WATER-INEFFICIENT POWER

Implementing Water Norms and Zero Discharge in India's Coal-Power Fleet

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1. BACKGROUND

Water stress is an urgent reality in India. With increasing water stress in many parts of India, conflicts between industries and local communities have intensified. Increasing industrial production, especially in water-intensive industries like coal power plants, puts pressure on India's limited freshwater resources. This coupled with increased water demand from other sectors such as infrastructure development, agriculture, domestic, etc. is leading to major conflicts over water availability. Amongst water intensive industries in India, coal power plants especially are huge guzzlers of water and are responsible for about 70 per cent of the total freshwater withdrawal by all industries in India.[1] As per the Centre for Science and Environment (CSE) 2015 study *Heat on Power*, Indian power plants were estimated to withdraw around 22 billion cubic metres (m^3) of water, which is over half of India's domestic water requirement.[2]

With increasing water scarcity, the very existence and long-term sustainability of these water-intensive industries is also at stake. Industries that are heavily dependent on water for their production have to sometimes curtail their production—mainly during summer season—due to water scarcity.

As per CSE's recent estimates, about 48 percent of our existing coal-power fleet is located in water-scarce regions. Several recent studies also indicate that more than 40 per cent of our coal-power fleet already lies in areas of acute water stress.[3] Coal-power plants in water-scarce regions such as Nagpur and Chandrapur in Maharashtra; Raichur in Karnataka; Korba in Chhattisgarh; Barmer and Baran in Rajasthan; Khammam and Kothagudem in Telangana and Cuddalore in Tamil Nadu already face the brunt of water scarcity. As per various media reports, power plants in water-scarce areas had to often resort to shutdown or curtail their electricity production due to reduced water availability or non-availability of water (see *Box: Media reports in the last five years of Indian power plants resorting to shutdown due to water scarcity).* With acute water shortage and declining availability of water, such a scenario is expected to become more frequent in the future. The crisis is especially aggravated during summers when there is additional demand for power due to increased cooling needs, adding pressure on coal power plants. Monsoon failure and drought also add to the stress.

Media reports in the last five years of Indian power plants resorting to shutdown due to water scarcity

Water crisis: Adani Power shuts 2,640 MW units at Tiroda plant
Indian Express, Maharashtra, 16 May 2016

Water shortage hits power generation at Raichur Thermal Power Station
Deccan Herald, Karnataka, 3 January 2019

NTPC's Solapur power plant faces water constraints
The Hindu, Maharashtra, 22 January 2018

No water: BTPS Power Plant Bellary left dry
Bangalore Mirror, Karnataka, 6 July 2017

NTPC's Farakka plant shutdown due to water shortage, hits power supply in five states
The Hindu, West Bengal, 27 January 2018

Dry Tamirabani river pulls the plug on 1050 MW Tuticorin thermal plant
The Times of India, Tamil Nadu, 28 February 2017

With only 37% rain, Chandrapur and CSTPS face water crisis
The Times of India, Maharashtra, 28 August 2017

WB: Water crisis cripples power generation at NTPC's Farraka plant
Hindustan Times, West Bengal, 12 March 2016

Water crisis may shutdown power generation in Chhabra thermal plant
Patrika, Rajasthan, 25 March 2021

Water scarcity cost power firms Rs 2400 crore revenue loss
Economic Times, Maharashtra, 9 June 2016

Parli thermal power station at Beed in drought-affected Marathwada has been shut down due to lack of water
DNA India, Maharashtra, 6 October 2015

Indian coal power plants with cooling towers consume twice as much water as their global counterparts. Also, many Indian power plants with inefficient water consumption practices and older technologies tend to have much higher specific water consumption and consume significant amounts of water. This is at a time when several parts of India already face severe water crises. It is very critical, therefore, that coal power plants in India use water judiciously and reduce their water footprint.

To make this happen, it is important that these plants comply with the specific water-consumption norms that were introduced by Ministry of Environment, Forest and Climate Change (MoEF&CC) in 2015 in order to regulate irrational use of water in coal power plants. The deadline to meet these water norms was December 2017. The deadline, however, has been largely ignored.

2015 water norms for coal-based power plants

To curtail water consumption of coal-based power plants, the Ministry of Environment, Forest and Climate Change (MoEF&CC) notified water standards in December 2015. Plants installed before 2017 were required to meet a norm of 3.5 cubic metre per megawatt hour (m^3MWh) and plants installed after 1 January 2017 had to meet 2.5 m^3/MWh along with zero liquid discharge. The norms did not make any distinction between freshwater-based and seawater-based plants in the December 2015 notification.

In June 2018, however, MoEF&CC issued an amendment to its 2015 notification (see *Table 1.1: Specific water consumption norms 2015 and subsequent amendment*). In this, the water consumption limit of 2.5 m^3/MWh for new plants—installed after 1 January 2017—was revised to 3 m^3/MWh. Also, sea water-based once-through plants were exempted from conversion to cooling tower-based systems. This revision of 2.5 m^3/MWh to 3 m^3/MWh was questioned in the Supreme Court by the court's amicus. Answering the query on why the specific water consumption norms were revised, the Central Electricity Authority (CEA) said the water consumption limit of 2.5 m^3/MWh was too stringent. Initially, it was suggested that the norm should be increased to 2.7 m^3/MWh. But as the operation of flue gas desulphurization (FGD) systems requires an additional water of 0.3 m^3/MWh, the limit was reviewed and revised upward to 3 m^3/MWh for new plants, i.e. those commissioned post 2016.

Thus, the revised water norms mandate only freshwater-based plants to meet the norm of 3.5 or 3 m^3/MWh and seawater-based plants are exempted from the

Table 1.1: Specific water consumption norms 2015 and subsequent amendment
All freshwater-based plants are required to meet the norm of 3.5 or 3 m^3/MWh. Additionally, freshwater-based closed-loop plants (commissioned post 2016) have to also achieve zero liquid discharge.

	MoEFCC notification (December 2015)	Amendment in notification (June 2018)
Plants installed before 2017	Achieve specific water consumption of 3.5 m^3/MWh within two years	No change in specific water consumption limit
Plants installed after 1 January 2017	Achieve specific water consumption of 2.5 m^3/MWh within a period of two years along-with zero discharge.	Specific water consumption was revised from 2.5 m^3/MWh to 3 m^3/ MWh. No amendment in zero discharge notification
Once-through cooling (OTC) plants	• Install cooling towers • Achieve specific water consumption of 3.5 m^3/MWh or less within a period of two years	Seawater-based once-through plants were exempted from the norms. Only freshwater-based once-through have to covert to CT and follow the limit of 3.5 m^3/MWh

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

norms. All freshwater-based once-through cooling plants are additionally required to install cooling towers and subsequently achieve the norm of 3.5 m^3/MWh. Apart from this, the 2015 notification also mandates new plants (commissioned post 2016) to additionally achieve zero liquid discharge along with meeting the norm of 3 m^3/MWh.

Deadline ignored

Specific water consumption norms for power plants came in 2015. All plants were required to meet the norms within two years of the notification, i.e. by December 2017. The norms were, however, largely ignored. As the deadline to meet the norms ended on 7 December 2017, the Central Pollution Control Board (CPCB) wrote to all power plants stating, among other things, 'the new timeline for compliance of water consumption limit shall be finalized in consultation with the plants'. Since then, no individual timelines have come up for the plants to follow.

It was only in January 2019 that the CPCB asked thermal power plants to submit their specific water consumption data on a quarterly basis, starting from October–December 2018. Based on the data obtained, plants that were not meeting the specific water consumption limit were asked to submit time-targeted action plans

Cooling-tower (CT) plants versus once-through-cooling (OTC) plants

Power plants are water guzzlers—input water is used mainly for cooling requirements of the plant. Roughly, 80 per cent of the water demand of a coal-based plant is from its cooling tower, 18 per cent from its ash handling, and 2 per cent from process and for drinking. This percentage, however, varies widely from plant to plant, depending on its water management practices and type of technology used.

Once-through-cooling (OTC) plants withdraw great amounts of water but consume relatively little water, as most of the water after circulating once is returned to the source without any closed loop circulation within plant (with around 1 per cent lost in evaporation), but at higher temperatures than at the draw.

In India, the water withdrawal rate of once-through plants is in the range of 70–200 m^3/MWh.[5] A 500 MW plant can withdraw around 500 million cubic metres of water per year. These plants are more exposed to fluctuations in water availability due to their high water withdrawal needs. This type of system is commonly found in coastal plants using seawater or older inland plants in India using freshwater. Coastal plants use seawater mainly for cooling and still require some freshwater for boiler makeup, domestic and other process requirements. Inland plants, however, use freshwater entirely, even for cooling. From 1999, freshwater-based once-through cooling (OTC) plants have been disallowed in India, but there is still a legacy of old and extremely polluting inland plants in India that use once-through cooling.

Cooling-tower (CT)-based plants has much less water withdrawal as the input water is circulated in a loop inside plant after passing and cooling it through cooling towers. Due to repeat circulation and the cooling cycle, water withdrawal is considerably reduced.

Water loss in a cooling tower-based plants is mainly due to evaporation and blow-down losses from cooling towers. Such plants mainly withdraw water only to replace water that is lost through evaporation and blow-down in the cooling tower. These systems, therefore, have much lower water withdrawals than once-through systems but tend to have appreciably higher water consumption. Plants that use freshwater and have cooling towers withdraw, on an average, 4 m^3/MWh in India. This is predominant cooling system used globally in power plants. Globally, a 500 MW supercritical cooling tower-based plant withdraws on an average 2.52 m^3/MWhr[6] or 10 million m^3 per year.[7]

for achieving the limit. No further action has, however, been taken by CPCB since then and no firm action has been taken on non-complying plants.

The 2015 water norms for power plants were introduced along with the emission norms. While the deadline for emission norms was extended in 2017 and again in 2021, there has never been any discussion on power plants getting longer deadlines for meeting the water norms along with zero liquid discharge (ZLD).

In such a scenario, many plants continue to flout the norms. CSE's current research shows that even after six years since the norms were notified, a large proportion of the coal-power capacity is still non-complying with water norms and continues to withdraw enormous amounts of water beyond the permissible limit set by the Ministry of Environment, Forest and Climate Change (MoEFCC).

Thus, water compliance is completely neglected, that too in the times when many power producing regions face acute water shortages and the brunt of water pollution due to power plants' effluent discharge. If implemented rigorously, the standards can drastically reduce overall water consumption of the sector and will make Indian plants water efficient.

This report details the current compliance and non-compliance of the coal power sector with respect to the implementation of water norms. Also, it critically analyses the authenticity of the specific water consumption data that is self-reported by power plants to regulatory authorities. The report also attempts to discuss the various zero discharge schemes and technologies and their applications in coal-based plants along with the way forward for the sector to achieve compliance with the 2015 water norms.

2. Water compliance status of Indian power plants

With regard to emission norms, the Central Electricity Authority (CEA) monitors quarterly the implementation of critical emission control technologies and updates the data in the public domain. With regard to specific water consumption and compliance, however, there is no information available in public domain, no transparency is maintained related to water consumption data and compliance status of each plant with respect to meeting the 2015 water consumption norms. In response to the RTI filed by CSE in 2020 to CPCB regarding status of water compliance of power plants, CPCB said that they do not keep a record of water compliance of plants and data is available only with the State Pollution Control Boards. Also, there is complete non-transparency with regard to putting the status of water compliance of plants in the public domain.

In order to ascertain the nation-wide compliance status, Centre for Science and Environment (CSE) therefore collected data on specific water consumption from a variety of sources—field surveys conducted by CSE in a few states, filled-in questionnaires received from few power plants, filing RTIs to various state Pollution Control Boards, annual environment statements of power plants and information available in the public domain. The collected water consumption data of various states was compiled and analysed to understand:

1. The overall compliance status with respect to the specific water consumption norms of 3.5 and 3 m^3/MWh;
2. Status of conversion of freshwater-based once-through plants to closed-loop cooling tower based system; and
3. Status of post-2016 plants in meeting the mandatory zero liquid discharge (ZLD) norm.

Compliance status

To understand the nation-wide compliance status, CSE compiled specific water consumption data of the last three years (2017–18, 2018–19 and 2019–20) as reported by individual coal-based power plants to the Pollution Control Boards. Most of the plants reported data obtained from CSE's state surveys and RTIs filed to state Pollution Control Boards to obtain annual environment statements of plants for last three years.

Table 2.1: Categorization of plants based on compliance to 2015 water norms

S. no.	Category	Details
1.	Complying	Comprised plants that were meeting the 2015 norm of 3.5/3 m^3 per MWh
2.	Non-complying	Comprised freshwater-based plants where freshwater consumption exceeded the 2015 norm of 3/3.5 m^3 per MWh. This category was further classified on the basis of presence and absence of cooling tower.
	a) Non-complying (cooling-tower based)	Comprised non-complying cooling-tower (CT)-based closed-loop plants that were withdrawing freshwater for cooling and other purposes and exceeding the norm of 3/3.5 m^3 per MWh
	b) Non-complying (once-through-cooling-based)	Comprised freshwater based once-through (OTC) plants that had still not converted to closed loop plants by installing cooling towers and, therefore, were non-complying. These plants need to convert to closed loop and follow the norm of 3/3.5 m^3 per MWh
3.	Exempted (seawater-based)	Comprised plants in coastal areas that withdraw seawater for cooling and other purposes and are, therefore, exempt from meeting 2015 specific water consumption norms.

Source: Centre for Science and Environment, 2021

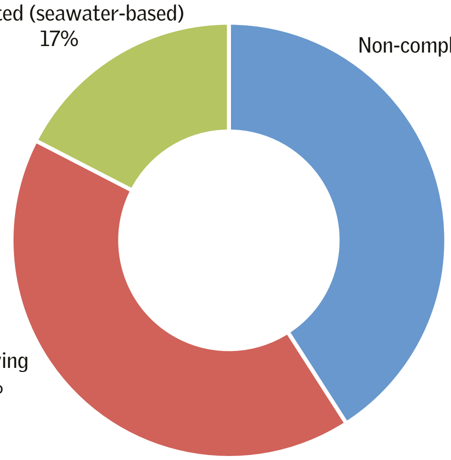
The entire analysis was done on the basis of water consumption data that plants self-reported in their annual environment statements. Of the total 205 GW of coal-based power capacity, data could be obtained for about 75 per cent (154 GW) of coal-based power capacity comprising over 132 power plants. To ascertain the overall compliance and non-compliance based on 2015 specific water consumption norms, power plants were classified into the three main categories—complying, non-complying and exempted (seawater based). Non-complying plants were further categorized into cooling-tower based and once-through plants (see *Table 2.1: Categorization of plants based on compliance to 2015 water norms*).

Specific water consumption (SWC) data obtained for last three years was averaged for the purpose of analysis. In case data was not available for all three years, the SWC value for the year it was available was considered.

Of the 132 power plants (154 GW capacity) for which data was available, 42 per cent plants were complying, 41 per cent were found to be non-complying and 17 per cent were seawater- based plants that were exempted from meeting the norms (see *Graph 2.1: High non-compliance observed even with lax norms*). Excluding seawater-based plants from the surveyed capacity, almost 50 per cent of the plants did not comply with the norms.

Graph 2.1: High non-compliance observed even with lax norms

Excluding seawater-based plants, about 50 per cent plants were complying and 50 per cent were non-complying in the surveyed capacity.



CT—Cooling tower; OTC—Once-through cooling

Source: Centre for Science and Environment, 2021

Of the 64 GW of complying capacity, a major percentage (about 53 per cent) included privately owned plants. Of the 59 GW of non-complying capacity, a major percentage (about 65 per cent) comprised state-owned plants (see *Graph 2.2: Compliance status—Ownership-wise [154 GW]*). Of the total non-complying plants, about 67 per cent (36 plants) were cooling-tower-based and the remaining 33 per cent (18 plants) were once-through cooling plants (see *Table 2.2: Overall compliance and non-compliance*). Of the 36 non-complying cooling towers based plants, about 20 plants had a high specific water consumption of more than 4 m^3/MWh (see *Table 2.4: Non-complying cooling-tower-based plants with high SWC >= 4 m^3/MWh).*

As per CSE analysis, most of the complying plants in surveyed states belonged to privately owned companies. A few complying plants with lowest specific water consumption included Nabha Power Limited (SWC—1.79), Sasan Power Limited (SWC—1.9), KSK Nariyara (SWC—2.05), Surat Lignite (SWC—2.07), MB Power limited/Anuppur TPS (SWC—2.2), Jaypee Bina Limited (2.2), GMR Warora (SWC 2.3), Adani Korba West (SWC—2.35) and Budge Budge TPS (SWC—2.23). All these plants belong to privately owned companies. Private companies are doing fairly well in terms of compliance. The plants were considered complying on the basis of self-reported data submitted by them to pollution control authorities.

