POLICY BRIEF

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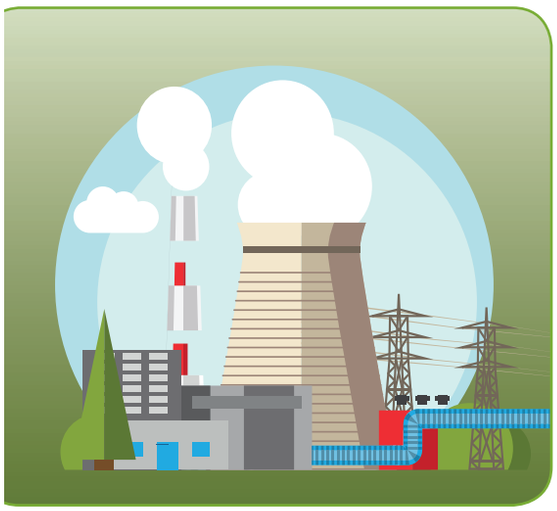

Water Neutral Electricity Production in India: Avoiding the Unmanageable

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Authors
Shresth Tayal, TERI
Sonia Grover, TERI

Advisor
Dr S K Sarkar, TERI

The Energy and Resources Institute
Darbari Seth Block, IHC Complex,
Lodhi Road, New Delhi- 110 003

Tel. 2468 2100 or 4150 4900
Fax. 2468 2144 or 2468 2145
India +91 Delhi (0) 11

www.teriin.org

Indian Power sector is dominated by coal based thermal power plants, constituting 87% of total installed capacity of 200.7 Gigawatt (GW), as on 31st January 2016. In India, production of coal has increased by 7.5 times and production of electricity has increased by 13 times since 1970-71. Furthermore, Niti Aayog projects that the total installed capacity for electricity generation in the country will range from 300-700 GW by 2047 under different policy initiative scenarios. Considering the practicality of implementation, even with best of efforts to diversify the fuel and technology mix in the power generation sector, India would continue to rely heavily on coal based electricity generation, accounting for atleast 50-60% of the total capacity.

Thermal Power Plants are reported to be accounting for 87.8% of total industrial water consumption in the country. In general, specific water consumption of coal based power plants with cooling tower in India is about 5-7 m^3/h per MW. As such, thermal power production in the country is consuming atleast 16.8 million m^3 of water per day at 80% load factor, which is equivalent to per capita water requirement of about 20% population of the country. Ministry of Environment, Forests and Climate Change has stipulated rules for water consumption by thermal power plants, and has asked them to reduce their maximum specific water consumption to 3.5 m^3/hr per MW by 2017. These standards are in agreement with the practices followed in countries like Germany, United States of America and United Kingdom.Once implemented, it has a potential to save water equivalent to per capita water requirement of about 8% population of the country. However, implementation of these norms will lead to trade off with reference to electricity production and improvement in operational efficiency by thermal power plants. For example, improvement in plant load factor to enhance production capacity will negatively influence the water consumption requirements of the plants.

Country is witnessing 6-8% growth in electricity consumption per decade since 1980. This is accompanied with approximately 24%

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transmission and distribution losses (both technical and non-technical) of electricity produced in the country, ranking India among the countries with highest Transmission & Distribution (T&D) losses. This also implies that a significant amount of water consumed by power plants also gets wasted due to T&D losses of electricity. In the purview of water stress scenarios of the country, this is a significant loss.

India is already water stressed[1] country and will soon be in the category of water scarce[2] country. As per World Resources Institute (WRI) report, more than 50% of India's area is experiencing high to extremely high stress. Additionally the potential to increase the volume of utilization of water is as low as 5-10%, which will accelerate India's pace towards a water scarce country.

Therefore these measures are not sufficient to ensure sustainability of water resources in the region. There are many other competing users for water in the surrounding areas of the power plants. With the growing population, increasing urbanization, demand for water will increase manifold, which would create more inter-sectoral competition for water. As per the National Water Policy 2012, the priority for water supply is for domestic purpose and industries are less prioritized compared to domestic sector. With the burgeoning water stress, and considering priorities of the National Water Policy, industries will be the worst hit in the coming years. Hence the need of the hour is that the industries including power plants look beyond their boundaries and pay back to the natural system.

