Implications of New Regulations for Water Consumption by Coal Thermal Power Plants

Full Detailed Note

Manthan Adhyayan Kendra. February 8, 2016.

On 8th Dec 2015, the Ministry of Environment, Forests and Climate Change (MoEFCC) notified new regulations concerning emissions and water use of thermal power plants (TPPs) in India. This was in the form of amendments to the Schedule I of the Environment (Protection) Rules 1986. This note analyses some implications of these new regulations.

This note limits itself to looking at the implications of rules with respect to the water consumption limits of coal based power plants.

KEY NEW REGULATIONS

The notification essentially brings in four changes or new regulations:

1. It requires all thermal power plants with once through cooling (OTC) to install cooling towers (which we can infer to mean that they have to switch to recirculating cooling)
2. It requires all these above plants, and all existing plants with cooling towers to achieve a maximum specific water consumption of 3.5 Cubic meter / MWh (Cum/MWh).
3. New plants to be installed after 1 Jan 2017 to meet specific water consumption of 2.5 Cum/MWh.
4. New plants to be installed after 1 Jan 2017 to achieve zero waste water discharged.

Before we look at the implications of each, two important overarching facts need to be noted. One, there is limited data available in public domain regarding designed water consumption by thermal power plants, and practically no data regarding theactual water consumption. This makes it difficult to gauge fully the implications of the new rules. Second, water consumption varies widely across individual power plants, depending on a host of factors ranging from plant technology, plant efficiency, coal quality, location, operation and maintenance practises etc. This means that the implications for each plant will vary on a case by case basis.

SUMMARY HIGHLIGHTS

- For the first time, there will be legally mandatory limits on the amount of water a thermal power plant can consume. This is a welcome step, for thermal power plants are huge consumers of water.
- The regulations for existing plants, allowing maximum specific consumption of 3.5 Cum/MWh, are considerably lax. The Central Electricity Authority (CEA) itself has noted in its 2012 report on minimisation of water use at thermal power plant that even sub-critical plants (which is the technology used by most existing TPPs) can achieve a specific consumption of 3.0 Cum/MWh. Even these lax regulations would however, be an improvement over the current water consumption of existing TPPs.
- The water consumption limit set for plants to be installed after Jan 2017 is 2.5 Cum/MWh. This represents the advantage that would be offered by the use of better and more efficient

technology as TPPs after this date are also required to be based on supercritical technology. These norms are well within the reach for such technologies. However, CEA and MoEFCC will need to ensure that the newer plants are actually designed to take full advantage of what the new technology offers, particularly in water and coal use. This is not the case right now.

- Many TPPs are likely to require significant modifications to their original designs to comply with the new regulations. These changes could be in the cooling systems like installing cooling towers, or in the ash disposal systems, or in waste water disposal systems or others. CEA/MoEFCC should assess all existing and proposed TPPs to see which TPPs need what kind ofdesign changes and retrofits, and should monitor the progress on the same.
- If the water consumption limits are implemented and adhered to in letter and in spirit, these limits will have two major benefits. One is of course that if thermal power plants follow these limits, then significant quantities of water would be saved, water that could be used for other purposes, or could remain in the water bodies and ecosystems, helping preserve and protect these.
- MoEFCC should revise environmental clearances to TPPs to reflect the new water requirements, and should work with state governments to ensure that TPPs surrender any water allocation that is in excess of the newly worked out water requirement.
- Another, and equally major benefit of the new regulations would be a curb on huge quantities of ash being dumped as slurry in ash ponds all over the country. This is because one major component of water consumption goes towards wet disposal of ash, and dry disposal and full utilisation of fly ash would be critical to meetingthe proposed limits – at least the limits for the plants installed after 1 Jan 2017.
- At the same time, the new limits, combined with some other regulations introduced by the MoEFCC, would need significant quantities of coal to be first “washed”, which would be done by washeries in the mining areas. This could result in pushing and concentrating the ash disposal as well as water consumption problem onto coal mining areas, where it has already reached crisis proportions. This implies that along with the new water regulations, it is important to also bring in better regulations and their better implementation for the washeries and for washery reject based thermal power plants.
- Proper implementation in letter and spirit of the new water consumption regulations will be critical factor that will determine how effective these regulations are.
- The regulations related to water, as well as the existing regulations related to ash utilisation, and some new amendments to them are complementary and reinforce each other. If MoEFCC can also bring in better regulations for washeries and washery reject based power plants, all these would provide tremendous synergy in achieving multiple benefits of reducing water use and curbing pollution due to ash.
- Some of the factors that will help better and more effective implementation of these norms include the political will of the authorities, especially MoEFCC to enforce these regulations, the synergetic application of regulations for ash, water, washeries, and washery reject based plants, regular and publicly accessible monitoring and reporting of actual water use by TPPs, and effective citizen and community participation.
- Effective citizen and community participation will be critical to effective implementation. In turn, effective public participation will need full transparency, and hence MoEFCC and CEA must mandate full monitoring of the actual water use, including its breakup for various