Table 2.2: Overall compliance and non-compliance

Of the 154 GW surveyed capacity (comprising 132 plants), 59 GW capacity comprising 54 plants was non-complying

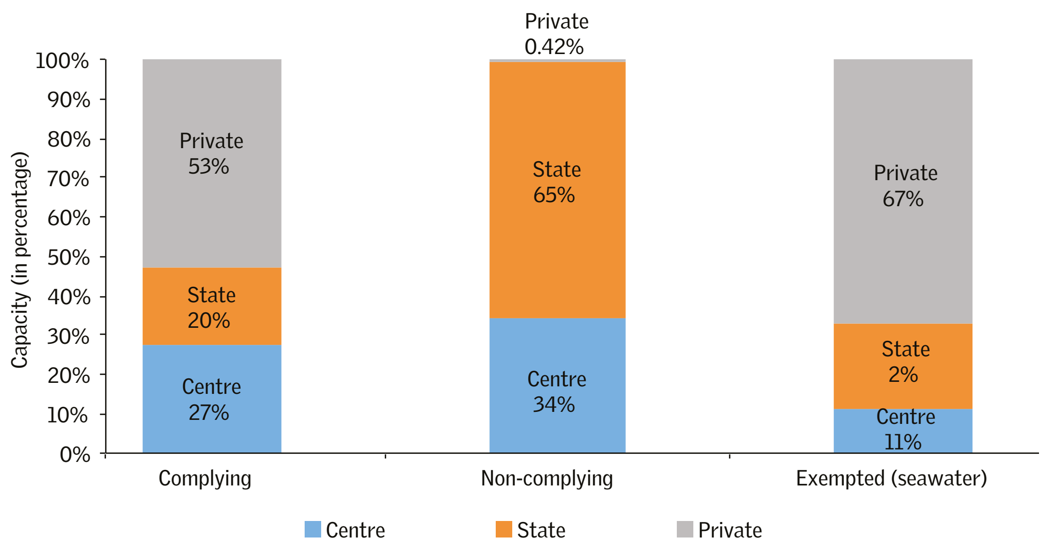
S. no.	Category	Capacity (in GW)	No. of plants
1.	Complying	64 GW	55
2.	Non-complying	59 GW	54
	Non-complying (CT* based)	42 GW	36
	Non-complying (OTC** based)	17 GW	18
3.	Exempted (seawater based)	31 GW	23

*CT—Cooling tower; **OTC—Once-through cooling

Source: Centre for Science and Environment, 2021

Graph 2.2: Compliance status—Ownership-wise (154 GW)

Private plants led in compliance while state-owned plants lagged behind



Source: Centre for Science and Environment, 2021

In the non-complying category, a major capacity included state-owned plants belonging to—Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited (UPRVUNL), Maharashtra State Power Generation Company (Mahagenco), Rajasthan Rajya Vidyut Utpadan Nigam Limited (RRVUNL), Gujarat State Electricity Corporation Limited (GSECL), Chhattisgarh State Power Generation Company Limited (CSPGCL), Andhra Pradesh Power Generation Company (APGenco), Telangana State Power Generation Company Limited (TSGenco) and Gujarat State Electricity Corporation Limited (GSECL). Uttar Pradesh and Maharashtra possessed maximum number of non-complying plants (see *Table 2.3: State-wise list of non-complying power plants in surveyed capacity)*. While huge non-compliance in Uttar Pradesh can be attributed to the age of plants, it is also observed that many of the older plants—including Obra, Parichha, Anpara, Rihand and Singrauli—

are freshwater-based once-through plants. Non-complying plants in Maharashtra also possess older units commissioned before 1997, including Mahagenco's Koradi, Nashik and Chandrapur TPS.

Table 2.3: State-wise list of non-complying power plants in surveyed capacity

Most of the plants flouting water norms belong to state-owned companies

State	Non-complying plants and its owner companies	Total surveyed and non-complying capacity
Uttar Pradesh	UPRVUNL—Obra TPS, Parichha TPS, Haduaganj TPS, Anpara TPS, NTPC—Singrauli STPS, Unchahar TPS NTPC Rihand (Units 1 and 2);	Total surveyed: 11.37 GW Non-complying: 9.4 GW
Maharashtra	Mahagenco—Koradi TPS, Nashik TPS, Paras TPS, Chandrapur TPS NTPC—Solapur TPS	Total surveyed: 22.59 GW Non-complying: 9.6 GW
Madhya Pradesh	MPPGCL—Shree Singaji TPS, Sanjay Gandhi TPS, Satpura TPS (Units 6–9) NTPC—Khargone TPS	Total surveyed: 19.93 GW Non-complying: 6.01 GW
Rajasthan	RRVUNL—Suratgarh TPS, Kota TPS, Chhabra TPS	Total surveyed: 8.91 GW Non-complying: 4.1 GW
Chhattisgarh	CSPGCL—Dr Shyama Prasad Mukherjee TPS, Hadeo Korba West TPS (Units 1–4); Korba III (Units 5 and 6) TPS, Korba East TPS	Total surveyed: 21.12 GW Non-complying: 2 GW
Karnataka	KPCL—Yermarus TPS (Unit 2), Raichur TPS NTPC—Kudgi STPP	Total surveyed: 7.78 GW Non-complying: 5.72 GW
Tamil Nadu	TANGEDCO—Mettur TPS (Units 1–4); TAQA Neyveli; NLC India—Neyveli TPS I, Neyveli TPS II	Total surveyed: 12.16 GW Non-complying: 3.06 GW
West Bengal	WBPDCL—Sagardighi TPS, Bandel TPS NTPC—Farakka TPS CESC Limited—Southern REPL TPS	Total surveyed: 7.38 GW Non-complying: 4.3 GW
Odisha	NTPC—Talcher TPS	Total surveyed: 3 GW Non-complying: 3 GW
Gujarat	GSECL—Gandhinagar TPS; Wanakbori TPS, Ukai TPS (Units 1–3), Kutch Lignite TPS	Total surveyed: 14.82 GW Non-complying: 3.1 GW
Andhra Pradesh	APGENCO—Dr Narla Tata Rao TPS; Rayalaseema TPS	Total surveyed: 11.44 GW Non-complying: 3.41 GW
Telangana	TSGENCO—Kothagudem TPS, Ramagundem B TPS	Total surveyed: 3.68 GW Non-complying: 2.6 GW
Jharkhand	DVC—Bokaro 'A' TPS , Bokaro 'B' TPS; TVNL—Tenughat TPS	Total surveyed: 3.36 GW Non-complying: 1.13 GW
Bihar	NTPC—Kahalgaon TPS	Total surveyed: 4.27 GW Non-complying: 2.34 GW
Punjab	PSPCL—Guru Hargobind	Total surveyed: 2.32 GW Non-complying: 0.92 GW

Note: Non-compliance is ascertained on the basis of reported specific water consumption

Source: Centre for Science and Environment, 2021

Surprisingly, over 90 per cent of the surveyed 21 GW capacity in Chhattisgarh was found to be complying which could be because a major capacity in Chhattisgarh is relatively young. It was observed that NTPC Korba and NTPC Sail II which were commissioned 35 years ago are also complying with the norms. NTPC Korba plant, in its 2019–20 annual environment statement, has reported its specific water consumption as 0.0005009729 m^3/kWh which is found to be hugely under-reported data. This puts a big question on the self-reported data which is submitted by plants to Pollution Control Boards.

Table 2.4: Non-complying cooling tower based plants with high SWC >= 4 m^3/MWh

About 20 out of 36 identified non-complying cooling-tower-based plants in the surveyed capacity had high SWC greater than 4 m^3/MWh

Plant	Owner	State	Capacity (MW)	SWC limit (m^3/MWh)	Average SWC (m^3/MWh)
Rayalaseema TPS (Units 1–6)	APGENCO	Andhra Pradesh	1,650	3.5 (Units 1–4); 3 (Units 5–6)	4.09
Dr Narla Tata Rao TPS (Unit 7)	APGENCO	Andhra Pradesh	500	3.5	4.105
Gandhinagar TPS (Units 1–5)	GSECL	Gujarat	870	3.5	4.25
Bokaro 'B' TPS	DVC	Jharkhand	210	3.5	7.8
Kudgi STPP	NTPC	Karnataka	2,400	3.5 (Unit 1); 3 (Units 2–3)	4.36
Raichur TPS	KPCL	Karnataka	1,720	3.5	4.92
Khargone STPP	NTPC	Madhya Pradesh	1,320	3	4.5
Shree Singaji TPS (Units 3–4)	MPPGCL	Madhya Pradesh	1,320	3	4.7
Nashik TPS	Mahagenco	Maharashtra	630	3.5	4.09
Koradi TPS	Mahagenco	Maharashtra	2,400	3.5 (Units 1–4); 3 (Unit 5)	4
Paras TPS	Mahagenco	Maharashtra	500	3.5	5.24
Chhabra TPS (Units 5–6)	RRVUNL	Rajasthan	1,320	3	4
Suratgarh TPS (Unit 1–6)	RRVUNL	Rajasthan	1,500	3.5	4.15
Kota TPS (Units 6–7)	RRVUNL	Rajasthan	390	3.5	>5
Neyveli TPS-II	NLC India	Tamil Nadu	1,470	3.5	4.39
Neyveli TPS-II (Ext)	NLC India	Tamil Nadu	500	3.5	5.25
Mettur TPS (Units 1–4)	TANGED-CO	Tamil Nadu	840	3.5	5.9
Ramagundem-B TPS	TSGENCO	Telangana	62.5	3.5	4.04
Harduaganj TPS	UPRVUNL	Uttar Pradesh	500	3.5	4.26
Unchahar TPS	NTPC	Uttar Pradesh	1,550	3.5 (Units 1–5); 3 (Unit 6)	5.25
Sagardighi TPS	WBPDCL	West Bengal	1,600	3.5	4.58

Source: Centre for Science and Environment, 2021

Surprisingly, a few younger plants commissioned after 2005 were found to be non-complying in the surveyed capacity. These included Yermarus TPS and NTPC Kudgi in Karnataka, Bokaro 'A' TPS in Jharkhand, Dr Shyama Prasad TPS and NTPC Solapur in Maharashtra, NTPC Khargone in Madhya Pradesh and Sagardighi TPS in West Bengal

Status of conversion of once-through cooling plants to closed-loop plants

As per the 2015 MoEFCC notification, all freshwater-based once-through plants were required to install cooling tower and achieve the limit of 3.5 m^3 per MWh by 2017. In June–July 2019, however, the CPCB issued directions to these freshwater-based once-through plants (about 17 GW capacity) to install cooling towers and comply with the standards by 30 June 2022 (see *Table 2.5: List of once-through plants in India*). The plants were also directed to submit six-monthly progress reports on actions taken on compliance.

However, the status of conversion of these plants is still not known as it is not disclosed. The only information that is in the public domain is based on an affidavit filed by the Ministry of Power after the 2015 norms were notified seeking exemption for older generation power plants from making this change in technology—from OTC to cooling towers—arguing scarcity of land and lack of finances.

As per CSE analysis and survey, majority of them have still not installed cooling towers and continue to flout the norms.

Old once-through-cooling (OTC) plants—to decommission or retrofit?
All once-through-based power plants in India are old and polluting plants, built before 1999. They withdraw enormous amounts of water and are also lagging in meeting emission norms. Many of these plants were identified for retirement but have not yet retired. They continue to operate, with no plan to upgrade or install either emission control equipment or cooling towers. These plants include Bandel TPS, Chandrapura TPS, Dr Narla Tata Rao TPS, Korba III (Korba East), Mettur TPS, Neyveli TPS and Obra TPS.

Installing a cooling tower takes two to three years and requires an investment of Rs 20–25 lakh per megawatt. Payback is possible only when the plant has another 10–15 years of operating age. The choice is, therefore, to completely retrofit the plants identified for retirement or retire them. Allowing these older plants to continue to pollute cannot be an option. Plants identified for retirement must be closed down immediately if they have no plans to retrofit or to install emission

Table 2.5: List of once-through coal-based plants in India

All the freshwater-based once-through plants are old. Only a small capacity of these plants has decommissioned; a major capacity continues to operate with no plan to install cooling towers

Plant	District	State	Capacity	No. of units	Year of commis-sioning
Dr Narla Tata Rao TPS	Vijayawada	Andhra Pradesh	1260	6 x 210	1979–94
Korba-III (Korba-East) TPS Units 5 and 6	Korba	Chhattisgarh	240	2 x 120	1966–67
Hadeo Korba-West TPS (CSPGCL) Units 1–4	Korba	Chhattisgarh	840	4 x 210	1983–86
Ukai TPS (GSECL) Units 1–3	Tapi	Gujarat	610	2 x 200, 1 x 210	1979–85
Tenughat TPP (TVNL)	Tenughat	Jharkhand	420	2 x 210	1994–96
Sanjay Gandhi TPS (MPPGCL) Unit 1–5	Umaria	Madhya Pradesh	1,340	210 x 4, 500	1993–2008
Satpura TPS (MPPGCL) Units 6–9	Betul	Madhya Pradesh	830	200, 210 x 3	1979–84
Guru Hargobind TPS	Roopnagar	Punjab	920	2 x 210, 2 x 250	1997–2010
Kota TPS (RRVUNL) Units 1–5	Kota	Rajasthan	850	2 x 110, 3 x 210	1983–94
Kothagudem TPS (TSGENCO) Stage I–IV	Khammam	Telangana	720	4 x 60, 4 x 120	1966–77
Anpara TPS (UPRVUNL)	Sonbhadra	Uttar Pradesh	1,630	3 x 210, 2 x 500	1987–94
Rihand TPS (NTPC) Units 1 and 2	Sonbhadra	Uttar Pradesh	1,000	2 x 500	1988–89
Obra TPS (UPRVUNL)	Sonbhadra	Uttar Pradesh	1,550	5 x 50, 3 x 100, 5 x 200	1967–82
Paricha TPS (UPRVUNL) Units 1 and 2	Jhansi	Uttar Pradesh	220	2 x 110	1984, 1985
Singrauli STPS (NTPC)	Sonbhadra	Uttar Pradesh	2,000	5 x 200, 2 x 500	1982–87
Bandel TPS (WBPDCL)	Hooghly	West Bengal	450	4 x 60, 1 x 210	1965–82
Farakka STPP (NTPC)	Murshi-dabad	West Bengal	2100	3 x 200, 3 x 500	1986–87
Southern REPL TPS (CESC)	Kolkata	West Bengal	136	2 x 68	1990–91

Source: Centre for Science and Environment, 2021

control technologies and/or cooling towers. Else, they will continue to withdraw enormous amounts of freshwater in regions that are already reeling from acute water shortages. Clearly, water stress will only grow if these plants continue to operate. In addition, these older plants are extremely inefficient, and so their cost of operation is already high. When the cost of emission control or water conservation is added, these plants will become unviable to operate.

Compliance to zero liquid discharge (ZLD) norm

For plants commissioned after 1 January 2017, the limit for specific water consumption was fixed at 3 m^3/MWh. These plants are also required also to achieve zero liquid discharge. A power plant can claim to be a zero discharge plant if it is able to completely recycle its generated wastewater streams (such as cooling tower blow-down, ash pond water, flue gas desulphurization (FGD) wastewater and other unused wastewater streams) and no drop of water is discharged outside the plant boundary.

About 22 gigawatt (GW) of coal power capacity comprising of 42 units has been commissioned post 2016. Of this, about 21 GW capacity is freshwater-based and required to meet the norm of 3 m^3/MWh along with zero liquid discharge (see *Table 2.6: State-wise list of freshwater based plants commissioned post 2016*). It includes more than 30 plants (comprising 40 newer units). Most of the newer units have come up in Maharashtra, Chhattisgarh and Madhya Pradesh. Also, a significant number of these units belong to NTPC.

With regard to the zero liquid discharge (ZLD) norm, there is no information on whether these newer plants follow the zero liquid discharge condition laid down in the 2015 water norms. Even Pollution Control Boards are not keeping a track on the ZLD implementation norm as no on-ground monitoring and inspection is carried out to check compliance with respect to zero discharge. There could be a possibility that none of the newer plants are abiding by the zero discharge notification. These plants must furbish their ZLD status in their environment statements along with various steps taken to achieve ZLD. Additionally, Pollution Control Boards must keep a track of the ZLD compliance status of new plants by periodic monitoring and ask plants to submit action plans to achieve ZLD.

Table 2.6: State-wise list of freshwater-based coal-power plants commissioned post 2016

About 21 GW identified capacity commissioned post 2016 had to achieve the ZLD norm along with specific water consumption of 3 m^3/MWh immediately post operation. Many of these new units belong to NTPC.

