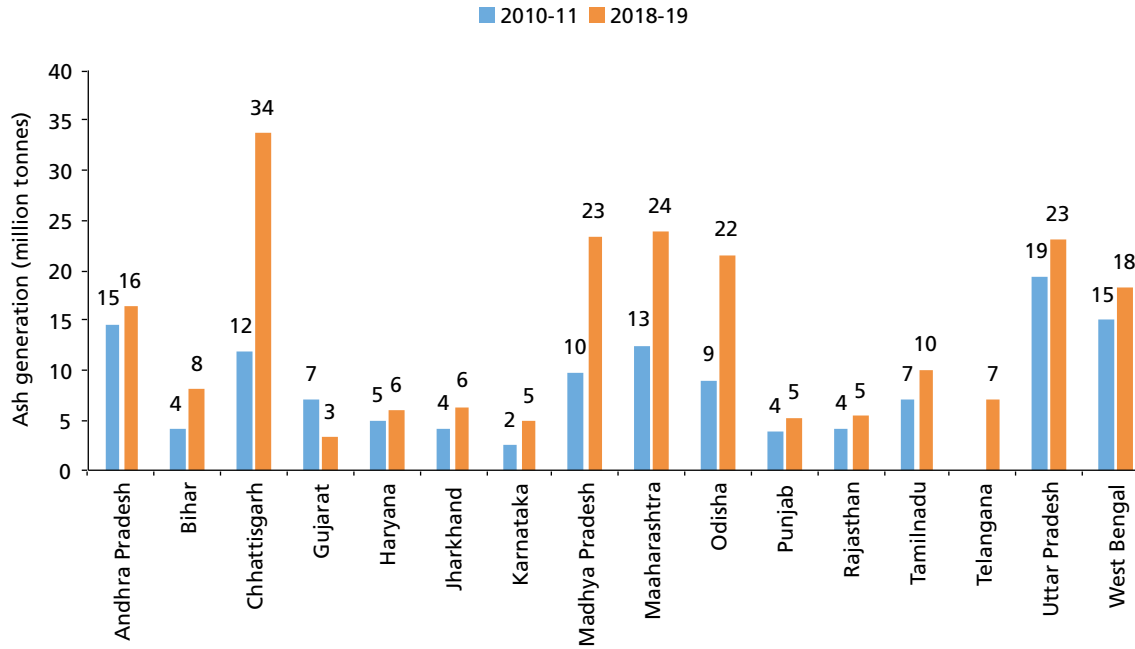
State- and Centre-owned coal power plants are the worst performers with regard to fly ash utilization

States with huge capacity addition in the past ten years

States that have witnessed a sharp increase in fly ash generation in the past ten years due to more coal capacity addition have lower ash utilization rates. Fly ash generation almost doubled within a decade in many states (see *Graph 4: Comparison of fly ash generation in 2010–11 and 2018–19*). These states include **Bihar, Chhattisgarh, Karnataka, Madhya Pradesh, Odisha and Telangana.** Interestingly, all these states have lower ash utilization rates of 35–55 per cent (see *Table 5: Coal capacity addition versus ash utilization rate*).

Graph 4: Comparison of fly ash generation in 2010-11 and 2018–19

Fly ash generation almost doubled in Chhattisgarh, Madhya Pradesh, Odisha and Maharashtra during these years



Source: Data sourced from CEA annual ash generation report of 2010–11 and 2018–19

Table 5: Coal capacity addition versus ash utilization rate

States that witnessed rapid increase in coal capacity addition have lower ash utilization rates and more piled up ash stock

State	Installed coal power capacity (As on 28 February 2010)[8]	Installed coal power capacity (As on 31 March 2020)[9]	Increase in coal capacity (per cent)	Average ash utilization rate (per cent)
Bihar	530	5,338	907	35
Chhattisgarh	2,060	11,946	480	46
Karnataka	1,970	9,846	400	48
Madhya Pradesh	2,807	15,651	457	44
Odisha	420	5,894	1,300	55
Gujarat	4,190	15,143	261	78
Andhra Pradesh	3,883	10,431	168	64
Haryana	2,015	8,660	330	71
Jharkhand	1,190	2,276	91	91
Rajasthan	3240	10,862	235	97
Punjab	2630	8,327	216	99
Tamil Nadu	2970	11,833	298	84

High coal capacity addition, low ash utilization

Low coal capacity addition, high ash utilization

Source: CSE analysis; all India installed capacity data sourced from CEA

Regions with many power plants tend to have lower utilization rates as the demand cannot keep up with the supply

Concentration of large capacity coal power plants in a region

Regions where many power plants are in close proximity tend to have lower utilization rates as there is overabundance of ash and the demand cannot keep up with it, due to limited number of cement, brick or construction agencies present within a 300 km radius of such regions. Singrauli–Sonebhadra, spread across parts of Uttar Pradesh and Madhya Pradesh, is one such region. The two states together account for about 51 GW of power generation capacity in India, half of which is generated in the Singrauli–Sonebhadra region. Nine major power plants operate in this region, with a combined capacity of around 21,270 MW. More than half of the capacity (11,180 MW) is less than 10 years old and was added by construction of either new power plants or addition of stages to existing plants in the region. Due to a skewed demand–supply ratio, the two states are in the top four in terms of fly ash generation and in the bottom four in terms of utilization rates.

Distance from cement and brick manufacturing, and construction units

Transportation and settlement plays an important role in determining the ash utilization rate. States with more cement or brick manufacturing units, that are in proximity to power plants, tend to have higher utilization rates.

Andhra Pradesh, Haryana, Karnataka, Punjab, Rajasthan and Tamil Nadu together account for about **60 per cent of total cement production capacity** in India. These are also the states with the highest ash utilization percentages. On the other hand, in states like Chhattisgarh, demand for ash is limited due to minimal presence of businesses that utilize ash.