different purposes, and must ensure that all this information is available in the public domain.

- CEA/MoEFCC must also make public the design changes and retrofits required for all existing, under-construction and planned TPPs. They should track the progress on this, which too should be made public.

IMPLICATIONS OF NEW REGULATIONS IN DETAIL

A. Water Needs of a TPP

To understand the significance of the new regulations, we need to understand how water is used in a power plant. The two major uses of water in a coal based power plant are for cooling the hot steam that is used in the turbine to generate electricity, and for ash disposal.

In a cooling tower based system – which is what all TPPs now have to eventually switch to –water is used to cool the steam that circulates in the boiler-turbine-condenser loop. This water, which itself become hot when it cools the steam, is cooled in the cooling tower. In the process, some of it evaporates. This is one part of the consumptive use of water. At the same time, as part of the water evaporates in the cooling tower, the concentration of salts increase there; to maintain it at allowed levels, some part of the water is drained away and replaced by raw water from the source. This is called blow down, and is another significant amount of water used by the system. The blow down water can be used for other needs in the TPP including ash disposal.

Burning of coal generates ash, which needs to be disposed off. Indian coal is particularly very high in ash content (30% to 45%) and hence amounts of ash generated by TPPs burning Indian coal are massive. Till recently, much of this was just mixed with water, made into slurry and disposed off into vast ash ponds. This not only needs large quantities of water (sometimes even more than for cooling) but also contaminates the environment. Indeed, it would not be wrong to say that ash from coal based TPPs has become a menace of the first order in the country[1]. Ash is of two kinds. One is "fly ash" which gets airborne with the flue gases (exhaust gases) and is trapped and precipitated using electrostatic precipitators or other technologies, before the flue gases escape through the chimney. The second is the bottom ash, which collects at the bottom of the furnace in a coal power plant. The rough proportion in which fly and bottom ashes are generated is 80:20[2].

To give an idea of the dimension of the problem, coal ash generated in the country in 2014-15 was about 184 million tons[3].

As fly ash is a major contaminant, and there is increasing evidence that it is also toxic, there has been an attempt to minimise its disposal in the environment and try and reuse it. Fly ash can be used in the manufacture of cement - its biggest use so far, to manufacture fly ash brick and in concrete mixes. Other uses are more controversial as they are more of a disposal rather than re-use, and can

[1] See http://indiatogether.org/grave-threat-from-coal-ash-environment for a detailed account.
[2] *Report on Minimisation of Water Requirements in Coal Based Thermal Power Plants*, Central Electricity Authority, Government of India, 2012. Page 5
[3] *Report on Fly Ash Generation at Coal/Lignite Based Thermal Power Stations and Its Utilisation in the Country for the Year 2014-15*, Central Electricity Authority, Government of India, Oct. 2015. Page 2

pose serious threats to the environment and human health, particularly from pollutants leaching or leaking into surface and ground water. These include use in agriculture as a soil conditioner, use to fill mine voids and for reclaiming low lying areas. MoEFCC regulations now mandate 100% fly ash re-use within 4 years of commissioning of a TPP. If this regulationis implemented properly, this would in effect mean that there will be no ash to dispose (except in emergencies and in the initial years), and hence practically no water would be needed for this purpose. It may be reiterated, however, that some of the categories of "utilisation", as mentioned earlier, could endanger the environment and human health.