Plant	Unit	Capacity (MW)	Year of commission-ing	Owner
Andhra Pradesh				
Rayalaseema TPS	6	600	2018	APGENCO
Assam				
Bongaigaon TPP	2 and 3	250 x 2	2017 and 2019	NTPC
Bihar				
Muzaffarpur TPS	4	195	2017	KBUNL
Nabi Nagar TPP	1	660	2019	NTPC
NTPC Barauni	8 and 9	250 x 2	2018	NTPC
Chhattisgarh				
Binjkote TPP	1 and 2	300 x 2	2017 and 2018	SKS Power
Nariyara TPP (Akaltara)	3	600	2018	KSK Energy
NTPC Lara	1	800	2018	NTPC
Raigarh TPS	2	300	2017	TRN Energy
Ucchpinda TPP	4	360	2019	RKM Power
Gujarat				
Wanakbori TPS	8	800	2019	GSECL
Karnataka				
Kudgi STPP (NTPC)	2 and 3	800 x 2	2017 and 2018	NTPC
Yermarus TPS	2	800	2017	KPCL
Madhya Pradesh				
Gadarwara TPP	1	800	2019	NTPC
Mahan TPP (Essar)	2	600	2018	Essar Power
Shree Singhaji	3 and 4	660 x 2	2018 and 2019	MPPGCL
Niwari TPP	2	45	2019	BLA Power
NTPC Khargone	1 and 2	660 x 2	2019 and 2020	NTPC
Maharashtra				
Koradi TPS	10	660	2017	Mahagenco
Mauda STPP	4	660	2017	NTPC
Shirpur Power	1	150	2017	Shirpur Power
NTPC Solapur	1 and 2	660 x 2	2017 and 2019	NTPC
Odisha				
Ib Thermal Power Station	3 and 4	660 x 2	2019	OPGCL
Rajasthan				
Chhabra TPP	5 and 6	660 x 2	2017 and 2019	RRVUNL

Plant	Unit	Capacity (MW)	Year of commission-ing	Owner
Telangana				
Kothagudem TPS	12	800	2018	TSGENCO
Uttar Pardesh				
Bara TPP (Prayagraj)	3	660	2017	Tata Power
Meja TPS	1	660	2019	NTPC
NTPC Unchahar	6	500	2017	NTPC
NTPC Tanda	5	660	2019	NTPC
West Bengal				
Hiranmaye (India Power)	1 and 2	150 x 2	2017	Hiranmaye Energy
TOTAL	40 units	21 GW		

Source: Centre for Science and Environment, 2021

Flaws identified in self-reported data and reporting format

Due to the absence of any information on water consumption data in the public domain, CSE collected data from a variety of sources, including field surveys conducted by CSE in a few states, filled-in questionnaires received from power plants during surveys and filing RTIs to various state Pollution Control Boards to get annual environment statements. Most of the water data was compiled from annual environment statements which every power plant submits to its respective state Pollution Control Board.

After analysing environment statements of various plants in different states, CSE noted various flaws in reporting as discussed below:

1) **No uniform format is followed by power plants across states nor even within a state for submitting data for water consumption**

   Any environment statement pertaining to a power plant with adequate data on water consumption will have a per day or annual breakup of freshwater consumed in three or four main sections within the plant—process, cooling, domestic and ash handling. Sometimes, freshwater water consumed in the de-mineralized (DM) plant makeup, coal-handling plant, ash handling and other services is all covered in 'process' water consumption only. The environment statement must also separately mention plant's specific water consumption per unit of product which in the case of a power plant is represented in terms of cubic metre per megawatt hour (m^3/MWh) or litre per kilowatt hour (litre/kWh). Also, a plant's specific water consumption value should reflect the entire freshwater water consumed by plant in all sections, i.e. process, cooling, domestic, ash handling and others. In other words, the specific water consumption value should consider the total inlet freshwater entering the plant.

While analysing many environment statements, however, the following observations were made:

- It is observed that many plants skip providing data especially on specific water consumption and are only providing water consumption break-up which is of no relevance when it comes to identifying plant's compliance and non-compliance and its efficiency in terms of water consumption unless plant also gives its annual electricity production data. Plant-specific water consumption is an important indicator that every power plant must report in its environment statement along with other data.

- Many plants were not giving their water consumption in process, domestic or ash handling section or were leaving the column blank, making it difficult to understand the actual water consumption in different sections of the plant.

Thus, a uniform format must be followed across all states for reporting water consumption data of power plants in order to ascertain compliance and non-compliance (see *Box: Format to report water consumption data in environment statement*).

2) **Many plants continue to under-report or report their specific water consumption incorrectly to authorities**

Specific water consumption (SWC) value should reflect the entire water being consumed by plant in all its sections, i.e. process, cooling, domestic, ash handling, etc. It is seen that many plants instead of reporting plant specific water consumption are either reporting their demineralized (DM) plant water consumption or process water consumption per unit of product in the specific water consumption section of environment statement. In such cases, the specific water consumption is much less as it accounts for only water consumption in one section of the plant and can be misrepresented as the overall plant's specific water consumption, leading to underreporting. Therefore, instead of process or DM water consumption per unit of product, a plant's specific water consumption should be reported taking into account entire freshwater consumption.

Also, several plants continue to report incorrect specific water consumption data in environment statement which makes no sense (see *Table 2.7: Missing, incorrect or under-reported water consumption data by plants).*

Table 2.7: Missing, incorrect or under-reported water consumption data by plants

Plant	Data reported in environment statement	Remarks
NTPC Korba (2,600 MW)	• Process water consumption per unit of product in FY 2018–19—**0.0002428453 m^3/KWh** • Process water consumption per unit of product in FY 2019–20—**0.0005009729 m^3/KWh**	Incorrect SWC value
Jindal STPP Raigarh (1,000 MW)	• Process water (DM water make-up) per product for FY 2017–18—**50 ml/kWh** • Process water (DM water make-up) per product for FY 2017–18—**50 ml/kWh**	Plant SWC not reported instead DM water SWC is mentioned
Jhabua Power Ltd (600 MW), Dist. Seoni	• Process water consumption per unit of product in FY 2018–19—**0.035 m^3/KWh** • Process water consumption per unit of product in FY 2019–20—**0.019 m^3/KWh**	Incorrect SWC value
NTPC Kudgi	• Process water consumption per unit of product in FY 2017–18—**1.03 litre/KWh**	Underreported SWC value; CSE estimated value—4.36 litre/kWh
Amarkantak power station (210 MW), MPPGCL, Dist. Anuppur	• DM water consumption per unit electricity in FY 2019–20—**0.023 litres/KWh**	Plant SWC not reported instead DM water SWC is mentioned
Shree Singaji TPP, (1320 MW), MPPGCL	• DM water consumption per unit electricity in FY 2018–19—**0.0889 litres/KWh**	Plant SWC not reported
Tata Jojobera (Units 1–5), Jamshedpur	• Process water consumption per unit of product in FY 2017–18—**0.3419 m^3/MWh**	Incorrect SWC value
NTPC Vindhyachal STPP (4760 MW), Dist: Singrauli	• Process water consumption per unit of product in FY 2018–19—**0.731 litre/KWh**	Incorrect value; Plant SWC not reported
Sanjay Gandhi TPS III, (500 MW), MPPGCL, Dist. Umaria	• Process water consumption per unit of product in 2018–19—**0.6870 litre/KWh**	Incorrect SWC value; plant SWC not reported
DB Power Limited (1,200 MW), Dist: Janjgir–Champa	• Water consumption in FY 2018–19—42,303 m^3/day for process, cooling and domestic	No water consumption break-up provided by plant

The SWC figures are self-reported by plants to Pollution Control Boards. These, or the status, have not been verified either by the state Pollution Control Boards or any other independent agencies. In such a scenario, plants might continue to under-report and operate with specific water consumption higher than the limit, leading to excessive water wastages by the sector. There is an urgent need for a uniform reporting format to be followed across all states, robust monitoring and implementation plan for these plants.

Format to report water consumption data in environment statement

There must be a uniform format followed by all power plants across all states while reporting water data in environment statement. A common format must be shared with all plants. Central and state Pollution Control Boards must ensure that the correct format is being adhered to by all plants while reporting their water consumption data.

Format to report water consumption data in environment statement:

i) Source of water:

ii) Annual electricity produced (million units or million KWh):

iii) Freshwater consumption breakup (m^3/day or m^3/annum)

Section	**During previous financial year (FY________)**	**During current financial year (FY________)**
	m^3/day or m^3/annum	**m^3/day or m^3/annum**
Process		
Cooling		
Domestic		
Ash handling		
Other		
Total freshwater		

iv) Plant specific water consumption

Name of product	**Plant water consumption per unit of product output**	
	During previous financial year (FY________)	**During current financial year (FY________)**
	m^3/MWh or litre/KWh*	**m^3/MWh or litre/KWh***
Electricity		

*Please specify correct unit along with SWC value

v) Is ZLD mandatory for the plant (Yes/No)?

vi) Is the plant following ZLD (Yes/No)?

3. State-wise profile and water compliance of surveyed states

Based on specific water consumption data collected from various sources, CSE prepared profiles of some states for which water consumption data was available for a major capacity. These profiles indicate state-wise compliance and non-compliance of power plants with respect to the 2015 water norms. They also highlight water scarcity and pollution issues faced by regions where these power plants are located.

RAJASTHAN

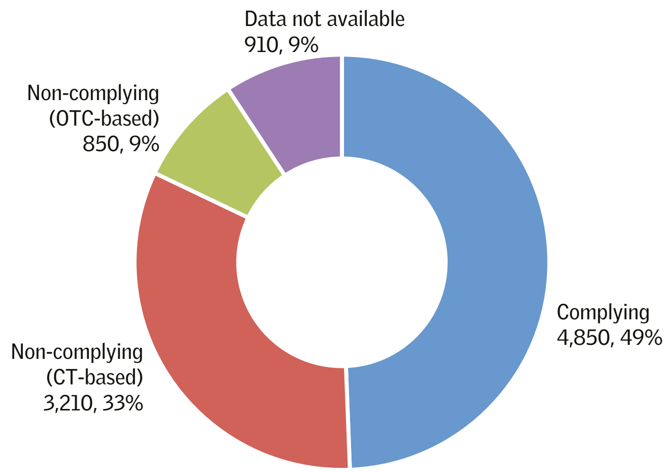
As on 31 July 2020, Rajasthan had a total installed coal-based power capacity of 9.8 GW. Rajasthan has a young fleet of thermal power plants, with 21 units comprising 6.57 GW (67 per cent of total) capacity less than 10 years old. Rajasthan Rajya Vidyut Utpadan Nigam Limited (RRVUNL) is the largest power-generating company in Rajasthan, with a combined capacity of 7.17 GW (73 per cent of the total). The private sector companies have the second largest share with a total installed capacity of 2.4 GW (24 per cent of the total). Adani Kawai (1.32 GW) and JSW Energy (Barmer) Limited (1.08 GW) are the two private players in the state. Neyveli Lignite Limited (NLC India Limited), owned by the Central government, contributes 0.25 GW (3 per cent of the total).

Rajasthan is a water-scarce state, with most districts highly water-stressed. This also includes the regions where thermal power plants are located. Several villages in Barmer and Baran district where power plants are located have been hit by water crisis. For example, JSW Barmer Power Station is located in Bhadresh village, where the baseline water scarcity is more than 80 per cent.

Average SWCs as per the monthly reports (Jan–June 2020) for Suratgarh, Kota and Chhabra (Units 5 and 6) Thermal Power Plants were found to be 4.14 m^3/MWh, 12.92 m^3/MWh, and 4.01 m^3/MWh respectively. These values are much higher than the prescribed water consumption standard of 3/3.5 m^3/MWh. These plants represent 42 per cent of the total capacity and all of them are state-owned. 4.85 GW representing 49 per cent of the capacity is compliant with the stipulated norms. The rest of the capacity has either been shut down or no information is available for it.

Graph 3.1: Status of water compliance in Rajasthan (capacity in MW)

About 42 per cent of surveyed capacity is non-complying



Source: CSE, 2021

Table 3.1: Plant-wise specific water consumption—compliance status

Most of the non-complying plants belong to RRVUNL

Plant	Region	Capacity (in MW)	Water source	OTC/CT based	SWC limit (m^3/MWh)	Reported average SWC (m^3/MWh)	Compliance status
Adani Kawai TPS	Baran	1,320	Freshwater	CT	3.5	2.88	Complying
JSW Jalipa Kapurdi TPS	Barmer	1,080	Freshwater	CT	3.5	2.67	Complying
RRVUNL Chhabra TPS	Baran	1000 (Units 1–4)	Freshwater	CT	3.5	2.27	Complying (Units 1-4)
	Baran	1,320 (Units 5 and 6)	Freshwater	CT	3.5	4.0	Non-complying (Units 5 and 6)
RRVUNL Kalisindh TPS	Jhalawar	1,200	Freshwater	CT	3.5	3.49	Complying
RRVUNL Kota TPS	Kota	1,240	Freshwater	OTC (Units 1–5); CT (Units 6 and 7)	3.5	12.92 (for once-through)	Non-complying Units 1–5 (OTC based)
RRVUNL Suratgarh TPS	Ganganagar	1,500	Freshwater	CT	3.5	4.14	Non-complying (CT based)
NLC Barsingsar Lignite	Bikaner	250	Freshwater	CT	3.5	2.68	Complying

Note: CT—Cooling tower; OTC—Once-through cooling

Source: CSE, 2021

RRVUNL Kota Units 1–5 comprising of 850 MW capacity is a freshwater based once through cooling tower plant with very high SWC. It has been asked by CPCB to install a cooling water system to comply with the specific water consumption standards latest by 30 June 2022. Actual status is not clear as these units are more than 30 years old and are scheduled to retire as per National Electricity Plan (NEP), 2018.

As per RSPCB inspection reports on power plants, water metering is found to be poor in most of the units. Issues related to Continuous Effluent Quality Monitoring Systems (CEQMS) and data connectivity with SPCB/CPCB were also observed. As per inspection reports, major non-compliance issues were observed with RRVUNL Chhabra and RRVUNL Kota.

MAHARASHTRA

Maharashtra has the largest installed thermal power capacity (25.8 GW) among all states. Our survey covered 63 units in 18 power plants with a combined capacity of 22.6 GW. Maharashtra State Power Generation Company Limited (Mahagenco) is the largest power-generating company in the state with a capacity of 10.2 GW (39 per cent of total). The private sector also contributes significantly, with a total installed capacity of 9.4 GW (36 per cent of total). National Thermal Power Corporation (NTPC), the Central power generating company, contributes 14 per cent (3 GW) to the installed capacity.

Many power plants in Maharashtra are located in Vidarbha, Chandrapur and Nagpur region which face acute water shortages. In the past, a few power plants in Maharashtra—including Parli in Beed district, Koradi in Nagpur district, and Chandrapur (2,340 MW) and Khaperkheda in Vidarbha—had to shut down or curtail their production due to acute water shortages in their region.[8]

Data for specific water consumption as reported by plants was available for about 22.6 GW capacity comprising 18 plants. Of this, a significant number of power plants are located in the Chandrapur (4.66 GW) and Nagpur (6.66 GW) region. Of the 18 power plants for which data was available, ten plants were complying, five plants were non-complying and remaining three plants are exempted from meeting the norms as these are seawater-based plants. Capacity-wise, a major capacity was found to be complying as per the reported data. The five non-complying plants are Mahagenco Koradi (SWC—4), Mahagenco Paras (SWC—5.24), Mahagenco Nashik (SWC—4.09), Mahagenco Chandrapur (SWC—3.6) and NTPC Solapur (SWC—3.72).

Chandrapur Power Station was found to be marginally complying, but an analysis of the water consumption data of the plant in its environment statement showed that the plant recycles only about 25 per cent of its ash water back to plant. The remaining 76 per cent is either drained or lost as leakages in the system. That is why the plant's freshwater consumption for ash handling is high, i.e. about 30 per cent of total freshwater consumption.