Table 6: Power plants currently operating in the Singrauli–Sonebhadra belt

Concentration of large capacity plants in the region results in overabundance of fly ash

Name of the plant	Owner	Year in which the most recent capacity addition took place	Total capacity (in MW)	Unit count
Mahan Power Plant	Essar	2018	1,200	2
Sasan Ultra Mega Power Plant	Reliance Power	2015	3,960	6
Nigrie Thermal Power Plant	Jaypee	2015	1,320	2
Vindhyachal Super Thermal Power Station	NTPC	2015	4,760	13
Rihand Thermal Power Station	NTPC	2013	3,000	6
Anpara Thermal Power Station	UPRVUNL	2012	2,630	7
Anpara Lanco	LANCO	2011	1,200	2
Singrauli Super Thermal Power Station	NTPC	1987	2,000	7
Obra Thermal Power Station	UPRVUNL	1982	1,200	7
			21,270	

Source: Down to Earth, Centre for Science and Environment, 2020[10]

Low demand for fly ash in rural settlements

Less urbanized states have low demand for fly ash due to lower construction activity. Case in point: Chhattisgarh, where power plants are mostly located in remote areas consisting of rural settlements.

Underutilization of fly ash in cement and brick manufacturing, and the construction industry

In general, there is lack of awareness about the benefits of fly ash bricks. There is a common misconception that fly ash bricks and cement are of lower quality. This and similar problems result in underutilization of fly ash. To illustrate, a 2016 CSE analysis of fly ash use in Chhattisgarh found that an additional 1.8 million tonnes of fly ash could be absorbed by the cement industry and 1.2 million tonnes by the road construction industry.[11]

Use of fly ash in backfilling of abandoned, open cast and underground mines has significant potential, especially in case of pithead thermal power stations that otherwise have limited avenues for fly ash utilization due to their remote location.

3. Notification on fly ash utilization

In order to minimize environmental pollution caused due to fly ash, Ministry of Environment, Forest and Climate Change (MoEF&CC) has come up with several notifications in the past. These notifications have sought to promote utilization of fly ash produced by coal- or lignite-based thermal power plants, including captive power plants and co-generation plants. They have also sought to restrict excavation of top soil for manufacture of bricks.

- The **notification** on fly ash utilization came into force in **September 1999**. It stipulated targets for utilization of fly ash produced at thermal power plants by construction companies falling within the prescribed radius. The notification was subsequently amended in 2003, 2009, 2016 and 2019. With each subsequent amendment, the radius around coal- and lignite-based thermal power plants for which the said norm is applicable was increased to enhance use of fly ash.
- The **August 2003 amendment** mandated the use of 100 per cent fly ash by construction agencies in a phased manner in five years (by August 2007).
- Following this, the **November 2009 amendment** revised and extended the timelines and the period of implementation for achieving 100 per cent utilization in a phased manner to 2014.
- In **January 2016,** another amendment extended the area within which fly ash was to be utilized from 100 km to 300 km. The time period to comply with the requirements of 100 per cent utilization of fly ash was extended to 31 December 2017.
- In September 2020, a draft fly ash amendment has for the first time introduced a penalty framework based on polluter pays principle. The draft specifies a fine of Rs 1,500 per tonne of unused ash if the plant does not achieve at least 80 per cent ash utilization annually or is unable to utilize, on an average, 100 per cent of ash in a three year cycle. There is also a fine of Rs 2,000 per tonne for non-utilization of legacy ash. User agencies within 300 km radius of a power plant have also been made accountable through imposition of a fine of Rs 2,000 per tonne of non-utilized ash. The draft amendment is out for comments, and is likely to face criticism and objections, especially from the power sector, because, if notified, it will definitely lead to huge penalties on the large number of non-compliant plants, and especially those with poor ash utlization rates.

The fly ash notification first came into force in September 1999

The deadline for complying with the notification has already passed. However, even after 21 years since the first notification came into force, many power plants are still not able achieve the target of **100 per cent utilization**. As per CEA's latest report, the number of such power plants is 83.

Notifications on fly ash use and amendments made so far

1999 primary fly ash notification

- It was made mandatory to mix at least 25 per cent fly ash with soil in manufacture of clay bricks or tiles or blocks for use in construction activities within a radius of 50 km from coal- or lignite-based power stations.
- All local authorities were directed to modify their building bye laws to incorporate use of fly ash-based products.
- Coal- and lignite-based thermal power plants were directed to make ash available free of cost for at least ten years from the date of publication of the notification, i.e., till 2009, for the purpose of manufacturing ash-based products.
- Coal- or lignite-based power plants were required to progressively utilize 100 per cent of the ash they generated within a period of nine years from the date of publication of the notification.
- Coal- or lignite-based thermal power plants were directed to constitute a dispute settlement committee, which had to include the general managers of the plants and representatives of All India Brick and Tile Manufacture's Federation, in order to ensure unhindered loading and transportation of ash.
- Central and state government agencies, state electricity boards, NTPC and the management of thermal power plants were asked to facilitate the availability of land, electricity and water for manufacturing activities and setting up of ash-based production units in the proximity of power plants.

2003 amendment

The August 2003 amendment to the notification majorly focused on the demand side or agencies that can utilize ash in construction activities within a 100 km radius of a coal- or lignite-based power plant.

- The radius for mandatory utilization of fly ash use was increased from 50 km to 100 km.
- Construction projects within 50–100 km of a coal- or lignite-based thermal power plant were mandated to use fly ash as per the following minimum percentages (by volume of total bricks, blocks and tiles):
  (i) 25 per cent by 31 August 2004
  (ii) 50 per cent by 31 August 2005
  (iii) 75 per cent by 31 August 2006
  (iv) 100 per cent by 31 August 2007

- With respect to construction of buildings within a radius of 50 km from a coal- or lignite-based thermal power plant, the following minimum percentage (by volume) of use of bricks, blocks and tiles was set:
  (i) 50 per cent by 31 August 2004
  (ii) 100 per cent by 31 August 2005

- Regional officers of state pollution control boards (SPCBs) were made the authority for ensuring use of specified quantities of ash.
- State governments were made the enforcing and monitoring authority to ensure compliance with the aforementioned provisions.
- To further ensure utilization of fly ash within 100 km, all authorities sanctioning or renewing any land, soil or clay mining lease were asked to not grant such a lease or extension of lease or renewal to any clay brick, block or tile manufacturing unit within a radius of 100 km of a coal- or lignite-based thermal power plant in cases where the manufacturer does not mix a minimum of 25 per cent by weight of fly ash or pond ash in the manufacture of bricks or blocks or tiles.