Unfortunately, this regulation is violated grossly, and many power plants are not achieving the mandatory 100% reuse. CEA's report on fly ash generation and utilisation for 2014-15 states that the number of TPPs which achieved the target of ash utilisation as per the MoEF Notification of 3rd Nov 2009 was just 50 TPPs out of 145 monitored, whereas 89 TPPs could not meet the requirements of the regulations.

It appears that the new regulations for water consumption are partly designed to allow this violation to continue, as we shall explain below.

Bottom ash is difficult to dispose off in the dry form, and hence water will be needed for its disposal. However, this will be a lesser quantity than the water that is used for disposing fly ash, and can be obtained from the blow down.

In 2012, Central Electricity Authority (CEA) brought out a publication on minimising water use at TPPs, and suggested that TPPs could (and should) achieve a specific consumption of 3 Cum/MWh. The following table extracted from this report gives the major heads of this specific consumption.

Sr. No.	Particulars	Water (Cum/MWh)
1	Cooling Tower Make Up Water	
	Evaporative needs	2.040
	Blow Down	0.450
	Drift loss	0.060
2	Bottom Ash Handling system (from blow down, so not needed from raw water source) 0.09 Cum/MWh	
3	Other needs like Demineralisation plant input, service water, reservoir evaporation, potable water etc.	0.487
	TOTAL	3.000

Note: All heads are not listed by us, nor areseveral internal recycling and reuses.

As this table shows, the TPP would need to withdraw 3 Cum/MWh from raw water source. This water use plan has some key assumptions, including that fly ash will be fully utilised as per MoEFCC regulations, and will be handled in the dry form, that ash water recovery system will be in place, and that the TPP is a sub-critical plant. Sub-critical refers to the technology used by the plant (particularly the temperatures and pressures at which it operates) and defines the efficiency of converting fuel coal into electricity. These numbers do not include the water that would be needed if the plants have to install Flue Gas Desulphurisation (FGD) equipment.

Based on this, we now look at the implications of the new regulations

B. Regulations for Existing TPPs

While the 2012 CEA report on water minimisation at TPPs itself clearly shows that even sub-critical TPPs can attain water use of 3Cum/MWh, the new regulations allow it to go up 3.5 Cum/MWh. As the 3 Cum/MWh use is conditional to 100% reuse or utilisation of fly ash, the additional margin of 0.5 Cum/MWh clearly seems to be provided to allow TPPs to continue to dispose off fly ash in the wet form in ash ponds, allowing violation of the MoEFCC regulations.

This apprehension is supported by the 2012 CEA Report which says that if fly ash disposal in wet slurry mode is to be continued, then water needs of a TPP would be 3.6 Cum/MWh.

To put it in perspective, the additional 0.5 Cum/MWh that a TPP is allowed to use would mean that a 1000 MW TPP (operating at 80% plant load factor) would use about 3.5 million cubic meters of additional water every year. This additional water is equivalent to be water needed to irrigate about 700 ha of land.

Thus, the new regulations are quite liberal at least for existing TPPs and for those to be installed before January 2017.

It is ironic that even with these weak regulations, large number of TPPs will likely have to go for retrofits and change in design as they have been planned for much higher water consumption than even the liberal 3.5 Cum/MWh. The figures for actual water consumption by TPPs are not available in the public domain, but we have looked at the environmental clearances given to TPPs which give the design water requirement for any particular project. Even though these figures don't give any head wise break up, they indicate that TPPs have been planned with a wide range of specific water consumption.