Table 3.2: Chandrapur Power Plant ash water recovery data extracted from environment statement

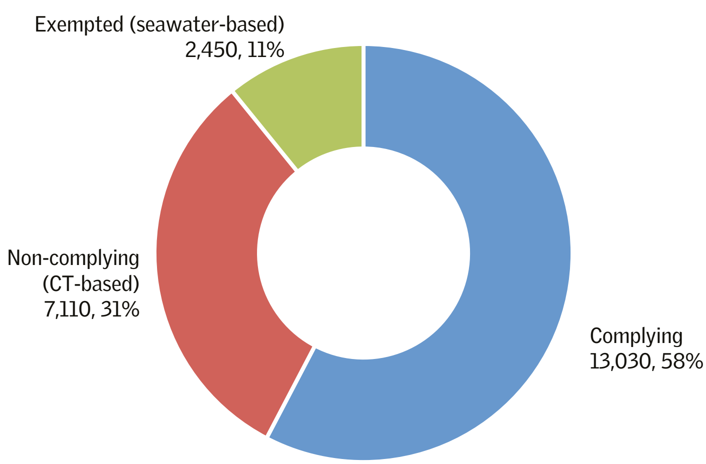
Substantial water losses occur in ash handling system of the plant

Ash-handling water	m^3/day
Total raw water consumption in plant	1,64,787
Raw water (for ash)	49,491
ETP recovered water (for ash)	37,397
STP recovered water (for ash)	2,208
Ash dyke water recovery	21,499
% recycled from ash dyke	24%
Ash water drained or leakages	67,597
% water lost or not recycled	76%

Source: CSE, 2021; data sourced from plant's environment statement

Graph 3.2: Status of water compliance in Maharashtra (capacity in MW)

About 31 per cent of surveyed capacity is non-complying



Source: CSE, 2021

Table 3.3: Plant-wise specific water consumption—Compliance status

The majority of non-complying plants belong to Mahagenco

Plant	Region	Capacity (MW)	OTC- or CT-based	Water source	SWC limit (m^3/MWh)	Reported average SWC (m^3/MWh)	Compliance status
Adani Dahanu TPS	Palgarh	500	OTC	Seawater	Exempted	Exempted	Exempted
Dhariwal Infrastructure Limited	Chandrapur	600	CT	Freshwater	3.5	2.21	Complying
KSK Wardha	Chandrapur	540	CT	Freshwater	3.5	2.29	Complying
Mahagenco Chandrapur	Chandrapur	2,920	CT	Freshwater	3.5	3.6 (2017-18)	Non-complying (CT based)
GMR Warora Energy Limited	Chandrapur	600	CT	Freshwater	3.5	2.3	Complying
Mahagenco Khaperkheda	Nagpur	1340	CT	Freshwater	3.5	3.25	Complying
Mahagenco Koradi	Nagpur	2400	CT	Freshwater	3.5 (Units 6–9); 3 (Unit 10)	4	Non-complying (CT based)
NTPC Mauda	Nagpur	2320	CT	Freshwater	3.5 (Units 1–3); 3 (Unit 4)	2.65	Complying
Reliance Power Plant, Butibori	Nagpur	600	CT	Freshwater	3.5	2.4	Complying
Adani Tiroda	Tiroda	3,300	CT	Freshwater	3.5	2.45	Complying
JSW Energy Limited	Ratnagiri	1,200	OTC	Seawater	Exempted	Exempted	Exempted
Mahagenco Bhusawal	Jalgaon	1,210	CT	Freshwater	3.5	Complying	Complying
Mahagenco Nashik	Nashik	630	CT	Freshwater	3.5	4.09	Non-complying (CT based)
Mahagenco Paras	Akola	500	CT	Freshwater	3.5	5.24	Non-complying (CT based)
Mahagenco Parli and New Parli	Beed	1,170	CT	Freshwater	3.5	3.3	Complying
Ratan India Power Limited	Amravati	1,350	CT	Freshwater	3.5	2.96	Complying
Tata Power Plant, Trombay	Chembur	750	OTC	Seawater	Exempted	Exempted	Exempted
NTPC Solapur	Solapur	660	CT	Freshwater	3	3.72	Non-complying (CT based)

Note: CT—Cooling tower; OTC—Once-through cooling

Source: CSE, 2021

With respect to environment statements, there is no clear and consistent reporting format for water consumption. For example, not all plants separately report use of freshwater in their ash handling system. Wardha Warora's environment statement shows water use for process as zero. Water consumed in process, ash handling and others is not specified by plant in its environment statement submitted to the Pollution Control Board.

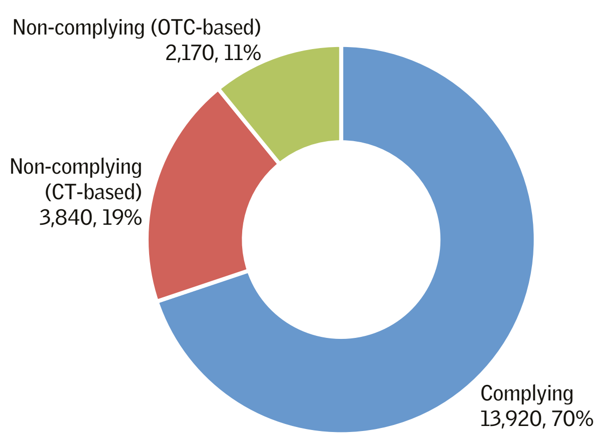
MADHYA PRADESH

Out of a total 22 GW capacity located in Madhya Pradesh, water consumption data was obtained for about 20 GW capacity. Of this, a major capacity (about 8.2 GW) is located in Singrauli district, which is a power hub of India. All plants in Madhya Pradesh are freshwater-based and consume a total of about 2.5 million m^3/day of freshwater.

About 33 per cent of the plants in Madhya Pradesh were found to be non-complying, including Shree Singaji TPS, Sanjay Gandhi TPS, Satpura TPS and NTPC Khargone. Except NTPC Khargone, all non-complying power plants are owned by Madhya Pradesh Power Generation Company Limited (MPPGCL). As per reported data, Amarkantak plant (MPPGCL) claims to be complying, but with a low COC of 2.16 it likely consumes excessive amounts of water and it is unlikely that it is complying.

Of the non-complying plants, two plants—Sanjay Gandhi TPS and Satpura TPS Units 6–9—are still freshwater-based once-through plants and have not yet installed cooling towers. Both of these plants are owned by MPPGCL. They continue to withdraw huge amounts of freshwater due to non-availability of the closed loop system.

Graph 3.3: Status of water compliance in Madhya Pradesh (capacity in MW)



Source: CSE, 2021

Table 3.4: Plant-wise specific water consumption—Compliance status

As per reported data, about 33 per cent plants do not comply with SWC norms.

Plant	Region	Capacity (in MW)	Water source	OTC- or CT-based	SWC limit (m^3/MWh)	Reported average SWC (m^3/ MWh)	Compliance status
NTPC—Vindhyachal STPP	Singrauli	4,760	Freshwater	CT	3.5	3.3	Complying
Essar Power Ltd	Singrauli	1,200	Freshwater	CT	3.5	3.2	Complying
Mahan Captive Power Plant	Singrauli	900	Freshwater	CT	3.5	2.5	Complying
Sasan Power Limited	Singrauli	3,960	Freshwater	CT	3.5	1.9	Complying
Jaypee Bina TPS	Etawa	500	Freshwater	CT	3.5	2.2	Complying
BLA Power Pvt. Ltd	Niwari	90	Freshwater	CT	3.5	3.1	Complying
MB Power Limited/ Anuppur TPS	Anuppur	1,200	Freshwater	CT	3.5	2.2	Complying
Jhabua Avantha Power Plant	Seoni	600	Freshwater	CT	3.5	2.5	Complying
Amarkantak Thermal Power Plant	Anuppur	210	Freshwater	CT	3.5	3.52	Complying
Shree Singaji TPS	Khandwa	1,200 (Units 1 and 2)	Freshwater	CT	3.5	3.9	Non-complying (CT based)
	Khandwa	1,320 (Units 3 and 4)	Freshwater	CT	3	4.7	Non-complying (CT based)
Sanjay Gandhi Thermal Power Station	Umaria	1,340	Freshwater	OTC	3.5	Freshwater based once-through	Non-complying (OTC based)
Satpura Thermal Power Plant	Betul	830 (Units 6–9)	Freshwater	OTC	3.5	6.3	Non-complying (OTC based)
	Betul	500 (Units 10 and 11)	Freshwater	CT	3.5	3.3	Complying
NTPC—Khargone Super Thermal Power Plant	Khargone	1,320	Freshwater	CT	3	4.5	Non-complying (CT based)
Jaypie Nigree	Singrauli	1,320	Freshwater	CT	3.5	Not known	Data not available
NTPC Gadarwara	Gadarwara	800	Freshwater	CT	3	Not known	Data not available

Note: CT—Cooling tower; OTC—Once-through cooling

Source: CSE, 2021

Also, major water pollution issues are reported from power plants in Madhya Pradesh due to mismanagement of ash slurry water. A major fly ash breach incident occurred in 2020 at the Sasan ultra-mega power plant (owned by Reliance Power). It resulted in human causalities and spread of toxic slurry in the surrounding areas (up to 6 km), destroying agricultural fields. In 2019, similar incidences of ash dyke breaches occurred at the Essar Mahan Power Plant and the NTPC Vindhyachal plant located in the same region. Such frequent instances of fly ash breach indicate mismanagement and inadequate recycling of ash slurry water from ash ponds. Though these plants are complying as per reported specific water consumption (SWC) figures, their ash water recycling system is highly flawed.

With water scarcity being a real and urgent concern in Madhya Pradesh, the continued non-compliance should be dealt with strictly. Power companies are well aware of the risk of water crisis in their business. Many plants have been forced to shut down because of shortage of water or conflict with local communities over its use in times of drought. Water conservation is, therefore, in the best interest of the companies.

Table 3.5: Reported COC and ash water handling data of few surveyed plants

Plants with high COC (about 5) and an effective ash water recycling system (AWRS) tend to have lower SWCs and are water-efficient

Plant	Reported SWC average (m^3/MWh)	Compliance status	COC	% of raw water for ash handling	AWRS system present or absent
Jaypee Bina TPS (500 MW)	2.2	Complying	5	24%	Present, not in use
Jhabua Avantha Power Plant (600 MW)	2.5	Complying	5.7	0; only recycled water used	Yes
Amarkantak TPS (210 MW)	3.52	Complying	2.16	–	Yes
Shree Singaji TPS 1,200 MW (Units 1 and 2), 1,320 MW (Units 3 and 4)	3.9	Non-complying (CT based)	3	23%	Yes
	4.7	Non-complying (CT based)	5.5	33%	Under commissioning
Sanjay Gandhi Thermal Power Station (1,340 MW)	Freshwater-based once-through	Non-complying (OTC based)	OTC	19%	Yes
Satpura Thermal Power Plant 830 MW (Units 6–9); 500 MW (Units 10 and 11)	6.3 (Units 6–9)	Non-complying (OTC based)	OTC	27%	Yes
	3.3 (Units 10 and 11)	Complying	5 (designed)	3.8%	Yes (HCSD)

Note: CT–Cooling tower; OTC–Once-through cooling

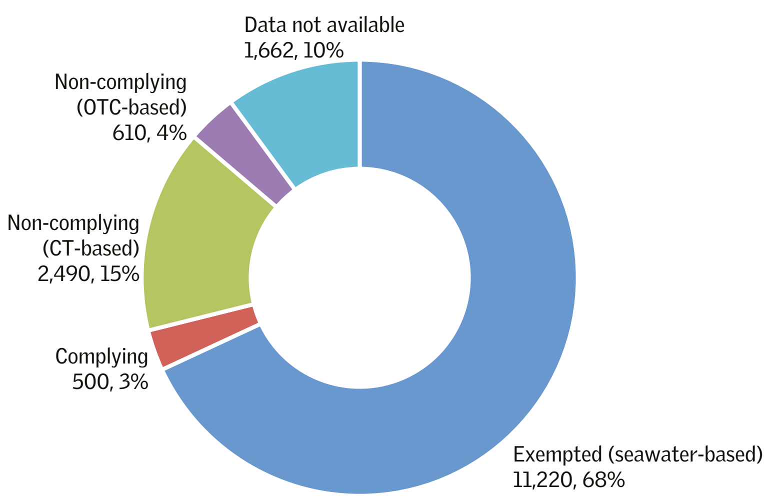
Source: CSE, 2021

GUJARAT

There are only private and state-owned plants in Gujarat. Gujarat State Electricity Corporation Limited (GSECL) is the largest power-generating company in the state. The private sector players comprising Adani, Tata Power and Torrent Power also contribute significantly to the total installed capacity.

Gujarat being a coastal state, most of its power plants are located near the sea and they withdraw seawater for cooling and other purposes. The plants are mainly seawater-based once-through plants and are, therefore, exempt from meeting any specific water consumption norms. Out of the total capacity surveyed, 72 per cent (about 11.98 GW) is seawater-based and comprises eight plants. The remaining 4.5 GW capacity comprises plants that have to follow the norms. This includes one freshwater-based once-through plant and six freshwater-based closed-loop CT plants. Of the 4.5 GW capacity that has to follow the norms, about 65 per cent capacity (2.95 GW) is non-complying with the norms; for the remaining capacity (1.5 GW) data is not available and compliance and non-compliance could not be ascertained.

Graph 3.4: Status of water compliance in Gujarat (capacity in MW)
A major capacity is seawater-based and is therefore exempted from meeting the norms



Source: CSE, 2021

Table 3.6: Plant-wise specific water consumption—Compliance status

Non-complying plants mainly belong to state owned GSCEL

Plant	Region	Capacity (MW)	OTC- or CT-based	Water source	SWC limit (3, 3.5 or exempted)	Actual average SWC (m^3/MWh)	Compliance status
Bhavnagar Lignite Thermal Power Station	Bhavnagar	500	OTC	Seawater	Exempted	Exempted	Exempted
Adani Mundra Thermal Power Station	Kutch	4,620	OTC	Seawater	Exempted	Exempted	Exempted
Akrimota TPS	Kutch	250	OTC	Seawater	Exempted	Exempted	Exempted
Gandhinagar Thermal Power Station (GSECL)	Gandhinagar	870	CT	Freshwater	3.5	4.25	Non-complying (CT-based)
Mundra Ultra Mega Power Plant	Mundra	4,150	OTC	Seawater	Exempted	Exempted	Exempted
Salaya Power Plant (Essar)	Jamnagar	1,200	OTC	Seawater	Exempted	Exempted	Exempted
Sikka Rep TPS (GSECL)	Jamnagar	500	OTC	Seawater	Exempted	Exempted	Exempted
Surat Lignite (CFBC)	Surat	500	CT	Freshwater	3.5	2.07	Complying
Torrent Sabarmati TPS	Ahmedabad	362	CT	Freshwater	3.5	Not known	Data not available
Ukai TPS	Tapi	610 (Units 1–3)	OTC	Freshwater	3.5	–	Non-complying (OTC-based)
	Tapi	500 (Unit 4)	CT	Freshwater	3.5	Not known	Data not available
Wanakbori TPS (GSECL)	Kheda	7 x 210	CT	Freshwater	3.5	3.6	Non-complying (CT-based)
	Kheda	1 x 800	CT	Freshwater	3	Not known	Data not available
Kutch Lignite TPS	Kutch	150	CT	Freshwater	3.5	3.74	Non-complying (CT-based)

Note: CT—Cooling tower; OTC—Once-through cooling

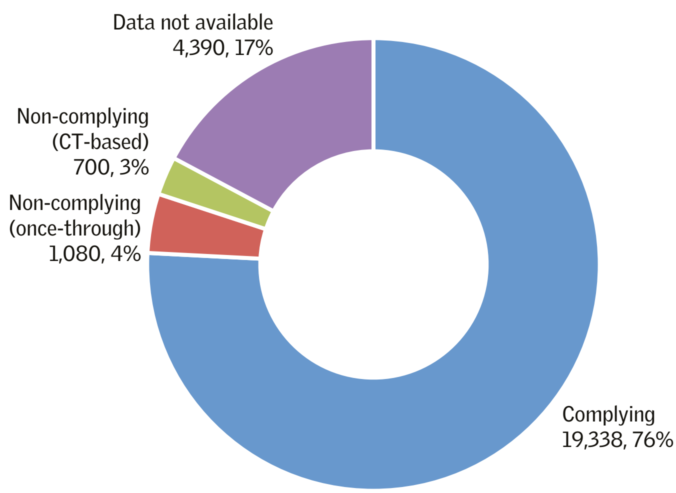
Source: CSE, 2021

CHHATTISGARH

About 21.12 GW of total capacity was surveyed in Chhattisgarh district. Of this, a major capacity (about 7.8 GW) is located in Korba region, 6.8 GW in Raigarh region, and 5.4 GW in Janjgir-Champa region. As per specific water consumption data reported by plants in their environment statements, a major capacity in Chhattisgarh is found to be complying with the water norms.

The non-complying plants included Dr Shyama Prasad Mukharjee TPS (CSPGCL), Korba III East, Hasdeo Korba West. Of the non-complying capacity, Korba III East (240 MW) and Hasdeo Korba West (840 MW) are once-through plants that have still not converted to closed-loop. Already Korba region is reeling under acute water crisis and with presence of major coal-based capacity in the region, conditions will only worsen as the majority of non-complying plants in Chhattisgarh are located in the Korba region.