2009 amendment

Even after six years of the 2003 amendment, construction agencies were unable to achieve the target of 100 per cent utilization of fly ash-based products and many power plants were also unable to meet their fly ash targets. Keeping this in mind, another amendment was made to the notification in November 2009.

- Plants commissioned before 3 November 2009 were given five years to achieve the target.
- Plants commissioned after 3 November 2009 were given a target of four years to comply with the notification.
- It was made obligatory for all construction agencies within 100 km radius of a coal- or lignite-based power plant to use fly ash-based products. All construction agencies of Central, state or local government and private or public sector were mandated to submit annual returns to the concerned SPCB or pollution committee.

2016 amendment

- The January 2016 notification further increased the radius for restriction on use of fly ash from 100 km to 300 km.
- Restriction to provide 20 per cent of dry ESP fly ash free-of-cost was lifted on those power plants which were able to utilize 100 per cent of their fly ash.
- Every coal- or lignite-based power plant was required to upload and periodically update on its website the details of stock of ash available with them.
- Every construction agency engaged in the construction of buildings within a radius of 300 km from a coal- or lignite-based thermal power plant was required to use only fly ash-based products for construction.
- Coal- or lignite-based thermal power plants within a radius of 100 km were directed to bear the entire cost of transportation of ash to the site of road construction, or the site for manufacturing ash-based products or for use as soil conditioner in any agricultural activity. The cost of transportation within a radius of 100–300 km has to be borne equally by the generator and the user.
- Coal- or lignite-based thermal power plants were asked to promote, adopt and set up ash-based product manufacturing units so as to meet the requirement of bricks and other building construction materials and also to reduce transportation charges.
- To ensure that contractors of road construction utilize fly ash, concerned authorities were mandated to link payment to contractors with the certification of ash supply from thermal power plants.
- The notification also mandated the use of fly ash-based products in projects under all government schemes such as Pradhan Mantri Gram Sadak Yojana, Mahatma Gandhi National Rural Employment Guarantee Scheme and Swachh Bharat Abhiyan.
- Coal- or lignite-based power plants were asked to comply with the above provisions in addition to 100 per cent utilization of fly ash by 31 December 2017.

2019 amendment

- Certain fly ash uses like mine filling, reclamation of low-lying areas and as soil conditioner in agricultural use were prohibited under the environmental clearance (EC) conditions for thermal power plants. The 2019 amendment reverses such EC conditions in order to enhance utilization.

Source: MoEF&CC notification on fly ash and amendments to it in 1999, 2003, 2009, 2016 and 2019

4. Fly ash incidents, impacts and court orders

Management of fly ash has been a matter of concern for coal- and lignite-based power plants due to the requirement of a large area for its disposal and its adverse impact on the environment and health of the people living nearby due to its hazardous nature. Non-utilization and improper disposal of fly ash leads to severe air and water pollution. Apart from lime, silica and alumina, fly ash contains toxic heavy metals like lead, mercury, arsenic and hexavalent chromium, all of which are known carcinogens. Several health studies conducted in communities living near thermal power plants have clearly established health problems associated with fly ash. Several major coal ash pond accidents have been reported across the country in the last ten years, from utility thermal plants as well as captive power plants. Minor fly ash incidents which occur on a regular basis are not even reported. At times, these incidents have led to loss of life and property in nearby settlements. Since many power plants are located close to surfacewater bodies serving as a source of freshwater for the plant, leaking or overflowing slurry from ash ponds often finds its way into these surfacewater bodies leading to their contamination.

NGT has recently come down harshly on non-compliant power plants and those facing litigation due to ash dyke breaches or ash leakages, by way of imposing penalties on them. However, penalties imposed on plants in the last two–three years have not been an effective deterrent as many of them are far from meeting the 100 per cent utilization rate and continue to pollute their immediate surroundings with ash. A good illustrative example of continuous non-compliance is the North Chennai Thermal Power Station (NCTPS), where fly ash leaked from a busted pipeline in August 2020 and flooded the nearby village. The residents of the village have been battling against this issue (and the plant) for many years. At times, ash slurry enters their houses and there are high levels of ash in the air and nearby waterbodies which affect the health of residents. River and borewell samples show high rates of contamination with heavy metals. Back in 2017, NGT had warned that the plant would be completely shut down if discharge of fly ash was not contained. Later, a committee was appointed to observe the plant for violations. In January 2020, NGT even imposed a penalty of Rs 8.34 crore on the plant. Despite all these measures, the plant continues to pollute the area.

Over the last few years, such incidents have increased. To ensure better compliance, stricter penalties, shutting down non-complying plants and stricter monitoring are the need of the hour.

Many plants continue to be in violation of the fly ash notification even after penalties have been imposed on them

Incidents and litigation

According to CSE's 2015 study *Heat on Power*, of the 47 power stations studied, 40 had had complaints related to fly ash spill or ash pond breaches. States with a large number of coal power plants (Chhattisgarh, Madhya Pradesh, Maharashtra, Odisha and Tamil Nadu) top the list of number of coal ash accidents. These are also the states with very low ash utilization percentages, indicating piling up of huge amounts of unused ash in dry or wet form.

There have been cases where power plants have expanded without obtaining land for additional ash ponds and continue to dump huge quantities of ash in the existing ponds. At times, ash overflows in these ponds or the boundary walls are breached. A major fly ash breach incident occurred on 10 April 2020 at the Sasan ultra-mega power plant (owned by Reliance Power in Singrauli–Sonebhadra region). It resulted in human causalities and spread of toxic slurry in the surrounding areas (up to six kilometres), destroying agricultural fields. In 2019, similar incidences of ash dyke breaches had occurred at the Essar Mahan Power plant and NTPC Vindhyachal plant located in the same region. Three instances of fly ash breach within a year have raised concerns regarding the management of fly ash at coal power plants.