Furthermore, considering the increase in thermal power production capacity under the normal scenarios, the benefits accrued due to reduction in specific water consumption will have temporary affect in overall water balance of the country. Also, its impact will be limited to ensuring additional water available within the direct source of water to the plants only. With future increase in demand for water from other sectors, overall water scarcity will resurface and reducing specific water consumption by thermal power plants will only be a temporary respite. Hence, a more holistic approach dealing with the reduction and offsetting the impacts of direct water footprints of thermal power plants is required, which may ultimately lead to water neutral electricity production in the country.

This policy brief is an attempt to highlight the necessity of reducing water footprints of power plants to maintain hydrological balance in an area, and incorporating the concept of water neutrality into the policy framework regulating power plants. It also presents a way forward through a set of recommendations to achieve the water neutrality of electricity production in the country.

Recent issues of Water stress in electricity production

- Maharashtra: Parli power plant shuts down after severe water crisis – 2012
- Maharashtra's Chandrapur Super Thermal Power Station (CSTPS) was forced to shut down due to an unprecedented scarcity of water
- Thermal power plants currently under construction in Orissa state are undergoing delays due to water allocation issues
- In Kerala, power cuts were imposed to tackle water scarcity in 2008 when the state received 65% less rainfall in monsoon than normal. (Source: Thaindian News 2008)
- Opposition to Adani power projects is growing in Nagpur because the local community believes that this power plant will threaten the availability of water for drinking and irrigation (Source: The Times of India 2011)

Water neutrality of Power plants

As Specific Water Consumption (SWC) is a measure of the water consumed by power plants per unit of electricity produced, it indicates only the direct water footprints of electricity production. While it is a necessity to use water for production of electricity through thermal processes, it's not possible to reduce their SWC beyond a certain limit, currently stipulated as 3.5m^3/ hr /MW. This means that under future growth scenarios, power plants would still be consuming more than 1 million m^3 water every hour, which is a significant amount considering future water scarcity scenarios.

Water neutrality is an approach to offset this irreducible water use. The approach has potential to make an activity 'water neutral' by promoting water saving technology, water conservation or environmental protection measures, wastewater treatment and water

"Water neutral is not about nullifying water use, but about water saving where possible and offsetting the negative environmental and social effects of water use."

1 Water stress: situation when annual water supplies drop below 1,700 m^3 per person per year

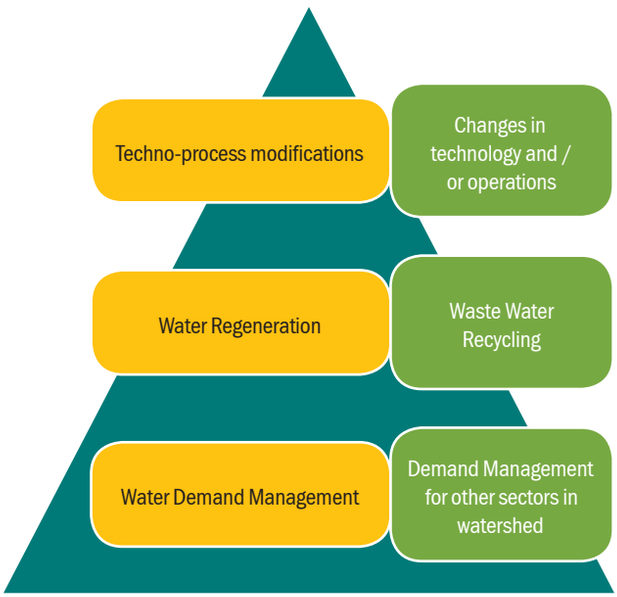
2 Water scarcity: situation when a country is below 1,000 m^3 per person per year