Graph 3.5: Status of water compliance in Chhattisgarh (capacity in MW)
As per reported data a major capacity is complying with the norms



Source: CSE, 2021

Table 3.7: Plant-wise specific water consumption—Compliance status

Most of the non-complying plants are located in the Korba region and belong to the state-owned CSPGCL

Plant	Region	Capacity (MW)	OTC- or CT-based	Water source	SWC Limit (3, 3.5 or exempted)	Reported average SWC	Compliance status
Balco Captive Power Plants II and III	Korba	1,740	CT	Freshwater	3.5	2.30	Complying
DB Power Limited (Baradarha TPP)	Jangir-Champa	1,200	CT	Freshwater	3.5	2.60	Complying
KSK Nariyara	Jangir-Champa	1,800 (3 x 600)	CT	Freshwater	3.5 and 3	2.05	Complying
Adani Korba West Power Station (Avantha Bhandar)	Raigarh	600	CT	Freshwater	3.5	2.35	Complying
Bhilai TPS (NSPCL)	Durg	574	CT	Freshwater	3.5	2.77	Complying
Binjkote TPP (SKS Power)	Raigarh	600	CT	Freshwater	3	–	Data not available
TRN Energy Pvt. Ltd (Nawapara TPP)	Raigarh	600	CT	Freshwater	3.5	–	Data not available
Chakabura TPP (ACB India)	Korba	60	CT	Freshwater	3.5	2.84	Complying
Dr Shyama Prasad Mukharjee TPS (CSPGCL)	Korba	500	CT	Freshwater	3.5	3.85	Non-complying (CT based)
Kasaipalli TPS (ACB India)	Korba	270	CT	Freshwater	3.5	2.98	Complying
Katghora TPP (Vandana Vidyut)	Korba	35	CT	Freshwater	3.5	–	Data not available
NTPC Korba	Korba	2600	CT	Freshwater	3.5	2.80	Complying
Korba-III (Korba-East)	Korba	240 (2 x 120)	OTC	Freshwater	3.5	12	Non-complying (OTC based)
Korba-III (Korba-East)	Korba	200 (4 x 50)	CT	Freshwater	3.5	>3.5	Non-complying (CT based)
Korba-West TPS (Hasdeo)	Korba	840 (4 x 210)	OTC	Freshwater	3.5	–	Non-complying (OTC based)
	Korba	500	CT	Freshwater	3.5	2.92	Complying
Marwa Thermal Power Plant	Janjgir-Champa	1,000	CT	Freshwater	3.5	3	Complying
OP Jindal TPS	Raigarh	1,000 (4 x 250)	CT	Freshwater	3.5	3.40	Complying
	Raigarh	2,400 (4 x 660)	CT	Freshwater	3.5	2.77	Complying

Plant	Region	Capacity (MW)	OTC- or CT-based	Water source	SWC Limit (3, 3.5 or exempted)	Reported average SWC	Compliance status
PATHADI TPP (Lanco Amarkantak)	Korba	600	CT	Freshwater	3.5	2.20	Complying
Raikheda TPP (GMR Chhattisgarh Energy Ltd)	Raipur	1370	CT	Freshwater	3.5	–	Data not available
Salora TPP (Vandana Vidyut)	Korba	135	CT	Freshwater	3.5	–	Data not available
NTPC Sipat	Bilaspur	2980	CT	Freshwater	3.5	2.96	Complying
Swastik Korba TPP (ACB India)	Korba	50	CT	Freshwater	3.5	–	Data not available
Uchpinda TPP (RKM Power Gen Pvt. Ltd)	Janjgir-Champa	1440	CT	Freshwater	3.5 and 3	2.68	Complying
NTPC Lara	Raigarh	1600	CT	Freshwater	3	–	Data not available
NTPC SAIL III	Bhilai	500	CT	Freshwater	3.5	2.87	Complying
NTPC SAIL II	Bhilai	74	CT	Freshwater	3.5	3.46	Complying

Note: CT—Cooling tower; OTC—Once-through cooling

Source: CSE, 2021

TAMIL NADU

About 12.2 GW capacity was surveyed in Tamil Nadu state. Of this, a major capacity (about 4.3 GW) is located in Thiruvallur region, 3.8 GW in Cuddalore region, 2.5 GW in Tuticorin region.

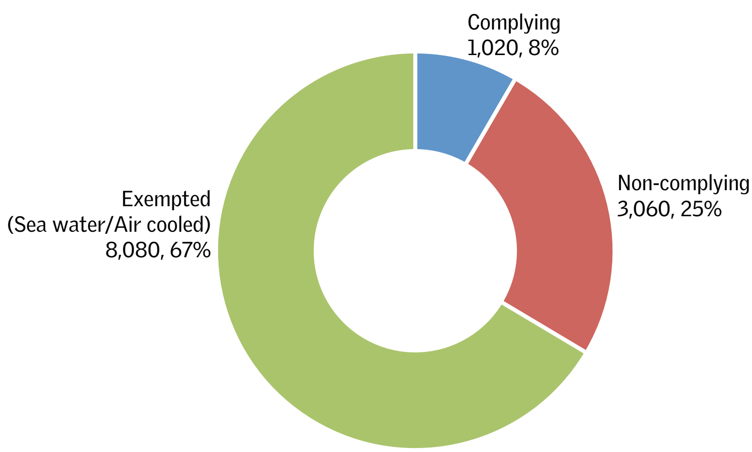
As Tamil Nadu is a coastal area, most of the plants are located near the sea and withdraw seawater for cooling and other purposes. These are mainly seawater-based once-through plants and are therefore exempted from meeting any specific water consumption norms.

Out of total 12.2 GW surveyed capacity, 67 per cent (about 8.08 GW) is seawater-based. Of the remaining 4.08 GW capacity, a major capacity (3.06 GW) is non-complying with the norms. A chunk of the non-complying power plants lie in the Cuddalore region. All non-complying power plants are closed-loop CT-based plants.

Average SWC for Mettur thermal power plant with a capacity 840 MW is found to be 5.9 m^3/MWh, which is much higher than the prescribed water consumption standard of 3.5 m^3/MWh. Also, Neyveli TPS I and II continue to non-comply with average SWC of 4.39 m^3/MWh and 5.25 m^3/MWh respectively.

Graph 3.6: Status of water compliance in Tamil Nadu (capacity in MW)

The major capacity is seawater-based. About 25 per cent of surveyed capacity was non-complying.



Source: CSE, 2021

Table 3.8: Plant-wise specific water consumption—Compliance status

Plant	Region	Capacity (MW)	OTC- or CT-based	Water source	Limit (3/3.5/ exempted)	Reported average SWC	Compliance status
ITPCL TPP	Cuddalore	1,200	OTC	Seawater	Exempted	Exempted	Exempted
Mettur TPS	Salem	840	CT	Freshwater	3.5	5.9	Non-complying
Mettur TPS	Salem	600	CT	Freshwater	3.5	2.56	Complying
Mutiara TPP	Tuticorin	1,200	OTC	Seawater	Exempted	Exempted	Exempted
Neyveli TPS I (Ext)	Cuddalore	420	CT	Freshwater	3.5	<3.5	Complying
Neyveli TPS-II	Cuddalore	1,470	CT	Freshwater	3.5	4.39	Non-complying
Neyveli TPS-II (Ext)	Cuddalore	500	CT	Freshwater	3.5	5.25	Non-complying
North Chennai TPS (TANGEDCO)	Thiruvallur	1,830	OTC	Seawater	Exempted	Exempted	Exempted
TAQA, Neyveli	Cuddalore	250	CT	Freshwater	3.5	3.6	Non-complying
Tuticorin (JV) TPP-NLC Power	Thiruvallur	1,050	OTC	Seawater	Exempted	Exempted	Exempted
Tuticorin TPS	Tuticorin	1,000	OTC	Seawater	Exempted	Exempted	Exempted
Vallur TPP (NTEC Ltd.)	Thiruvallur	1,500	OTC	Seawater	Exempted	Exempted	Exempted
Tuticorin (P) TPP-Ind Bharath	Tuticorin	300	Air-cooled	Air-cooled	Exempted	Air-cooled	Exempted

Source: CSE, 2021

UTTAR PRADESH

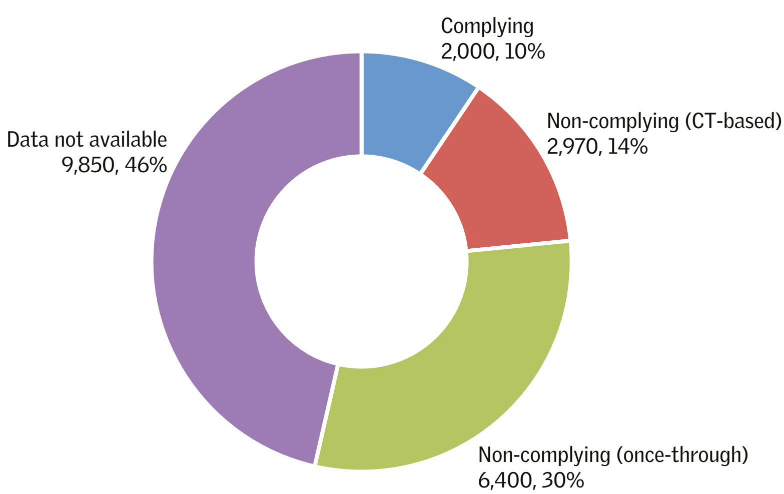
Out of total 21 GW capacity, data was available for about 12 GW capacity in Uttar Pradesh. Of this, a major capacity (about 6.18 GW) is located in the Sonbhadra region. The National Green Tribunal (NGT) had in the past sought many directions to restrain thermal power plants in Sonbhadra from dumping industrial effluents, fly ash slurry and other toxic residues in the Rihand reservoir and other waterbodies located in the region as there had been frequent incidents of fly ash slurry and other industrial effluents contaminating the freshwater sources in the region. All coal-power plants in this region must follow maximum ash water recycling and other water-efficient practices to minimize water consumption.

Of the total capacity surveyed, 9.37 GW was non-complying. Of the non-complying capacity, a significant capacity (68 per cent) were once-through cooling plants. Majority of non-complying plants belonged to UPRVUNL. Non-complying once-through cooling plants include UPRVUNL's Anpara, Obra and Parichha and NTPC's Rihand and Singrauli plants.

Only 10 per cent (2 GW) of the surveyed capacity was found to be compliant. For the remaining capacity (9.85 GW), data was not available and compliance and non-compliance could not be ascertained.

Graph 3.7: Status of water compliance in Uttar Pradesh (capacity in MW)

44 per cent of the surveyed capacity was non-complying. A significant number of non-complying capacity is OTC based



Source: CSE, 2021

Table 3.9: Plant-wise specific water consumption—Compliance status

The majority of non-complying plants belong to UPRVUNL. A majority of non-complying plants are freshwater-based once-through-cooling plants.

Plant	Region	Capacity (MW)	OTC- or CT-based	Water source	Limit (3, 3.5 or exempted)	Reported average SWC	Compliance status
Obra TPS	Sonbhadra	1,550	OTC	Freshwater	3.5	Freshwater-based once-through	Non-complying (OTC-based)
Paricha TPS Units 1 and 2	Jhansi	220	OTC	Freshwater	3.5	Freshwater-based once-through	Non-complying (OTC-based)
Paricha TPS Units 3–6	Jhansi	920	CT	Freshwater	3.5	>3.5	Non-complying (CT-based)
Harduaganj TPS	Aligargh	500	CT	Freshwater	3.5	4.225	Non-complying (OTC-based)
Anpara TPS	Sonbhadra	1,630	OTC	Freshwater	3.5	Freshwater-based once-through	Non-complying (OTC-based)
NTPC Rihand Units 1 and 2	Sonbhadra	1,000	OTC	Freshwater	3.5	Freshwater-based once-through	Non-complying (OTC-based)
NTPC Rihand Units 1 and 2	Sonbhadra	2,000	CT	Freshwater	3.5	<3.5	Complying
Singrauli STPS	Singrauli	2,000	OTC	Freshwater	3.5	Freshwater-based once through	Non-complying (OTC-based)
Unchahar TPS	Rai Bareilly	1,550	CT	Freshwater	3.5 (Units 1–4); 3 (Unit 5)	5.25	Non-complying (CT-based)
Bajaj Energy, Barkhera	Barkhera	450	CT	Freshwater	3.5	Not known	Data not available
Bara TPP	Prayagraj	1,980	CT	Freshwater	3.5 (Units 1–2); 3 (Unit 3)	Not known	Data not available
Lalitpur TPP (LPGCL) Unit 1	Lalitpur	1,980	CT	Freshwater	3.5	Not known	Data not available
Rosa TPP	Shahjahanpur	1,200	CT	Freshwater	3.5	Not known	Data not available
NTPC Tanda	Ambedkar Nagar	1,760	CT	Freshwater	3.5 (Units 1–4); 3 (Unit 5)	Not known	Data not available
Dadri (NCTPP) Units 1–4	Gautam Buddh Nagar	1,820	CT	Freshwater	3.5	Not known	Data not available
Meja STPP Unit 1	Allahabad	660	CT	Freshwater	3	Not known	Data not available

Source: CSE, 2021

JHARKHAND

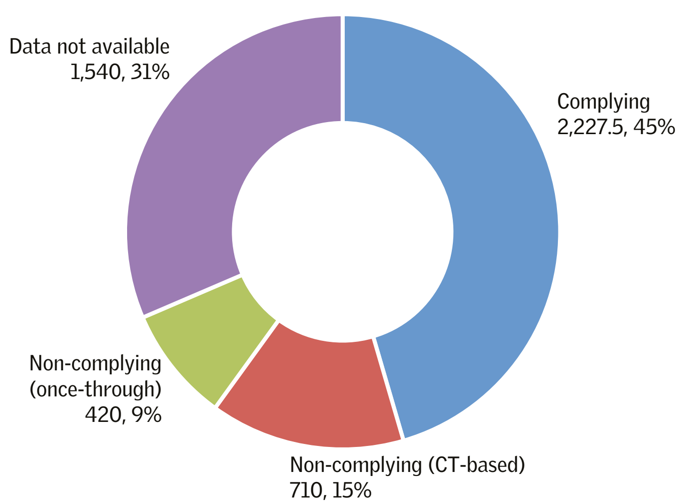
Jharkhand is a rich storehouse of minerals but not so in water resources. Bokaro, Ranchi and other regions face acute water crises. Of the total 4.9 GW total capacity, data was available for about 3.36 GW of capacity. Out of 3.36 GW surveyed capacity, about1.13 GW was non-complying.

Bokaro 'B Thermal Power Station exceeds the prescribed water consumption standard and its average SWC was found to be 7.8 m^3/MWh even with installed cooling towers. This power plant is also infamous for its fly ash slurry breach incidents. A major fly ash breach, reported in 2019, resulted in slurry flooding agricultural lands and in water bodies before it drained into the Damodar River, contaminating the source of potable water for millions of people.

Tenughat Thermal Power Station is a freshwater-based once-through cooling plant located in Jharkhand.

Graph 3.8: Status of water compliance in Jharkhand (capacity in MW)

About 24 per cent of surveyed capacity is non-complying with water norms



Source: CSE, 2021

Table: Plant-wise specific water consumption—Compliance status

Plant	Region	Capacity (MW)	OTC- or CT-based	Water source (freshwater or seawater)	Limit (3, 3.5 or exempted)	Reported average SWC	Compliance status
Jojobera Power Plant (Tata Power)	Jamshedpur	547.5	CT	Freshwater	3.5	3.4	Complying
Bokaro 'A' TPS (DVC)	Bokaro	500	CT	Freshwater	3.5	3.6	Non-complying (CT-based)
Bokaro 'B' TPS (DVC)	Bokaro	210	CT	Freshwater	3.5	7.8	Non-complying (CT-based)
Chandrapura TPS (DVC)	Chandrapura	630	CT	Freshwater	3.5	Complying	Complying
Koderma TPS	Koderma	1,000	CT	Freshwater	3.5	Not known	Data not available
Mahadev Prasad STPP	Dhanbad	540	CT	Freshwater	3.5	Not known	Data not available
Maithon Right Bank TPP (Tata DVC)	Dhanbad	1,050	CT	Freshwater	3.5	2.45	Complying
Tenughat TPP	Tenughat	420	OTC	Freshwater	3.5	Freshwater-based OTC	Non-complying (once-through)

Source: CSE, 2021

TELANGANA

Telangana has fourth highest number of water-stressed districts. Power plants in Telangana are also located in three of the water stressed districts namely Warangal, Khammam and Kothagudem. Of the 4 GW of total capacity surveyed, about 2.6 GW was non-complying with water norms. The non-complying plants in Telangana included Kothagudem TPS Stage I-IV (Telangana State Power Generation Corporation Limited [TSGENCO]), Kothagudem TPS Stage V–VI (TSGENCO), Ramagundem-B TPS, TSGENCO. All non-complying plants in surveyed capacity belonged to TSGENCO.