A committee appointed by NGT to look into the breaches at ESSAR thermal power plant and NTPC, Vindhyachal found that no sincere efforts had been made for ash disposal by these plants since their commissioning in the early 1980s.

People living in such areas have been facing the adverse effects of the pollution for several years. A 2012 study conducted by CSE in the Sonebhadra district found that 84 per cent of the blood samples and 54 per cent of the hair samples contained high levels of mercury. Mercury contamination was also established in the groundwater and the Rihand reservoir. The same story has been repeated in many other regions of the country (see *Table 7: Fly ash accidents and litigation*).

There are also issues with improper maintenance and lining of ash ponds. Environmental clearances granted to thermal power plants set up after 2006 made it mandatory for plants to have impervious lining at the bottom of ash ponds. This requirement was to avoid any leaching of toxic heavy metals present in ash slurry into the groundwater. No monitoring agency exists to ensure that plants put in place impervious lining before disposing of ash slurry into the ponds. There is gross mismanagement and unsafe disposal, evident from the high levels of contaminants and heavy metals found in groundwater samples taken from the vicinity of ash ponds.

Frequent fly ash dyke breach incidents underline poor management practices

Latest NGT and court orders on fly ash utilization

The adverse effects of fly ash mismanagement are well acknowledged in the decision of courts as well as by public authorities. In the wake of such frequent ash accidents, NGT passed an order in **February 2020**, directing all power plants to take steps for scientific disposal of fly ash or else be ready to pay compensation for non-compliance. Though the last date for achieving 100 per cent utilization was 31 December 2017 and the date has not been extended, many plants and states are still not in compliance with the norms.

Table 7: Fly ash accidents and litigation

As toxic ash slurry keeps accumulating in ash ponds of many power plants, and strict governance and monitoring is missing, incidents of ash dyke breaches have become more frequent

Year	Location	Power plant	Incident	Effects	NGT, court and SPCB orders
2020					
August 2020	Tamil Nadu	North Chennai thermal power plant	Toxic fly ash slurry from busted pipeline floods a village[12]	Extremely high levels of ash in air as dust contaminates food and water. Adverse health impacts	Case in NGT since 2017 due to frequent ash incidents. Despite imposition of a penalty and necessary directions issued to the plant previously, proper ameliorative measures not taken.
July 2020	Punjab	Goindwal Sahib, Nabha Power and Guru Hargobind thermal power plants	Failure to scientifically dispose of fly ash		NGT directed three power plants to pay Rs 1.5 crore (total amount) as environmental compensation. NGT directed the SPCB to ensure compensation is deposited with CPCB within 30 days
April 2020	Singrauli, Madhya Pradesh	Sasan Ultra Mega Power Project, Reliance	Breach in fly ash dam	Ash slurry flooded into inhabited villages of Singrauli, killing six people, damaging acres of agricultural land and polluting the Rihand reservoir	An NGT-appointed committee determined that significant quantities of fly ash (between 1.5 to 2 lakh tonnes) has spread on the banks of Goiwahai drain over a stretch of 6.5 km (till its confluence with the Rihand river). A plea seeking closure and cancellation of the environmental clearance of the plant has been filed with the NGT (order dated 15 July 2020)[13]
March 2020	Talcher, Odisha	NTPC Talcher,	Breach in the pipeline carrying fly ash slurry for coal mine filling. Several leakages reported in the past as well	Houses, farms and roads were inundated with fly ash slurry. Locals claim that of late leakages have become a regular feature[14]	
2019					
October 2019	Madhya Pradesh	NTPC Vindhyachal power plant	Collapse of the fly ash reservoir that led to the release of > 35 lakh metric tonnes of fly ash into Govind Vallabh Pant Sagar 'Rihand' reservoir	Damage to agricultural land, groundwater and standing crop. Thirteen acres of land destroyed and 15 cattle deaths reported	An NGT-appointed committee found that a large portion of the ash dyke had been breached. Rs 10 crore interim compensation imposed by the NGT towards damage. The plant was advised to set up an RCC wall to strengthen its ash dyke. (order dated 16 July 2020)[15]

Year	Location	Power plant	Incident	Effects	NGT, court and SPCB orders
July 2019	Haryana	NTPC Aravali and CLP Jhajjar power plants	Huge accumulation of fly ash	Several complaints by inhabitants of the area regarding fly ash pollution	Haryana SPCB submitted a report to NGT in 2019 showing huge amounts of accumulated ash at NTPC Aravali and CLP Jhajjar.[16] NGT sought a report from both the plants about the current status of fly ash management and disposal and an action plan with a timeline
September 2019	Bokaro, Jharkhand	Bokaro thermal power station (DVC plant)	Breach in ash pond	Ash slurry flooded agricultural lands, contaminated groundwater and drained into the Damodar river. Contamination of Damodar river affected drinking water supply downstream	A petition was filed on 12 September 2019 in the NGT alleging that the DVC took no steps to clear the agricultural fields of the toxic slurry. NGT formed a committee comprising of regional office, CPCB, Kolkata. The district magistrate, Bokaro and Jharkhand SPCB was to inspect the area and verify the factual position on the ground
August 2019	Madhya Pradesh	Essar power plant[5]	Fly ash breach	Huge quantities of ash entered in agricultural lands, houses were destroyed and people were trapped due to sudden release of fly ash	Rs 10 crore interim compensation for damage caused (order dated 20 August 2019)[17]
July 2019	Nagpur, Maharashtra	Khaparkheda thermal power plant	Breach in ash pond	Reports of major crop damage, groundwater and Kolar river pollution	
April 2019 and June 2019	Nagpur, Maharashtra	Koradi thermal power station		Damaged hundreds of acres of crops, caused groundwater pollution and reduced air quality in the area	
2017					
July–December 2017	Chennai, Tamil Nadu	North Chennai thermal power plant	Discharge of toxic fly ash in the water bodies of Ennore	River and borewell samples showed a high rate of contamination with presence of Cu, Mn, Cd, Hg, Pb and Ni	NGT warned a complete shut down of the plant if discharge of fly ash to Ennore creek was not contained within a week. May 2019: An NGT-appointed committee observed that the violation still continues. Also, high concentration of heavy metals was found in the groundwater. January 2020: NGT imposed a penalty of Rs 8.34 crore