For example, looking at the environmental clearances given to coal based TPPs between 2006 and 2012, there were 22 TPPs with specific water consumption greater than 4 Cum/MWh. (We have excluded coastal TPPs which typically have much higher water consumption, even though they too will be covered by the new regulations). A look at some of the later environmental clearances also shows TPPs with similar levels of water consumption. Older TPPs are likely to have even higher levels of water consumptions. The CEA2012 report notes that the older TPPs have water consumption between 5 to 7 Cum/MWh. This indicates that many TPPs will have to substantially modify their designs to reduce their water consumption.

Additionally, if some of these plants have to install FGDs, which may be necessary due to the air pollution related parts of the new regulations, then they would have to make further adjustments to stay within the water consumption limits.

The extent and kind of modification needed will depend on the specific conditions of individual plants.

For these existing TPPs, we would urge that since many of them would anyway have to retrofit, CEA/MoEFCC should encourage them to move to the norm of 3 Cum/MWh, rather than the 3.5 Cum/MWh allowed now by the new regulations. Similarly, we would urge that the norms should be

tightened to the lower figure of 3 Cum/MWh, which CEA itself has indicated is achievable by a normal sub-critical plant.

C. Regulations for TPPs to be installed after Jan 2017

TPPs to be installed after 1 Jan 2017 will be required to limit their water consumption to 2.5 Cum/MWh. Given that the CEA report on minimisation of water at TPPs itself gives a normative minimum consumption of 3 Cum/MWh, how are the new plants to achieve this limit, which is lesser than 3 Cum/MWh?

The key is that the figure of 3 Cum/MWh is for sub-critical plants. The Government of India has now adopted a policy decision that all coal based TPPs to be commissioned in the 13th Plan period (2017-2022) would have to be super-critical or better[4].

Super-critical plants are more efficient than sub-critical plants in terms of the amount of electricity generated per fuel burnt (the so called Station Heat Rate, SHR). This will significantly lower water consumed in the cooling side, particularly the evaporation. Evaporative water requirement of about 2 Cum/MWh for subcritical plants could go down to 1.5 – 1.7 Cum/MWh for supercritical plants. This leaves enough marginwith the plants for water for other needs including blowdown.

However, this is in theory. A look at the parameters for several of the TPPs currently planned shows that just theevaporative water requirements of even supercritical plants are close to 2 Cum/MWh or even more. Given this, and the otherwater requirements of a TPP, such supercritical plants will have to introduce design changes to achieve lesser evaporative rates, and ensure dry collection and 100% utilisation or fly ash to meet the new norms of limit of 2.5 Cum/MWh.

This makes the new regulations welcome, for they will not only curb water use but will put pressure on the plants to ensure full use of fly ash, thus helping alleviate somewhat the fly ash menace.

To ensure proper implementation, MoEFCC/ CEA may have to examine each of the new plants coming up after 2017 to see that its design is aligned to the new limits, and if not, it is suitably modified.

Apart from ensuring that new plants are designed to achieve the new water norms, it is also important to understand some other factors or threats that create risks of new TPPs not meeting the standards.

First, given the current experience of the huge gap between what the law requires and what the TPPs have been able to achieve in terms of utilisation of fly ash, there is room for concern on the water utilisation limits too. In case power plants continue to slip-up on fly ash target, they are likely to pressure Government to ignore their defaulting on the water limits also. At present, the government just seems helpless in ensuring that fly ash utilisation target are met, and as a result, millions and millions of tons of fly ash is accumulating in the country without any clue as to what will happen to it.

[4] Press Note of Ministry of Power, dated 12 March 2015, at http://pib.nic.in/newsite/PrintRelease.aspx?relid=116893

It's a moot question as to how a Government that cannot find the political will to implement the fly ash regulations will find it to implement the water consumption regulations.

Second, the Ministry of Power has indicated that out of the total thermal capacity of 87,000 MW under construction as in March 2015, 48,000 MW is supercritical[5]. This means that 39,000 MW is sub-critical. The capacity from this 39,000 MW which is not commissioned before 1 Jan 2017 will still have to meet the norm of 2.5 Cum/MWh water use, which would be very difficult for a sub-critical plant. It remains to be seen what the Government would do in such a case. We hope that the new regulation period does not start by a relaxation of norms for these plants. To avoid such a situation, it's important that the CEA/MoEFCC examine each of the TPPs likely to come up after 2017 and ensure that they modify their designs to meet the new standards.