Located in a water-scarce region, Kothagudem TPS with 12 units fails to meet its prescribed water consumption standards. Further, the power plant is said to be polluting the Kinnerasani River due to the mismanagement of fly ash. Eight of its units (720 MW) are 36–48 years old and are once-through cooling systems.

Table 3.10: Plant-wise specific water consumption—Compliance status

All non-complying plants in the surveyed capacity belonged to TSGENCO

Plant	Region	Capacity (MW)	OTC- or CT-based	Water source (freshwater or seawater)	Limit (3, 3.5 or exempted)	Reported average SWC	Compliance status
Kakatiya TPS (TSGENCO)	Warangal	1,100	CT	Freshwater	3.5	<3.5	Complying
Kothagudem TPS Stage I–IV (TSGENCO)	Kothagudem	720	OTC	Freshwater	3.5	7.99	Non-complying (once-through)
Kothagudem TPS Stage V–VI (TSGENCO)	Kothagudem	1800	CT	Freshwater	3.5	Non-complying	Non-complying (CT-based)
Singareni TPS	Mancherial	1200	CT	Freshwater	3.5	Not known	Data not available
Ramagundem STPS (NTPC)	Peddapalli	2600	CT	Freshwater	3.5	Not known	Data not available
Ramagundem-B TPS, TSGENCO	Peddapalli	62.5	CT	Freshwater	3.5	4.0388	Non-complying (CT-based)

Source: CSE, 2021

KARNATAKA

Coal power plants in Karnataka are located in Raichur, Bellary, Bijapur and Udupi region. About 5.72 GW of the capacity was non-complying with the norms in the surveyed capacity. The non-complying plants in Karnataka included Yermarus TPS in Raichur, Raichur TPS in Raichur and NTPC Kudgi in Bijapur.

Raichur district, which has the major capacity, is reeling under acute water crisis. Power plants in Raichur have had to shut down during times of water shortage. Both of the thermal power plants in this region Yermarus TPS and Raichur TPS—with SWC 3.501 m^3/MWh and 4.9 m^3/MWh—are unable to meet their water consumption standards. Also, the NTPC Kudgi plant reported its specific water consumption to be 1.03 m^3/MWh in environment statement, which seemed under-reported. CSE extracted its water consumption and electricity generation data from its 2017–18 environment statement, and our estimated SWC for the plant worked out to 4.36 m^3/MWh, and hence the plant was found to be non-complying.

Table 3.11: Plant-wise specific water consumption—Compliance status

Plant	Region	Capacity (MW)	OTC- or CT-based	Water source (freshwater or seawater)	Limit (3, 3.5 or exempted)	Reported average SWC	Compliance status
Kudgi STPP (NTPC)	Bijapur	2,400	CT	Freshwater	3.5 (Units 1–2); 3 (Unit 3)	4.36	Non-complying (CT based)
Yermarus TPS	Raichur	1,600	CT	Freshwater	3	3.501	Non-complying (CT based)
Raichur TPS	Raichur	1,720	CT	Freshwater	3.5	4.92	Non-complying (CT based)
Torangallu TPS Ext (JSW Energy)	Bellary	860	CT	Freshwater	3.5	2.23	Complying
Udupi TPP (Adani)	Udupi	1,200	OTC	Seawater	Exempted	Exempted	Exempted
Bellary (Kudatini TPS)	Bellary	1,800	CT	Freshwater	3.5	Not known	Data not available

Source: CSE, 2021

4. Achieving zero liquid discharge in power plants

As per the 2015 norms, plants commissioned post 2016 are required to achieve zero liquid discharge (ZLD) along with meeting the specific water consumption norm of 3 m^3/MWh. About 21 GW of freshwater-based coal-power capacity was commissioned post 2016 and need to follow zero discharge. Though many plants claim in their reported data to be zero discharge, no authority monitors their actual implementation on ground. As per CSE's 2015 rating study of power sector, many plants that claimed to be ZLD were issued notices for wastewater discharge. Also, local communities had complaints regarding discharge of wastewater from plant. Zero discharge can be a saviour for power plants located in water-stressed regions as it leads to significant reduction in freshwater consumption due to complete effluent recycling practices with no discharge outside the plant.

How a plant can attain zero discharge status?

For any plant to achieve zero discharge status, it is important to plug all major wastewater streams by either eliminating or preventing discharge or by 100 per cent recycling and reuse of the generated waste streams so that there is literally no discharge outside the plant boundary or even from its ash ponds which are normally located outside plant boundary, sometimes kilometres from plant. Any coal-based plant running without zero discharge in place will normally have effluent drains generating from either its central monitoring basin (CMB), coal handling plant, overflow drains from ash ponds or wastewater generated from its flue gas desulphurization (FGD) system. Unused cooling-tower blow-down water and other process effluent drains are collected in a plant's central monitoring basin. As more than one drain or discharge point emanates from a plant, a combination of schemes or different technologies—not a single scheme or technology—can help it achieve zero discharge status.

The approach of a typical end-of-pipe treatment of industrial wastewater needs to shift towards decentralized, process integrated water management with efforts towards 'zero discharge' thus reducing freshwater consumption as well as pollution. This requires comprehensive information about the quantity and quality of water used and generated at different stages of the industrial processes. Therefore, to

Water terminology used in a typical coal power plant

Make-up water: Water added to compensate for loss due to evaporation, blow-down and other water losses. Cooling-tower make-up compensates for evaporation, blow-down and drift losses from cooling tower. Boiler make-up compensates for boiler blow-down in steam generating boilers.

Circulating water: Water flowing in closed loop between cooling towers and condensers of power-generating units.

Demineralized (DM) water: Water used in boilers for generating steam. DM water is produced in a DM plant and is supplied to boilers.

Ash handling water: Water used for handling and transferring ash generated during combustion process in the boiler section. Water is mixed with ash to form slurry which is transferred through pipelines to ash ponds. Cooling tower blow-down water is used mainly for ash handling and the remaining water requirement is met by freshwater.

Potable water: Water used for drinking purposes within plant and colony.

Service water: Water used for processes like coal dust suppression; heating, ventilation, and air conditioning (HVAC) systems; gardening and other services within plant.

Fire water make-up: Water added to compensate for the loss in fire water-lines.

enable a plant to be zero discharge it is essential for the plant management to understand its major water-consuming sections and wastewater streams.

The following section details the major water consuming sections and wastewater streams in a typical coal-based power plant and major schemes or technologies that can be implemented in plant for it to become zero discharge.

Identifying major water-consuming sections and wastewater streams

In a typical coal-based power plant, the major water consuming and wastewater generating sections include cooling towers, DM plant make-up, ash handling, domestic and wet flue gas desulphurization unit (FGD).

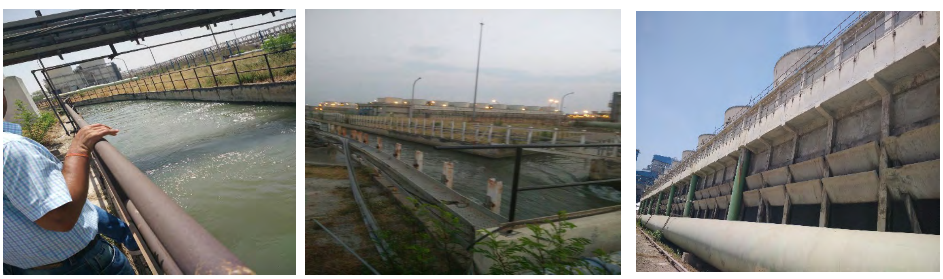
In coal-based power plants, roughly 80 per cent of the water demand is for cooling purposes, 18 per cent in ash handling and 2 per cent for process and domestic uses. However, this percentage varies widely from plant to plant. Plants that use freshwater and have cooling towers consume on average 4 m^3/MWh. Once-through power plants withdraw enormous amounts of water, most of which is returned to the source (with around 1 per cent is lost in evaporation), but at higher temperatures than at the draw. However, the water withdrawal of a once-through plant can be as high as 70–200 m^3/MWh.

In thermal power stations, freshwater is used for cooling water, or circulating water, drinking water, DM water, service water, ash water, fire water, washing equipment etc. The various sources of wastewater from any typical coal-based power plant include cooling-tower blow-down, coal-handling plant effluent, ash handling water and domestic effluent. A major amount of cooling-tower blow-down is utilized in ash handling and unused blow-down is collected in central monitoring basin (CMD). Apart from unused cooling-tower blow-down, generated unused wastewater at different locations within plant is collected (through a network of drains) at the central monitoring basin (CMB). Thus, major wastewater streams in any coal-based plant without zero discharge include effluent drains from the central monitoring basin, coal-handling plant, overflow drains from ash ponds or wastewater generated from the flue gas desulphurization (FGD) system.

The following details the major water-consuming sections and processes within a coal-based power plant and explains how excess water consumption and inefficient practices lead to excess effluent discharge. Only if water consumption in these sections can be minimized along with complete wastewater recycling will a plant be able to achieve zero discharge status.

- **Cooling tower make-up:** Cooling towers are the major water consuming structures in any power plant. These are attached to each power generating units for cooling the water received from condensers of each unit. Water is lost in significant amounts at each cooling tower due to evaporative, blow-down and drift losses. Maximum water loss in the thermal power plants is through the evaporation from the cooling towers. Water is circulated in a closed cycle, but after certain cycles water needs to be taken out as blow-down since the dissolved solids content builds up in the process over a period. To compensate for the blow-down water, evaporation and drift losses, treated freshwater is added as makeup to the system. The blow-down water is mainly utilized for ash handling purposes in order to transport the ash in ash slurry form to ash ponds located outside plant premises, sometimes kilometres away from plant and the unused blow down is usually sent to central monitoring basins (CMB). As per the Central Electricity Authority (CEA) for a typical 500 MW plant, the cooling-tower make-up requirement is normally 2.1 per cent of circulating water flow which comprises 1.7 per cent evaporation losses, 0.05 per cent drift loss and 0.35 per cent as blow-down. With increasing costs of water and cess to the industries, it is necessary to significantly reduce makeup water consumption by increasing the cycles of concentration (COC) of cooling towers. Any plant with a low COC (as low as 2 or 3) will tend to consume enormous amounts of water in cooling and will also generate significant quantities of cooling-tower blow-down, which ultimately ends up in ash ponds.

- o **Circulation water flowing in closed loop between cooling tower and condenser unit:** Circulation water is the bulk water kept in a closed loop between condensers of a plant's power-generating units and cooling towers. This is the largest water-consuming closed cycle of the power plant. The steam generated at boilers after use in the turbines is condensed in the condensers by the circulating cooling water from cooling towers, and the condensate generated is taken back to the boilers. The circulating cooling water after picking up the heat in the condenser is taken to the cooling towers for cooling and further re-circulated in closed loop system. Water losses incurred in this process is made up as makeup water from the raw water treatment plants.



Cooled circulation water from cooling tower sumps flowing to common open air channels (OACs) for recirculating back to condensers

- **Ash handling system:** A significant amount of water is used for handling ash generated in the power-generation process. It is estimated that over 30–40 per cent of total water requirement is accounted for by the ash handling plant alone. Water is used as a medium to carry the ash slurry to the ash ponds, which are located some kilometres from plant. The water requirement for wet slurry formation is usually fulfilled by cooling-tower blown-down water. Any additional water requirement is met from the raw water source. Wet ash slurry is pumped and transported through ash slurry pipelines. Decanted ash water from ash ponds is recirculated back to the plant by means of ash water lift pumps to the ash water supply pump house (AWSPH) for further use in ash handling units of the plant. Plants that are not able to efficiently recycle its ash water or do not recycle it at all often face issues of ashy dyke breach or ash water flooding to nearby surroundings.

Though government has made it mandatory for power plants to utilize 100 per cent of its ash in dry form, more than 50 per cent of the coal-based power plants in India are still in non-compliance of this order. Due to low utilization, about 35 per cent of the ash on an average has remained unutilized every year in last decade and it ends up in ash ponds.

In plants using lean slurry for ash transfer, the ash to water ratio is usually found to be as high as 1:20. Ash is transferred in lean form because the ash supply pumps installed in the plant are not designed to transfer ash in highly concentrated forms. Due to lean ash transfer or inefficient ash-water recycling systems, ash ponds overflow at times or ash walls even break due to excess pressure built-up.

Measures for reducing ash pond drains or overflow include reducing the water to ash ratio for slurry disposal, recirculation of ash pond water back to plant to the maximum extent possible or use of high concentration slurry disposal (HCSD) system which can transfer ash slurry in highly concentrated form thereby reducing ash water consumption and overflows. Also, if every power plant adopts 100 per cent utilization of ash in dry form, the issue to ash slurry disposal and ash pond overflows can be drastically reduced leading to zero discharge from ash ponds or ash handling plant of power plants.

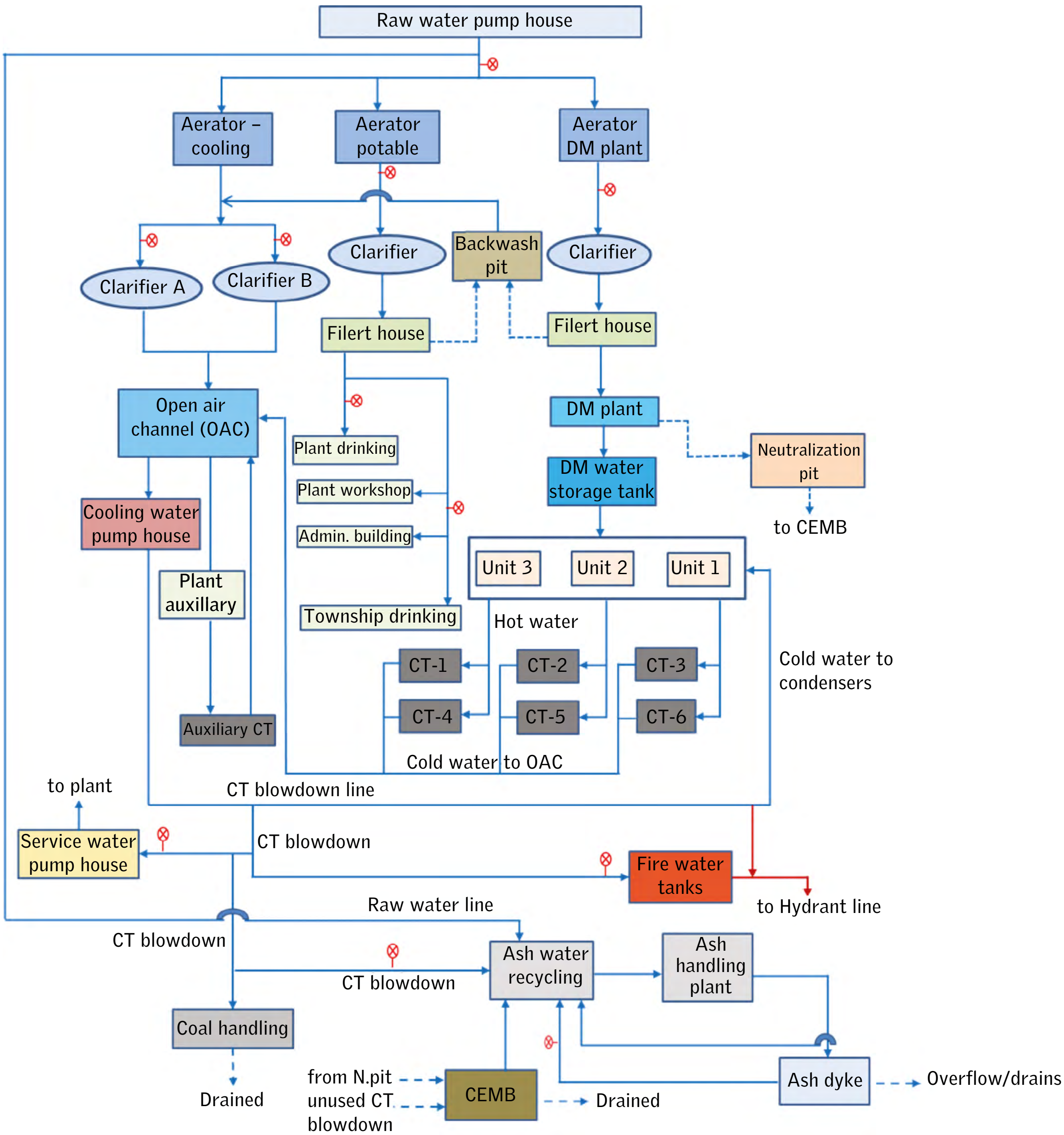
Bottom ash handling pumps

Fly ash handling pumps

Decanted ash water in ash pond

Ash water pumping and recycling system (AWRS) and decanted ash water in ash pond which is recycled back to the plant for reuse in ash handling