Year	Location	Power plant	Incident	Effects	NGT, court and SPCB orders
2016					
July 2016	Talcher, Odisha	NTPC Talcher	Breach in fly ash pipeline	Flooding of roads, roadside establishments, homes and farms in the region	
2015					
July 2015	West Bengal	Bakreshwar Thermal Power Plant[7]	Ash-laden water overflowing out of the pond into the river	In 2008, the plant expanded its capacity without obtaining more land for the additional ash. Ash pond was overwhelmed	NGT issued a show-cause notice and a penalty of Rs 5 crore for the environmental degradation caused by the fly ash contamination of rivers Chandrabhaga and Bakreshwar (order dated 13 July 2015). The court ordered the plant to remove ash from the riverbed
October 2014	Chennai, Tamil Nadu	Mettur thermal power station	Fly ash and decanted ash water overflowing from the ash ponds	Damage to nearby cotton fields and pollution of the Cauvery river	
May 2014		Hasdeo thermal power plant	Pipeline carrying ash slurry burst	Contamination of the Hasdeo river and damage to nearby fields	
2013					
October 2013	Bokaro, Jamshedpur	Bokaro thermal power plant[8]	Overflowing ash ponds	Kolar river contamination	Ordered to shut down the plant (27 October 2013)
September 2013	Vijayawada, Andhra Pradesh	Narla Tata Rao thermal power station	Seepage of fly ash from ash tanks	Surfacewater and groundwater pollution and build up of heavy metals	
January 2013	Odisha	NTPC Kaniha	Ash pond breach		Closure notice issued
2012					
December 2012	Nagpur, Maharashtra	Koradi thermal power station		Damaged hundreds of acres of crops, groundwater pollution came to the fore and air quality was reduced	
2011					
September 2011	Korba, Chhattisgarh	NTPC, Dhanras	Breach in fly ash pond	Paddy fields damaged	
June 2011	Odisha	NTPC, Talcher	Breach in ash pond	Pond developed cracks at several places and burst at one place	

Source: Centre for Science and Environment, 2020

NGT has passed a slew of orders against errant plants

The following section covers recent NGT orders and committees formed on fly ash utilization:

i) **January 2018: NGT passed an order directing states to submit action plans for fly ash use**[18]

- States and Union territories were directed to furnish their action plans for 100 per cent utilization of fly ash generated by thermal power plants in accordance with the 2009 amendment to the notification.
- Following this order, in **August 2018**, 20 states submitted their action plans—13 of them were incomplete and not unsatisfactory. MoEF&CC was directed to monitor compliance and submit a status report on them.
- Thereafter, MoEF&CC submitted a status report to NGT in **September 2018** wherein it was noted that the states had sought further extension of time by two to five years, i.e., upto 2023, for 100 per cent fly ash utilization. Moreover, a few plants had not even submitted action plans for 100 per cent utilization.

ii) **November 2018: NGT passed an order on forming a joint committee and imposing penalty on defaulters**[19]

- NGT directed MoEF&CC to constitute a committee comprising of representatives from MoEF&CC, CPCB, IIT Roorkee and any other members considered necessary for implementation of the action plan to achieve 100 per cent fly ash utilization by power plants in an environmentally sound manner. The committee was also required to assess the amount of damages to be paid for non-compliance with the notification. Following this order, MoEF&CC constituted a joint committee comprising of member secretary, CPCB and representatives from IIT Roorkee, Ministry of Power, Ministry of Coal, Ministry of Housing and Urban Affairs, National Highway Authority of India (NHAI) and Odisha SPCB.
- Until the committee can assess the damages, thermal power plants that failed to utilize 100 per cent fly ash by the end of 2017 have to deposit specified environmental penalty (see *Table 8: Penalty slabs*).

The NITI Aayog committee

In June 2018, NITI Aayog constituted a committee, headed by Joint Secretary, MoEF&CC, to develop a focused strategy for optimum utilization of fly ash. The committee was directed to revisit existing notifications; solve transportation issues of fly ash; ensure better utilization in the micro-, small and medium enterprise (MSME) sector, cement and allied industries; and promote the use of mobile apps, guidelines for ash ponds and regulation of red bricks; while incentivizing 100 per cent utilization and new innovations. The committee noted that the existing notification needed a review for better implementation.

Table 8: Penalty slabs

Penalties were to be paid within a month, failing which an interest of 12 per cent per annum would be levied on them

Capacity (in MW)	Penalty imposed
≤ 500 MW	Rs 1 crore
500–1,000 MW	Rs 3 crore
> 1,000 MW	Rs 5 crore

Source: National Green Tribunal's order on fly ash dated 20 November 2018

If the penalty wasn't deposited with CPCB within one month, an interest of 12 per cent per annum would be payable

- Following the November 2018 NGT order, the joint committee filed its report on **December 2019** on the progress made on action plans and compensation assessment. The report states that the quantity of **unused ash** was as high as **1,647 million tonnes** as on **31 March 2019**. The committee recommended a maximum of two years time for 100 per cent utilization. It also recommended that compensation should be obtained only from non pit-head power plants. Construction of fly ash dykes and their maintenance was not found technically sound at many plants.

iii) **February 2019: Supreme Court stayed environmental compensation imposed by NGT on non-compliant plants of NTPC and MPPGCL**