Third, while supercritical plants are more efficient and hence use less water, they also need better quality coal to operate. This means that the plants will have to either use imported coal – not all plants can do this – or will have to use Indian coal, but washed. If washed coal is not available in sufficient quantities, then the efficiencies of these plants may suffer and they would consume more water.

Recognising these threats is an important first step in addressing the risks to effective implementation of new regulations. To address these risks and ensure better implementation, we feel it would be important for CEA/ MoEFCC to undertake a project by project assessment of those TPPs coming up after Jan 2017 and ensure that their designs are aligned to meeting the new water norms. At the same there, there would be a need to ensure the implementation of norms related to water, ash and washeries in an integrated manner.

D. A Different Risk Scenario

Related to this is another risk scenario. All new coal thermal plants after Jan 2017 are required to be supercritical, and also to meet the water norms of 2.5 Cum/MWh. As these plants need higher quality coal, many of these plants will need to be supplied by washed coal. Further, Government of India (MoEFCC) regulations require TPPs located beyond 500 km of coal mines to use coal with ash content not more than 34%. This implies that many of these plants will also have to be supplied with washed coal. Given this, a big jump in washery capacity and washing of coal is expected, and is also planned.

Due to its very purpose, coal washing has to be confined to areas near coal mines – since the idea is to wash out the ash so that we don't transport unwanted ash along with coal. Coal washing is a water intensive process and also highly polluting[6]. It may be pointed out that coal washing – like any other washing – does not eliminate the waste (ash, in this case) but only separates (some of) it from the coal. While the "clean" coal will be taken away to TPPs, the waste will remain behind. Thesewashery "rejects" – the waste coal that now has much of the ash, and hence very high ash content - need to be disposed off, or are also burnt in reject-based thermal power plants. Such plants, which are located near the washeries, generate even higher quantities of ash than regular

[5] Press Note of Ministry of Power, dated 12 March 2015, at http://pib.nic.in/newsite/PrintRelease.aspx?relid=116893

[6] See http://indiatogether.org/pollution-from-coal-washery-rejects-choke-dhanbad-jharia-region-in-jharkhand-environment for some details.

plants, as they use coal with extra-high ash content. This means that the mining areas – which are already "hell-holes" of pollution, will face ever increasing burdens of washery pollution.

This calls therefore for much better regulation of washeries and reject-based power plants.

Moreover, washing of coal is a water intensive process. The norms suggested for this are 1.5 cubic meters of water per ton of coal processed. Our rough calculations based on this suggest that this would translate into 1.3 Cum/MWh water consumption. Thus, washing coal will add this much water consumption to water consumed for power generation in the TPP. So even if the TPPs meet the norm of 2.5 Cum/MWh water use with the help of supercritical technology, if they have to use washed coal, their total water use could go to 3.8 Cum/MWh or higher.

E. Adoption of Zero Discharge for Waste Water

This is a welcome step, but since the guidelines for zero liquid discharge are still to be finalised by the MoEFCC (a draft was put out for comments in January 2015), actual implications remain unclear.

F. All TPPs to move to Cooling Towers

Coastal plants are the primary ones that are likely to be affected by this change. This is because the EPA Rules 1986 already state (Sec. 84, Schedule I) that new thermal power plants commissioned after 1 June 1999 that are "using water from rivers/lakes/ reservoirs, shall install cooling towers irrespective of location and capacity."

However, whether this was complied with by all plants commissioned after 1999 is not clear. There are also older plants that are still operating with OTC systems. All these would now have to convert to cooling tower based systems.

This will mean refurbishment of the cooling systems to incorporate cooling towers, and related systems, incurring costs for the power plants. It is also likely that these costs will be passed on the buyers of electricity. However, the switch from OTC to cooling tower based systems is likely to make a huge impact on local water systems, especially where the TPP is using freshwater, as the withdrawals will go down sharply.