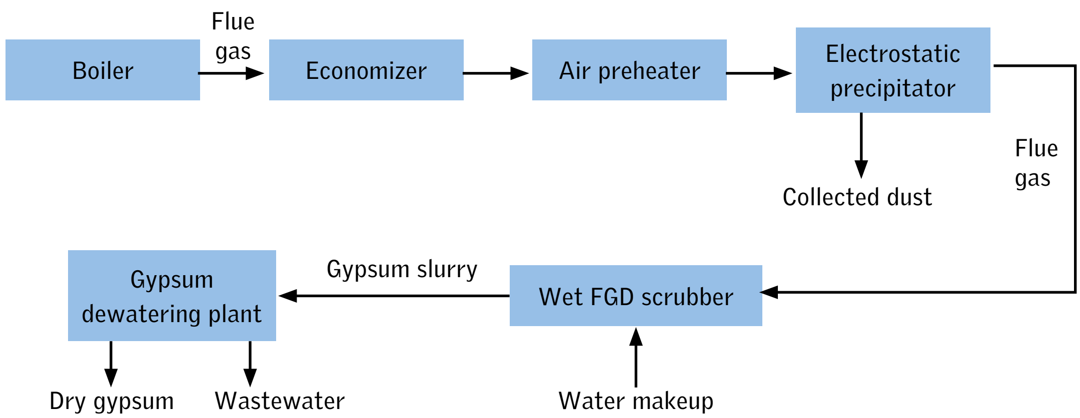
Figure 4.1: Water and wastewater circuit of a coal-based plant with three power-generating units depicting major water-consuming sections and process wastewater drains



Note: CT—Cooling tower; CEMB—Common effluent monitoring basin; DM—Demineralization; N. pit—Neutralization pit

Source: Centre for Science and Environment (CSE), 2021

Figure 4.2: Flue gas desulphurization (FGD) system showing water consumption and wastewater discharge schematic



Source: Centre for Science and Environment, 2021

- **Flue gas desulphurization (FGD) system:** With introduction of stringent norms for sulphur dioxide, it has been made mandatory for power plants to install flue gas desulphurization (FGD) systems which removes SO_2 gas from flue gas though scrubbing. However, only 35 per cent of the total coal-based capacity is so far complying or has awarded tenders for FGD installation. With installation of FGD, a plant's specific water consumption will also increase as the system requires water for scrubbing SO_2 out from flue gas. As per CEA, the operation of FGD requires an additional water of about 0.3 m^3/MWh. Wastewater from wet flue gas desulphurization (wet FGD) systems plants contain highly soluble salts, such as calcium and ammonium chlorides, and certain heavy metal salts. Therefore, plants that have already installed FGD need to treat and completely recycle its FGD wastewater along with plugging other major wastewater streams in order to be 'zero discharge'.

Strategies to achieve zero liquid discharge in power plants

For becoming a zero discharge plant it is important to plug all major wastewater streams by r eliminating or preventing the discharge or by 100 per cent recycling and reuse of the generated waste streams. These sections mainly include central monitoring basin (CMB), coal handling plant, overflow drains from ash ponds or wastewater generated from flue gas desulphurization (FGD) system.

The following are the technologies and schemes that can be implemented to plug and recycle each wastewater stream in order to be 'zero discharge'.

1) **Recycling unused CT blow-down and other effluent streams collected in common effluent monitoring basin (CEMB) after advanced treatment:**

For zero liquid discharge system normally the method is pretreatment ultra-filtration, reverse osmosis (RO) (multiple stages), evaporator or crystallizer (ZLD). Because cooling tower blow-down is relatively dilute, generally less than 10,000 mg/L total dissolved solids (TDS), reverse osmosis (RO) membranes are often used to pre-concentrate the cooling tower blow-down prior to concentrating the liquid in an evaporator; the remainder is reduced to solids in a crystallizer. For much higher water recovery amounting to 90–95 per cent, two or three stage RO technology or high recovery RO plants are used wherein the RO reject of the first stage is passed through RO stage II for further extracting water from the rejects.

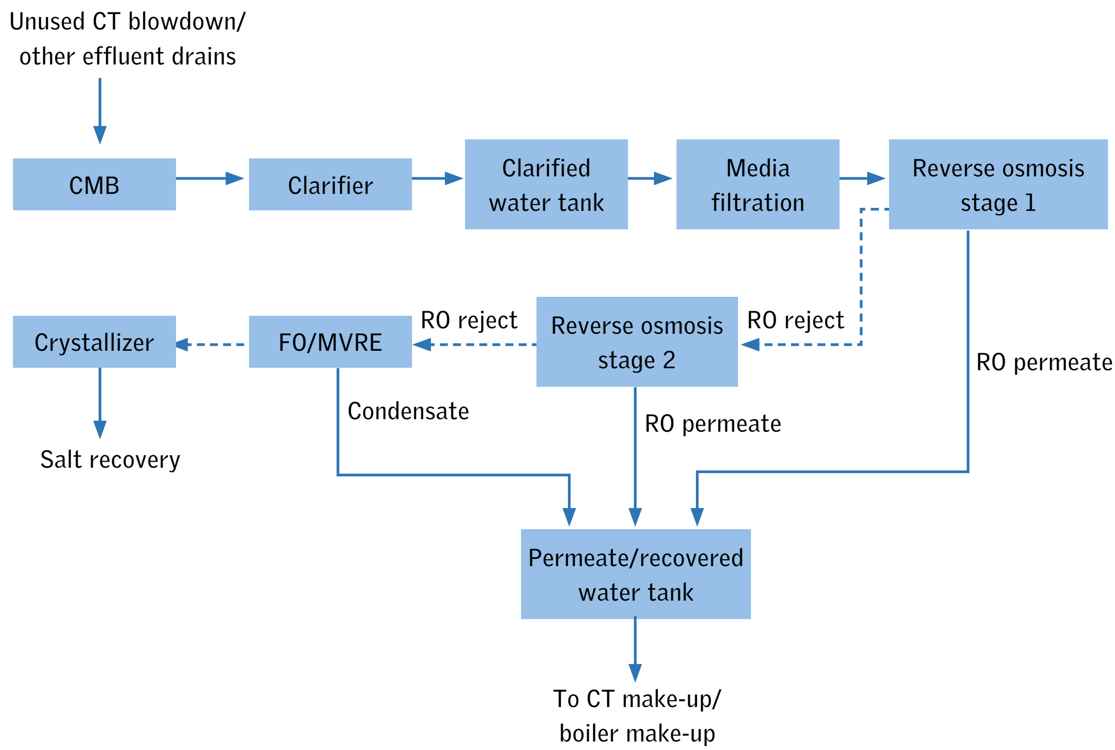
Thus, at the end of RO stage III, we get 95 per cent RO permeate water recovery and highly concentrated brine/salt solution in the form of RO reject that can be further treated as explained in the following. The recovered RO permeate water can be recycled back for cooling tower or boiler make-up.

- The salts present in cooling tower blow down are usually composed of sodium sulphate and sodium chloride with small quantities of calcium, magnesium, sulphate and bicarbonate. All of these salts can be readily crystallized by evaporation. The ZLD process flows have included reverse osmosis (RO) plus small brine concentrating evaporators, feeding either a last-stage crystallizer or discharging to a solar pond.

- There are at times evaporator design and performance issues in the first generation of ZLD plants, developed in 2005–09. This has opened door for newer and more advanced technologies such as high-recovery reverse osmosis (RO) and forward osmosis (FO) systems feeding into new thin film precipitating crystallizers. The treatment trains most commonly recommended by the design institutes for adoption in new ZLD projects have used either multi-effect evaporation or FO for the brine concentration step.[9]

In order to be zero discharge, unused CT blowdown or other drains getting collected in the central monitoring basin (CMB) can be treated through high recovery three stage RO systems which can lead to 95 per cent water recovery. This recovered water can be recycled back for cooling tower make-up or boiler make-up.

Figure 4.3: Zero discharge RO treatment scheme for unused CT blowdown and other effluent drains



Source: Centre for Science and Environment, 2021

2) **Recycling ash pond/dyke effluent drains or overflows to the maximum extent or practising 100 per cent dry ash collection**

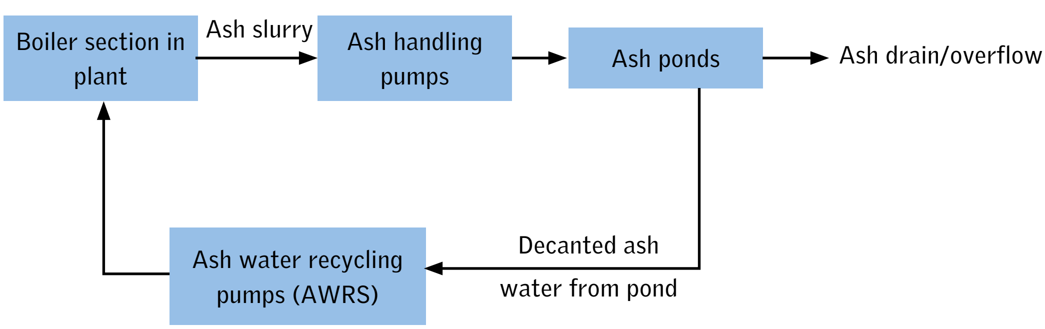
If every power plant adopts 100 per cent utilization of ash in dry form or its utilization to the maximum extent, then the issue of ash slurry disposal and ash pond overflows can be drastically reduced leading to zero discharge from ash ponds or ash handling plant of power plants.

While emphasis should be on extracting and handling ash in dry form to the maximum extent possible,, the remaining ash that is handled in wet form must have an effective ash water recirculation system in place which can transfer ash with minimum water requirement, as ash pumping and conveyance in lean slurry form leads to significant amounts of water consumption. A lean ash slurry mixture has over 25–30 per cent ash and the rest is all water which often leads to significant amount of freshwater use in ash handling. Plants following such conventional practice for ash handling usually have high specific water consumption due to excessive water usage for transferring ash in lean form. Excessive water usage can lead to pressure built up at ash ponds leading to frequent ash leakages and overflows from ponds. Also, inefficient recycling of decanted ash water from ash ponds back to the plant leads to water wastages and overflows from ash ponds to nearby areas. Therefore, in order to be zero discharge it is critical that power plants utilize water for ash handling judiciously, with maximum possible recycling. The water requirement can be drastically reduced with adoption of efficient ash water recirculation systems (AWRS) in place with water-efficient pumping and ash water conveying pipelines with no leakages in place. With AWRS systems in place, the decanted ash water from ash ponds is recirculated back to the plant for reuse in ash handling. One such technology for ash water recirculation is high concentration slurry disposal (HCSD). With effective operational AWRS system in place, more than 70 per cent of water can be recirculated back to plant from ash pond.

- **High concentration slurry disposal system (HCSD):** In HCSD systems, thick wet ash slurry is produced at a concentration of 65–75 per cent of ash which is pumped through specially designed high capacity pumps designed for transferring ash in highly concentrated form to ash ponds. Since ash is transferred in concentrated form, water consumption is reduced significantly and minimal water is released in the disposal area. HCSD system consists of a controlled feeding system for ash followed by its homogeneous mixing in Agitator Retention Tank (ART) to prepare a smooth slurry. Proper monitoring of the density of slurry is the key for successful implementation of this system. HCSD pumps transport the highly concentrated ash slurry from ART to ash ponds through pipelines.

Figure 4.4: Inefficient AWRS system without zero discharge

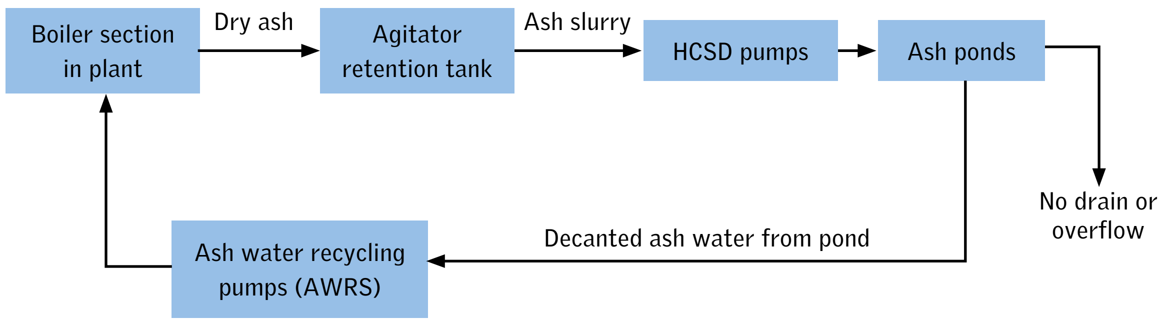
Any inefficient ash water recycling system will lead to ash pond overflows or drains. In order to be zero discharge it is important to have efficient ash management and a robust ash water recycling system in place



Source: Centre for Science and Environment, 2021

Figure 4.5: HCSD and AWRS system for achieving zero discharge in ash handling

With efficient ash water recycling pumps in place, zero discharge can be achieved in ash handling. Also, freshwater requirement for ash handling gets significantly reduced as entire water requirement can be met by recycled ash water from ash pond.



Source: Centre for Science and Environment, 2021

With adoption of efficient AWRS and HCSD systems, the entire water requirement for ash handling can be met by cooling tower blown down water with no additional freshwater make-up required to be added. Water requirement is almost one-tenth in HCSD systems as compared to lean slurry systems that transfer the ash in diluted form. This also drastically reduces the land requirement for ash disposal as high-density ash will require a smaller volume for disposal and also ash pond overflow or breach incidents can be prevented. The issue of frequent overflows due to lean slurry disposal can also be reduced. This system can help in achieving the goal of zero discharge in newer plants. It has been adopted by NTPC at its Mauda, Kudgi and Jhajjar plants. However, the status of its adoption by other state and private plants is not available in public domain.

3) **Recycling flue gas desulphurization (FGD) wastewater stream**: Wastewater from wet flue gas desulphurization (wet FGD) contains highly soluble salts, such as calcium and ammonium chlorides, and certain heavy metal salts, which are not so easy to crystallize by evaporation. As FGD wastewater is highly polluted, ZLD evaporation-crystallization processes for wet FGD require extensive pre-treatment. Usually, the wastewater must be treated with lime, soda ash, and other chemicals to replace the calcium, magnesium, ammonium, and heavy metal ions with sodium ions so that a crystalline solid can be produced. The pre-treatment equipment and chemicals increase the ZLD system footprint as well as the capital cost and system maintenance requirements. The water reuse system can include a series of tertiary treatment steps to generate an

effluent of desired quality. This includes pre-treatment steps such as a softener, media filter and Ion Exchange, followed by a two-stage reverse osmosis (RO) and forward osmosis (FO) or evaporator. The FO or evaporator reject can be processed through a crystallizer where an additional small proportion of the treated effluent is recovered which combined with the RO permeate water can be directly to the boiler. This technology involves multiple precipitation and crystallization steps, producing salts such as gypsum-magnesium hydroxide, magnesium hydroxide, and precipitated calcium carbonate.

Why has ZLD implementation not gained much traction in the coal-power sector in India?

Worldwide zero discharge technologies have been widely implemented in water intensive sectors like thermal power, steel, textiles and petrochemical industries. However, the adoption of these technologies have yet not gained much traction in the thermal power sector of India in spite of regulations that mandates zero discharge implementation in plants commissioned post 2016.

Today, power plants remain the major domain of ZLD implementation globally, where flue gas desulphurization (FGD) wastewater and cooling tower blow-down are treated and recycled using ZLD technologies. The challenge from the long-term perspective is to keep ZLD economically feasible. Evaporating wastewater to 95.5 per cent of solids is an energy intensive and expensive process. ZLD projects have high capital costs, expand the footprint of the power plant, and engender high operations and maintenance (O&M) costs—with coal-plant operators required to manage advanced water treatment equipment. Also, achieving ZLD in flue gas desulphurization (FGD) applications can be complex due to its highly polluting wastewater stream which needs to be treated and recycled.

In India, requiring all new plants after 2017 to achieve ZLD needs considerable thought and planning for selecting the most economical approach to achieve ZLD as the technologies required to achieve ZLD are costly and energy intensive. As a result national and regional GENCOs, and independent power producers (IPPs), are making slow progress in meeting the ZLD challenge. To help overcome the capital cost hurdle independent power producers (IPPs) are looking to government for some form of compensation, or increased tariffs. The high O&M cost of ZLD equipment has led the public sector GENCOs to seek a government incentive for it, and pursue a Supreme Court ruling on the possibility of Merit Order Dispatch changes that reflect the cost of implementing ZLD.