The Supreme Court stayed NGT's November 2018 order of imposing fines on NTPC and MPPGCL plants. These fines ranged from Rs 1–5 crore, depending on the power plant's capacity (see the November 2018 order). NTPC mentioned in its plea that NGT did not take into consideration the reluctance of end use industries, like cement and brick manufacturing plants, for taking fly ash from power plants as the 2016 notification had made it obligatory for user industries to uptake fly ash. The plea further mentioned that power plants only have to facilitate transportation of fly ash but cannot force user agencies to uptake fly ash.

iv) **February 2020: NGT passed an order on directing all power plants to take steps for scientific disposal of fly ash**[20]

- Following three fly ash breach incidents in Singrauli region in 2019–20, in **February 2020** NGT directed thermal power plants to take prompt steps for scientific disposal of fly ash, warning that failure to do so would lead to penalty. The tribunal stated that non-compliant plants will have to pay environmental compensation which would be determined from the cut-off date of 31 December 2017 as stipulated in the notification issued by the Union environment ministry.[21]
- In the same order, NGT asked CPCB to compute and levy environmental compensation with respect to individual plants in accordance with the law and submit a compliance report to the tribunal.

NGT has been pushing for a penalty regime against plants not practising 100 per cent utilization

End users are accountable too, but fly ash utilization is primarily a responsibility of power plants

v) **September 2020: Supreme Court issues a stay order on recovery of environmental compensation imposed by NGT on non-compliant plants**

- On 14 September 2020, Supreme Court stayed the recovery of fines imposed by NGT through its February 2020 order against non-compliant thermal power plants (that have not achieved the target of 100 per cent fly ash utilization and disposal). CPCB had issued notices to various non-compliant power plants after NGT's February order.
- The plea was filed by power producers stating that due to COVID-19 pandemic, there has been disruptions in fly ash utilization and disposal. The plea also mentioned that no case-by-case analysis was done while determining the environmental compensation for each plant.

Thus, it is clear that proper enforcement of regulations is lacking, both at the level of power plants and at the level of end users. The blame game has been continuing with NGT passing orders for environmental compensation against non-compliant plants and Supreme Court staying those orders after hearing pleas from power plants. While end users like cement, brick and construction companies should be made accountable, CSE believes it is primarily the responsibility of power producers to make efforts for effective utilization of waste generated by them, whether it be coal ash or any other hazardous waste. Power plants must ensure proper disposal of ash in an environmentally sound manner that does not cause harm to the surroundings. With so many ash breach incidents, it is clear that power plants have been negligent on their part and must be dealt with strictly by the regulatory bodies.

5. Various modes of utilization of fly ash from the power sector

As per the sector-wise ash utilization figures obtained from CEA's annual reports, the maximum amount of ash is utilized by the cement sector, followed by reclamation of low-lying areas, brick and tiles manufacturing and ash dyke raising.

Status of fly ash use in cement manufacturing

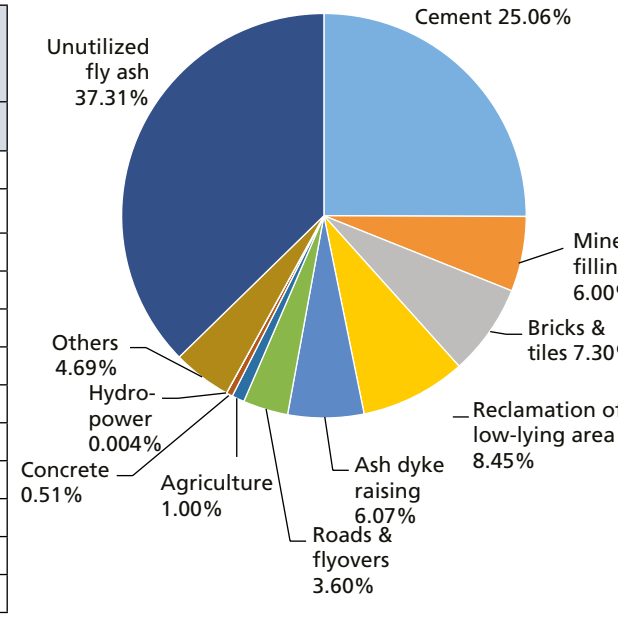
Andhra Pradesh, Haryana, Karnataka, Punjab, Rajasthan and Tamil Nadu together account for about 60 per cent of the cement production capacity of India. These are also the states utilizing the most fly ash, especially Haryana, Punjab, Rajasthan and Tamil Nadu, all of which have ash utilization percentages between 70–99 per cent.

Though fly ash utilization in the cement sector has increased over the last few years due to several government interventions and policy measures mandating its use, the uptake has not been commiserate with the tremendous growth in the production of cement. Between **2009 and 2019,** cement production in India increased from **187 million tonnes** to **334 million tonnes**, an increase of almost **78 per cent**. Currently, India produces about 334 million tonnes of

Graph 5: Sector-wise ash utilization

Cement manufacturing leads ash utilization. About 37 per cent ash from the power sector remains unutilized

Sector	Total ash utilized from coal power sector (2010–11 till 2018–19) (million tonnes)
Cement	389.98
Mine filling	93.38
Bricks and tiles	113.63
Reclamation of low-lying area	131.58
Ash dyke raising	94.46
Roads and flyovers	56.05
Agriculture	15.59
Concrete	7.94
Hydropower sector	0.07
Others	73.03
Unutilized ash	580.71
TOTAL	1556.41



Source: CSE analysis, data sourced from CEA annual reports

Pozzolanic properties of fly ash for making PPC cement

Fly ash is a pozzolanic material and enhances the strength and durability of concrete or portland cement. A 'pozzolan' is a siliceous material which in itself possesses little or no cementitious properties but in a finely divided form and in the presence of moisture, it chemically reacts with calcium hydroxide, present in cement, to form calcium silicate hydrates, a compound and binding agent that leads to enhanced strength. Portland cement is rich in lime (CaO) while fly ash is low in lime. Fly ash is rich in silicates while Portland cement has lesser amounts of silicates. It reacts with additional lime in the concrete to produce calcium-silicate-hydrate (C-S-H). Historically, fly ash has been used in concrete in concentration ranging from 15 per cent to 25 per cent by mass. The actual amount used varies widely depending on the application, the properties of the fly ash and the geographic location and climate.

cement annually and the production is expected to reach 400 million tonnes by 2025, owing to continuously rising demand.