G. Coastal Power Plants

As mentioned above, coastal power plants that are still using OTC will have to switch to cooling towers. However, many coastal plants are already being constructed or planned with cooling towers and recirculating cooling. Yet, even for these plants, including supercritical plants, meeting the norms of 2.5 Cum/MWh looks difficult. First of all, as mentioned earlier, even supercritical plants seem to have fairly high evaporative needs. Second, in coastal power plants, the blow down requirement is quite high due to high salt concentrations in the cooling water (sea water).

One way to "achieve" the norm for coastal plants would be to simply dispose off the blow down back to the sea (which many plants do) and then argue that it would not count towards "consumptive" use. However, while this may help meet the regulation related to consumptive use of water, this would violate the regulation that requires zero water discharge. Blow down is a big component of waste water.

H. TPPs Using Treated Water

There is a new thrust requiring TPPs coming up in the future to use treated urban sewage. For example, Government of India has recently amendment itsTariff Policy and mandated that all TPPs in 50 kms of sewage treatment plants will use treated sewage waters[7]. Similarly, the Government of Maharashtra has announced that new industries, including thermal power plants, will be mandated to use treated sewage and will not be allowed to draw fresh water[8].While this will save raw clean fresh water, the problem is that when the source of raw water is treated sewage or high in TDS, then the blowdown requirements go up significantly. Given this, it will be challenging for the TPPs to meet the norm of 2.5 Cum/MWh.

I. Suggestions for better implementation

As with all rules, implementation – in letter and in spirit – will be the real test of these regulations. The experience of implementation of such regulations so far is quite poor. The violations of the regulations related to 100% ash re-use have already been mentioned earlier. As a result, areas around TPPs are literally mired in ash, and this has become a menace. We are particularly mentioning this example because proper implementation of the ash utilisation rules will be almost a pre-condition to achieving water use norms.

While the state and regulatory machinery will need to show political will to implement the new regulations, citizens and communities can also play an effective role. Monitoring actual water use at TPPs and making this information public will be crucial to this.

To ensure better implementation, we would suggest the following measures.

- CEA/MoEFCC should assess existing thermal power plants and see which plants need to retrofit to ensure that they meet the new standards for existing plants. Based on this, progress of the TPPs in retrofitting can be monitored. The new notification gives two years for the TPPs to meet these norms. The progress on this should be made public.A special committee could also be set up for such a monitoring.
- Similarly, CEA/MoEFCC, or the committee as mentioned above should also make an assessment of the new plants that will be installed after Jan 2017, and ensure that their designs are aligned to meet the new standards.
- MoEFCC should revise the Environmental Clearances of TPPs, particularly the ECs for the plants to be newly installed in the coming years to reflect lesser water utilisation
- MoEFCC should also work together with respective state governments and where new regulations imply that TPPs will now use lesser water than what was planned and sanctioned, they should be asked to surrender the excess water back to the state. This can be used for other purposes including maintaining flows and water in rivers and water bodies.
- CEA/MoEFCCshould regularly monitor actual water use of all TPPs, including the use of water for different purposes (like it does for ash utilisation) and put all the data in public domain.

[7] Press Release, Power Min, 20 Jan 2016

[8] http://www.loksatta.com/pune-news/smart-city-cm-devendra-phadanwis-speech-1196353/ New Report of CM Fadnavis in Loksatta, 1st Feb 2016

- The points and locations from where TPPs draw water, and points to which TPPs discharge water much be made public, including their latitude/longitude, so that concerned citizens can also identify and monitor these activities.
- The Regulations for Zero Liquid Discharge should be notified at the earliest. Similarly, MoEFCC should implement properly, in tandem, regulations related to ash, water and washeries to derive maximum synergies from them.

All in all, the new regulations are a welcome first step. Some of the regulations are too lax, and below what is technically feasible. We hope that they are modified to the tighter limits. At the same time, political will on behalf of the authorities to implement the measures, proper monitoring and transparency in making all information public, and continuous vigil on behalf of communities and citizens will be needed to ensure that the regulations are effective.

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