Examples of water-efficient zero-discharge plants

- **Budge Budge Power Plant:** Located in Kolkata has a specific water consumption of 2.25 m^3/MWh, Budge Budge Power Plant (750 MW) station was identified by CSE as one of the most efficient for its commendable efforts in water conservation in its 2015 rating study. The initiatives adopted towards zero discharge handling include zero discharge system for bottom ash handling, complete dry fly ash evacuation and handling system and 100 per cent fly ash use, emergency fly ash disposal by HCSD system, all volatile treatment for boiler water, and cooling tower with a COC of 6. Instead of freshwater, cooling-tower blowdown water is used in the plant for road washing, bottom ash handling, high concentration ash handling and sprinkling in the coal plant.

- **Torangallu Power Plant (JSW energy):** Identified by CSE as among the most water-efficient plants in its 2015 rating study, Torangallu Bellary power plant located in Bellary, Karnataka, has an average specific water consumption of 2.23 m^3/MWh. An RO plant is installed for unused cooling-tower blow-down water treatment. Treated RO permeate is recycled for cooling tower make-up. RO plant rejects are sent to the guard pond of the JSW Steel Plant for its ore beneficiation unit.

Using RO, FO, evaporation, or other processes to recover an additional 60 per cent to 7 per cent of freshwater from a saline cooling tower blow down source becomes more viable as treatment costs diminish with new technologies. RO, FO and other zero discharge technologies discussed above can economically process complex wastewater streams such as cooling tower blow-down and recover additional quantities of freshwater are in a position to provide significant value for new and existing industrial plants. Adoption of such technologies can pave the way for an entirely new generation of coal power plants.

5. The way forward to compliance and better reporting of data

Power plants are huge guzzlers of water. Power companies are well aware of the risk of water crisis in their business as many plants in recent past have been forced to take shut down periodically because of shortage of water or conflict with local communities over its use in times of drought. Therefore, water conservation is in the best interest of these companies.

The thermal power sector has already missed the December 2017 deadline for water norms, set by the Union Ministry of Environment, Forest and Climate Change (MoEFCC) in its 2015 notification. Post the 2017 deadline breach, no further deadlines were given to plants to meet specific water consumption standards. The 2017 direction of the CPCB to all power plants only said that the timeline for compliance with the water standard would be finalized in consultation with the plants. Since then, there has been no firm action taken on the implementation of this critical norm.

Water norms were introduced along with emission norms in 2015. Though the timelines for meeting emission standards have been revised from time to time, there has been no discussion in the case of achieving water standards. Water norms are highly neglected by the environment ministry and in such a scenario about 50 per cent power plants continue to flout them even when the norms are lax. This is when many regions of the country are reeling under acute water shortages due to ever-increasing industrial and domestic water requirements and increasing pollution of available freshwater sources due to untreated or partially treated effluent discharges from plants. Thus, there is an urgent need for action and revised deadlines.

Also, CSE through its study found several loopholes in self-reported data and data format followed across states to report specific water consumption in environment statements. Additionally, there is no third party monitoring and verification of the data, which is self-reported by plants. In such a scenario, there is a high probability of data manipulation and underreporting.

Going forward, CSE recommends the following to expedite compliance of water norms and for better reporting of data:

Review implementation of water consumption norms and issue clear deadline to non-complying plants

CSE surveyed about 75 per cent of total coal-based capacity (205 GW) and found that over 42 per cent plants were non-complying to water norms in the surveyed capacity, about 41 per cent were complying and about 17 per cent exempted from meeting the 2015 water consumption norms (as they were seawater-based plants). Thus, even six years after the water norms were notified, a major capacity today tend to non-comply. The non-complying plants include both cooling-tower based plants flouting the norm of 3.5 and 3 m^3 per MWh and freshwater-based once-through plants which have not yet installed cooling towers. As per the CSE survey, the majority of these plants belong to state-owned generation companies. Uttar Pradesh and Maharashtra possessed the maximum number of non-complying plants many of which had older units commissioned 25–30 years ago and belonged to Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited (UPRVUNL) and the Maharashtra State Power Generation Company Limited (MahaGENCO).

CSE recommends that the Ministry of Environment, Forest and Climate Change (MoEFCC) and the Central Pollution Control Board (CPCB) should review the implementation of water standards. Though power plants submit on a quarterly basis their specific water consumption data to Pollution Control Boards, the task of monitoring should not be only to paper work and clear deadlines should be provided to plants to achieve compliance. Plants identified to be non-complying should be further issued directions and notices to immediately comply with the deadlines given to them.

Prioritize implementation of norms in water-scarce regions

As per recent CSE estimates, about 48 per cent of coal-power fleet already lies in districts facing water scarcity. Plants located in water-scarce regions must be made to comply immediately with the norms in order to reduce excessive water wastages by non-complying plants located in these regions. As identified by CSE, few such regions include Nagpur and Chandrapur in Maharashtra; Raichur in Karnataka; Korba and Raigarh in Chhattisgarh; Barmer and Baran in Rajasthan; Khammam and Kothagudem in Telangana, Cuddalore in Tamil Nadu and Birbhum and West Medinipur in West Bengal. It is important that CPCB come up with an action plan to expedite compliance of plants located in these regions by issuing them deadlines to immediately comply with the 2015 water norms.

Prioritize decommissioning of old freshwater-based once-through cooling plants or expedite its conversion to closed-loop plants.
About 17 GW capacity is identified to be freshwater-based once-through cooling plants. These are older units, the majority of which were commissioned before 1999. The 2015 standard had directed that all freshwater-based once-through cooling (OTC) plants mandatorily shift to cooling tower. This would reduce water withdrawal from 70–200 m^3/MWh to 3.5 m^3/MWh.

Of the 17 GW capacity, a major capacity was included in Ministry's plan of retiring old and inefficient plants but many of these plants have not yet retired and are continuing to operate with no plan to upgrade or install either emission control equipment or cooling towers. The once-through plants scheduled for retirement included Bandel TPS, Chandrapura TPS, Dr Narla Tata Rao TPS, Korba III (Korba East), Mettur TPS, Neyveli TPS and Obra TPS. Installing a cooling tower would take two to three years and requires an investment of Rs 20–25 lakh/MW. Payback is possible only when the operating age of the plant can be to another 10–15 years.

The choice is, therefore, to retire the old plants or completely retrofit them if they are not being retired soon. For much older plants with little operating life left, installing such expensive emission technologies and cooling towers is not economically feasible due to the longer pay-back period, and these plants should be immediately decommissioned instead of retrofitting them. Clearly, water stress will only grow further if these plants will continue to operate. The rest of the older plants with a slightly longer operating life can be issued deadlines for conversion to closed loop. Thus, the environment ministry and Pollution Control Boards must ensure that all freshwater-based once-through plants are either shut down permanently or install cooling towers at the earliest possible.

Self-reported water consumption data must be cross-verified by a third party agency or regulatory bodies through annual audits
It is seen that the SWC figures are self-reported by plants to Pollution Control Boards. These, or the status, have not been verified either by the state Pollution Control Boards or any other independent agencies. In such a scenario and as per CSE survey, many plants continue to under-report, misrepresent data and operate with specific water consumption higher than the limit, leading to excessive water wastages by them which is not even accounted for at times.

It is important therefore that the self-reported values are cross-verified by independent agencies either through full-fledged conduction of water audits and water balance studies, or through monitoring and verification audits, to assess the actual water consumption, very similar to the Perform, Achieve and Trade (PAT) scheme currently operating in India that allows independent third-party agencies to conduct periodic energy audits and also monitoring and verification audits of plants to validate and cross-verify energy consumption data submitted by plants under the PAT scheme to Bureau of Energy Efficiency (BEE).

Similarly, it must be made mandatory by the environment ministry or regulatory bodies that power plants conduct annual water audits especially non-complying plants as water audit studies can identify further scope for water conservation, recycling and reuse within a plant to achieve compliance. Annual water audit reports must be submitted to regulatory bodies along with environment statements.

Periodically calibrate raw water meter installed in power plant and submission of calibration report to regulatory agency

Water meters installed in the plant especially at raw water extraction side must also be checked by third parties or regulatory bodies for its correctness. Also, power plants must ensure calibration of their water meters from time to time and the record of it must be submitted to Pollution Control Boards. This is important so that the water consumption values are recorded correctly and show an accurate picture of water consumed by any plant as faulty meters often lead to underreporting of water consumption.

Adoption of uniform format to report water consumption and compliance data in environment statements

The CSE survey observed that few plants omitted providing data especially on plant-specific water consumption and only provided break-up of water consumption in terms of cubic meters per day (m^3/day) or cubic meters per annum m^3/annum in their environment statement which is of no relevance when it comes to identifying a plant's compliance and non-compliance unless the plant also provides data on its plant load or electricity production for that year, which makes it easier to calculate plant-specific water consumption in cubic meter per megawatt hour (m^3/MWh). Also, there are plants which instead of providing 'plant-specific water' tend to give either process or DM water consumption per unit of product (in m^3/MWh) which is always much less as it does not take into account cooling, domestic or ash handling freshwater consumption. This leads to immense confusion while comparing specific water consumption (SWC) of different plants and underreporting of SWC.

Therefore, a uniform format must be adopted in line with the water norms which can give complete information on compliance of the plant with respect to SWC and also zero discharge (see *Box in Section 2.2: Format to report water consumption data in environment statement*).

Document best practices of water-efficient complying plants with low specific water consumption (less than 2.5 m^3/MWh) and those that have successfully achieved zero discharge

Currently, the information on water management best practices and successful zero discharge implementation models is largely lacking in Indian power plants. Plants that report their specific water consumption to be as low as 2.5 m^3/MWh or below it, must document their approach and practices followed to maintain a low specific water consumption. Also, plants that have successfully achieved zero discharge should document their approach in achieving it. These documented practices must be shared with all power plants across India for them to adopt and follow it and must also be made available in public domain.

Based on reported SWC data, CSE identified several plants that were consuming 2.5 m^3/MWh or below, including Nabha Power Limited, Torangallu TPS, Sasan Power Limited, KSK Nariyara, MB Power Limited, Budge Budge, Adani Tiroda, Reliance Power Plant, Adani Korba west, Maithon TPP, etc. These plants must be directed by regulatory authorities to document and submit their water management practices which can be circulated with all power plants across India.

Evolve systems of effective deterrence to ensure compliance with water standards

It is clear that this sector which provides an essential service—that of power and electricity—is difficult to shut down. Pollution Acts have limited power to order closure. Even in times of power surplus, shutting down power plants could lead to local outages. Therefore, we need a system in which complying plants are incentivized—so that they invest in upgrading their technologies and reduce their water consumption—and a disincentive given for the laggards, who flout the SWC limit and continue to pollute the surroundings with its effluent discharge and compromise public health. The other option is through stiff penalties on the non-complying plants. Different penalty slabs can be devised for different SWC ranges. For example, a plant in the range of 3–4 m^3/MWh should pay a smaller penalty than a plant exceeding this range.

Robust and effective policy to encourage use of treated municipal sewage to reduce freshwater consumption in power plants

In states where freshwater charges for industries were high and where there was acute water stress, industries were seen to come forward to buy water from sewage treatment plants. In order to address the issue of water stress, the ministry had explored other ways to curtail demand for freshwater of power plants as well. To encourage use of treated sewage in power plants, the Union Ministry of Power (MoP), on 20 January 2016, amended the Power Tariff Policy of 2006, mandating thermal power plants within 50 km of a sewage treatment plant (STP) to compulsorily use treated sewage water. It was decided that the associated cost on this account would be allowed as a pass-through in tariff. However, policy could not effectively materialize on field. According to the MoP reply in Lok Sabha in December 2018, 'Only 1,179 million litre per day of STP water is available for TPP within 50 km which is only 5 per cent of the total treated sewage (23,000 million litre per day as per 2016 estimates) generated in India. Out of the total available sewage, only one per cent (250 million liter per day) of it is currently utilised.'[10]

Reasons for poor utilization of sewage water considered were the confusion between municipal corporation and power plants to set up pipelines and tertiary treatment plants as well assetting up the charges for water. Understanding the considerable delay happening in sewage utilization in thermal power plants, the MoP slightly tweaked the accountability in March 2020 to ensure sewage water be used by the thermal power plants. According to a report by non-profit Greenpeace International, less than 15 per cent of the total coal power plant capacity dependent on freshwater had a sewage treatment plant within 50 km of their location.[11] This is because large sewage treatment facilities are usually located near large urban areas while coal power plants are mostly located near coal mines or in regions where land and water is available at lower costs, which, again, are usually far away from urban regions. Such policies are leading to lack of positive ground results

Ensure zero discharge (ZLD) implementation in newer plants commissioned post 2016

As government has already made it mandatory for plants post 2016 to adopt zero discharge, these plants must be monitored for zero discharge compliance and non-complying plants should be dealt with strictly. Many of these post 2016 plants are owned by NTPC and some are state owned. NTPC must take the lead in implementing zero discharge in its newer fleet, which can set an example for other plants to follow. More stringent regulations, rising expenses for wastewater disposal, and increasing value of freshwater are key drivers for ZLD. But as the technologies for ZLD are costly and energy intensive, national and regional gencos, and independent power producers (IPPs) are reluctant in implementing it. To help overcome the capital cost hurdle independent power producers (IPPs) are looking to government for some form of compensation, or increased tariffs or the possibility of Merit Order Dispatch changes that reflect the cost of implementing ZLD. These aspects must be looked into by the ministry to expedite the zero discharge adoption.

Urgent interventions are needed to reduce the water footprint of the thermal power plant sector, which is heavily reliant on water for its operation. Water conflicts are set to increase with growing water demand within various sectors. Industrial sectors, especially power plants, will face the major brunt of this conflict. With over 40 per cent of the coal based plants located already in water stressed regions, it is important that the current and future fleet of coal power plants be able to sustain and operate in the ever increasing water crisis situation. It is matter of survival for thermal power plants and only a comprehensive approach towards water use can save their future. Ensuring compliance to water norms, adopting water efficient technologies, optimizing water use in various sections, using municipal sewage as input water and adopting zero discharge can drastically reduce the overall water footprint of the sector.

References

1. Soundaram Ramanathan, Sugandha Arora and Vinay Trivedi 2020. *Coal-Based Power Norms—Where Do We Stand Today? Centre for Science and Environment.*

2. 2015. India's first-ever environmental rating of coal-based power plants finds the sector's performance to be way below global benchmarks. Retrieved from: https://www.cseindia.org/indias-first-ever-environmental-rating-of-coal-based-power-plants-finds-the-sectors-performance-to-be-way-below-global-benchmarks-5685

3. Luo, T. 2018. 40% of India's Thermal Power Plants Are in Water-Scarce Areas, Threatening Shutdowns. Retrieved from: https://www.wri.org/blog/2018/01/40-indias-thermal-powerplants-are-water-scarce-areas-threatening-shutdowns

4. Soundaram Ramanathan, Sugandha Arora and Vinay Trivedi 2020. *Coal-Based Power Norms—Where Do We Stand Today?* Centre for Science and Environment.

5. Meldrum, J., Anderson, S., Heath, G. and Macknick, J. 2013. *Life Cycle Water Use for Electricity Generation: A Review and Harmonization of Literature Estimates.*

6. Meldrum, J., Anderson, S., Heath, G. and Macknick, J. 2013. *Life Cycle Water Use for Electricity Generation: A Review and Harmonization of Literature Estimates.*

7. Iris Cheng and Harri Lammi 2016. *The Great Water Grab—How the Coal Industry is Deepening the Global Water Crisis*; Greenpeace International.

8. Pradeep Pandey 2016. 'Water crisis hits power plants', *The Hindu*, 26 March 2016.

9. Water-Stressed Regions Provide Proving Grounds for Advanced ZLD Systems 2015. Retrieved from: https://www.powermag.com/water-stressed-regions-provide-proving-grounds-advanced-zld-systems/

10. Vinay Trivedi 2020. 'Why better policies are needed for sewage water use in thermal power plants', *Down to Earth*, 4 June 2020.

11. Jai Krishna R 2017. 'Pipe dreams-treated sewage will not solve coal power's water problems', Greenpeace India Society

Coal-power plants consume huge amounts of water. With growing water stress in several regions of India, it is vital that they use water judiciously.

To reduce their water footprint, these plants must comply with the water norms introduced by the Ministry of Environment, Forest and Climate Change (MoEF&CC) in 2015. The deadline to meet the water norms was December 2017, but it was largely disregarded.

This report studies the current status of compliance of coal-power plants with respect to implementation of the water norms. It highlights how the water-guzzling coal-power industry is ignoring water regulations and critically analyses the authenticity of the specific water consumption data that is self-reported by power plants to regulatory authorities. It also discusses the zero discharge schemes and their application in coal-based plants and the way forward to expedite compliance with the 2015 norms.

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