In 2017, MoEF&CC formed a committee, with representatives from the Ministry of Mines, Ministry of Power, CEA, Department of Industrial Policy and Promotion (DIPP) and Ministry of Coal, to examine the possibility of building cement plants near power plants to enhance utilization of fly ash. But utilization of fly ash in the cement manufacturing industry is hindered by several factors, chief among them being lack of or costly transportation, lack of awareness among cement manufacturers, and poor implementation and monitoring by government agencies.

Status of fly ash use in brick manufacturing

Fly ash bricks are made from fly ash, lime, gypsum and cement. Use of fly ash in the manufacture of fly ash bricks is a technically well established practice. However, average ash utilization percentage in the brick manufacturing sector has only been a low 7 per cent. Bureau of Indian Standards (BIS) has formulated standards for fly ash bricks. IS 12894: 2002 establishes specifications for fly ash–lime bricks. Fly ash can be easily used as a building material in place of red clay bricks and save precious top soil as well. Moreover, producing fly ash bricks is a relatively cleaner process as it does not require firing. India is currently the second largest producer of bricks in the world and with the rising demand for bricks, there is immense potential for utilization of fly ash in the brick sector. The major fly ash brick producing states are Andhra Pradesh, Bihar, Delhi, Maharashtra, Odisha, Tamil Nadu and West Bengal.

Fly ash can be easily used as a building material in place of red clay bricks and save precious top soil as well

To enhance utilization in this sector, **MoEF&CC** had issued the following directions through its 2016 notification:

- Mandatory use of fly ash-based products for construction activity within a radius of 300 km from coal- and lignite-based power plants.
- Power plants to bear transportation cost of fly ash up to a radius of 100 km. Beyond the radius of 100 km (up to 300 km), transportation cost shall be borne equally by fly ash users and power plants.
- MoEF&CC also issued a draft amendment to the notification in February 2019 inviting public comments, wherein the following proposals were made:
  - o No new red clay brick kiln shall be established within a radius of 300 km of a thermal power plant.

- Existing red clay brick kilns within a radius of 300 km of thermal power plants shall be converted to fly ash brick, block or tile manufacturing units.

To enhance utilization, a few state governments have started providing incentives to fly ash start-ups, made use of fly ash bricks compulsory in construction near coal power plants, and mandated use of fly ash bricks in construction of government buildings.

Despite government policies, fly ash utilization in the brick manufacturing sector remains poor in many states because:

- Brick kiln contractors still prefer clay bricks over fly ash bricks.
- There is no quality control system in place to ensure that fly ash production units comply with BIS standards.
- Lack of incentives to fly ash start-ups in many states.
- The process of making fly ash bricks requires more training and know-how in the hands of the workers, which is missing.
- There is also an absence of an existing market for fly ash bricks as adequate initiatives have not been taken by Central and state governments in this direction.
- Transportation of fly ash from power plants to brick units and costs involved in transportation also act as a hindrance to its utilization.
- A robust monitoring system is missing.

Status of fly ash use in other sectors

- **Reclamation of low lying areas:** Soil or sand can be substituted with fly ash in reclamation of low lying areas. This helps save precious top soil. Average ash utilization from power plants for reclamation activities is only around 8.45 per cent. About 21 million tonnes (out of 217 million tonnes) of fly ash generated was utilized in 2018–19 in reclamation of low lying areas.
- **Backfilling of mines:** Traditionally, river sand has been used as mine backfilling material, but its continued availability is suspect. Fly ash offers a viable alternative. Average ash utilization rate as mine filling has been around 6 per cent. About 0.65 million tonne of fly ash was used in backfilling and stowing of open cast and underground mines during 1998–99, which increased to 10 million tonnes by 2018–19.
- **Construction of roads and fly overs:** Road networks are expanding in India. New roads, highways and flyovers are coming up and existing ones are being widened. Fly ash use can be enhanced in this sector. Fly ash is pozzolanic and can enhance the strength of road structures. However, average ash utilization in this sector has only been 3.6 per cent.
- **Manufacturing blocks and tiles for walls and floors:** Fly ash is also used to manufacture floor and wall tiles (with fly ash content not exceeding 50 per cent). Fly ash-based blocks and tiles are as good as conventional clay-based building tiles.
- **Agriculture:** Several studies proclaim the benefits of using fly ash in agriculture. However, there are risks associated due to presence of toxic heavy metals in the ash which can find their way into the food chain.

7 per cent

Fly ash utilization in brick manufacturing in India

8.45 per cent

Fly ash utilization in backfilling of abandoned mines in India

3.6 per cent

Fly ash utilization in road construction in India

6. Measures to be adopted and the way ahead

It is clear that coal will remain the mainstay of energy generation in India in the near future, which will further aggravate the problem of fly ash management. A proper disposal and utilization framework is, therefore, vital in view of the growing environmental concerns associated with its generation. Along with the current emphasis on meeting emissions standards, ash utilization must also be made a priority area as its improper disposal significantly contributes to air pollution. Although there is a well-defined policy and regulatory framework for 100 per cent fly ash utilization, thermal power plants have failed to achieve the targets due to one or the reason discussed in this report. Ash lying around will always be a hazard despite the best disposal measures. Ensuring its 100 per cent utilization by converting it into a variety of useful products or using it in construction activities is the only way forward. Concerted efforts are required at the plant level as well as by agencies that utilize ash to make this possible. Only if all thermal power plants consistently utilize 100 per cent of the ash they generate in the coming years, while also clearing the ash backlog from previous years, will the adverse environmental impacts created due to ash be minimized. Instead of utilizing ash in batches, its continuous utilization should be made possible. User agencies within a stipulated radius of thermal power plants must be made accountable and should be strictly monitored for use of ash in their products.

Thermal power capacity additions should work in tandem with the capability in any region to ensure 100 per cent utilization of ash in an environmentally sound manner. Coal power plants should explore avenues to ensure 100 per cent utilization, and the government can regulate this with stricter monitoring and stringent penalties, and by creating a conducive fly ash-product market. Thus, power plants, regulatory bodies as well as the government need to take definite measures to improve fly ash utilization.

Measures required at the Central and state government level

1) **Discourage expansion or installation of coal capacity in regions where it is already heavily concentrated.** Doing so will ensure that there is no overabundance of fly ash in such regions and reduce the chances of serious fly ash pollution.

2) **Capacity addition should not be allowed in plants with limited ash pond capacity.** There have been several instances where plants have undertaken capacity addition without assessing the carrying capacity of their ash ponds. This should be strictly discouraged.

3) **Power plants not utilizing 100 per cent of their ash should not be given approval to expand capacity**.

4) **It must be made mandatory for non-compliant power plants to set up fly ash depots** in regions with high ash demand. In particular, plants with capacities exceeding 2,000 MW and also those with low ash utilization rates must set up such depots in urban areas.

5) **Monitor periodically and take strict action against plants not meeting the 100 per cent utilization target.** Government must come up with strict policy measures in the form of penalties and disincentives against such plants. Power stations should be asked to determine their availability only after accounting for their ability to utilize 100 per cent of the ash they produce, before committing to scheduling their stations to state load dispatch centres.

6) **Make disclosure of fly ash data by power plants mandatory to ensure better transparency.** It must be made mandatory for each power plant to put its annual ash generation and utilization (including of legacy ash) data on its official website for better transparency. Power plants must also disclose their fly ash procurers along with the amount utilized by each.

7) **Reduce plant load factor (PLF) of plants not meeting the 100 per cent target.** A low PLF will lead to lesser coal consumption and fly ash generation. The reduced amount can then be easily utilized to the extent of 100 per cent, solving the problem of its disposal.

8) **Provide guidelines on proper construction of ash dykes and appoint dedicated government- or SPCB-appointed authorities or officials in each state for periodic monitoring**. Capacity building of such officials is also needed.

9) **Provide adequate transport infrastructure** for bulk transfer of ash through roads, railways or waterways from power plants to utilizing agencies.

10) **Ensure strict monitoring of the mandated use of fly ash.** State governments must come up with stricter regulations and enforcement systems to ensure mandatory use of fly ash in the making of cement, bricks and roads. Non-compliance with such a mandate should be dealt with strictly.

11) **Encourage setting up of new cement and fly ash-based brick manufacturing units in close proximity to power plants.** State governments must provide suitable incentives and support to start-ups, agencies or power plants willing to establish fly ash-based units in the vicinity of power plants.

12) **Establish a market for fly ash-based products.** States should make use of fly ash products compulsory in construction activities near power plants. Use of fly ash bricks and cement should be made mandatory in construction of all government buildings.

13) **Strict enforcement of already existing policies.** MoEF&CC had mandated 100 per cent utilization of fly ash by power plants by end of December 2017. Regulations were passed on transportation cost bearing and mandatory use of fly ash by user agencies located within 300 km radius of power plants. However, on ground enforcement and monitoring has been poor. Stricter enforcement is required.

14) **Replication of success stories for higher ash utilization rate.** Success stories (whether intra-country of global) must be replicated.

Measures to be taken by coal- and lignite-based power plants

1) **Ensure dry extraction of ash to the maximum extent possible by building sufficient storage silos.** Dry ash is more suitable for making cement, bricks and for other uses. After a proper assessment of monthly fly ash generation, plants should ensure that they have at least one month's fly ash storage capacity within their premises. Power plants should also create facilities for faster loading of ash onto vehicles.

2) **Every power plant must have a dedicated ash management cell** working for proper management, safe disposal and utilization of ash. The cell must ensure the quality of fly ash supplied to user agencies. It must also inspect ash ponds periodically for leakages and other maintenance issues.

3) **For bringing in more transparency, power plants must disclose their annual ash generation and utilization figures**, including of legacy ash, on their official website and also in the annual environment statements they submitt to pollution control boards.

4) **Every power plant with a low ash utilization rate must install fly ash depots** in regions with high demand for fly ash.

5) **Power plants must explore the possibility of building fly ash-based brick or cement units** adjacent to the plant or selling fly ash for nearby construction activities

Measures to be taken by regulatory bodies and pollution control boards

1) **Regulatory bodies must devise a clear penalty mechanism as environmental compensation for damage and should impose strict penalties on plants mismanaging fly ash**. The collected money should be spend on restoration of the environment and in compensating the people affected by such incidents.

2) **Closure notices should be issued and heavy penalty must be imposed on plants with poor ash utilization rates.**

3) **Pollution control boards should renew 'consent to operate' only for stations that demonstrate adequate fly ash management** and submit proper action plans for its 100 per cent utilization.

4) **State and regional pollution control boards must periodically inspect and assess the condition of ash dykes**. Ash ponds must be monitored for leaks or overflow. Appropriate action should be taken against power plants through show cause notices, closure notices or by imposing penalty on defaulters, in case of mismanagement and unsafe disposal of ash in dykes or overflow of ash dykes.

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Coal based thermal power stations are responsible for one of the largest industrial waste streams in India—coal ash. As fugitive emissions in the dry form and as leakage of ash slurry from ash ponds, coal ash is a major environmental and health concern today. It has been under the regulatory scanner for more than two decades. However, attempts to ensure its 100 per cent utilization are yet to bear fruit. Therefore, along with the current emphasis on meeting emissions standards, ash utilization also must be made a priority issue.

This report highlights the issue of poor ash management by power plants and provides insights into the urgent interventions needed—in terms of policy measures, monitoring framework and practices—to tackle the problem of overabundance of ash, and to clear the huge stockpile of legacy ash.

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