supply to the poor that do not have proper water supply'.[3] It has two aspects attached to it. First and foremost is to reduce the water footprint of the operations, product, etc. Second is to offset the residual water footprint. This approach or concept can be applied at variety of contexts, and with the growing water crisis it becomes imperative for all water intensive users like power plants to offset their water consumption by giving back to the system through different modes. 'Water neutral' generally does not mean that water use is brought down to zero, but that the negative economic, social and environmental externalities are reduced as much as possible and that the remaining impacts are fully compensated. In case of thermal power plants, efforts to reduce the specific water consumption by plant level management will help to achieve (partially) only the first aspect of the concept of water neutrality. The second aspect of off-setting the water usage requires power plants to look beyond their boundaries and implement/undertake the potential strategies to reduce water stress in the watershed from where water is sourced. These strategies should be able to conserve water, enhance the water availability of the area and return back the equivalent amount of residual water to the system.

> "A business is water neutral when every resasonable effort has been undertaken to reduce the company's water footprint and when the firm takes measures to offset or compensate for the adverse social and environmental consequences of its residual water footprint."

Integrated Watershed Management: An approach to water neutrality

Water availability in a water body is the function of characteristics of the watershed surrounding it. Hence, it is necessary to manage the watershed surrounding the source of water, to ensure the continuity of water availability for power plant operations. Integrated watershed management refers to the management of human activities and natural resources across the hydrological boundary surrounding the water source. It considers the watershed wide water availability and its demand from various sectors holistically, and refers to the measures like water demand management in the watershed, rainwater harvesting, artificial groundwater recharge etc. This approach also leads to improvement in water quality, while ensuring water availability for future demand scenarios, from both power plant as well as other competing users in the region. Moreover, Integrated Watershed Management approach has the potential to make the electricity production (near) water neutral, while also striking goodwill with the local communities and adding to the fulfillment of corporate social responsibility. Thus, power plants need to adopt a wider approach and push themselves beyond their own boundaries, taking care of the local watershed to ensure not only their own sustainable operations but overall ecological balance of the system and other competing users.



Policy Analysis

Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India has laid out several policies and guidelines for the establishment of power plants in India. All the thermal power plants are required to seek prior Environmental Clearance before starting the construction or looking for expansion and modernization. Environmental Impact Assessment (EIA) is a necessary component of the environmental Clearance process and all the thermal power plants with a capacity of 5MW are mandatorily required to conduct EIA. However, environmental clearance is provided by central government for Category A projects ($\geq$500 MW) and state level authorities for Category B1 projects ($\geq$5MW). Conducting EIA is not mandatory for B2 projects ($\leq$5MW), mainly set up as captive power plants by some industries.

3 http://www.indiaresource.org/campaigns/coke/2008/Waterneutrality.pdf

Water and Financial Viability of power plants

Water scarcity has the potential to impact the financial viability of thermal power plants by affecting the project's rate of return. This could be due to delays in project execution leading to cost escalation and revenue losses, as well as due to affects during operating life of the project. During operations, any drop in plant load factor may reduce the revenues. It has been assessed that each 5% drop in plant load factor results in drop of nearly 0.75% in the projects rate of return . Also, additional expenses may be required for digging ponds/ drawing canals or pipelines, for extracting water from alternate/ backup sources.

Moreover, compliance with the environmental regulations related to maintenance of discharge water quality or quantity of water extracted from the source, have cost burden on the plant operations. Quality of intake water affects the operational expenses related to production of Demineralized (DM) water. For example, presence of colloidal silica in intake water could increase the cost of DM water production, exorbitantly.

In 2015, Ministry has released Standard Terms of Reference for conducting EIA study for thermal power plans and prescribes specific assessments related to water to be conducted. Hydro-geological study of the area has been made a mandatory exercise of the EIA study to be carried out through an institute/ organization of repute to assess the impact on ground and surface water regime. It also asks power plants to visualize in advance the possible impacts on source water due to water withdrawal by them, even in lean season, and submit a plan for specific mitigation measures to ensure hydrogeological sustainability of the area. The mitigation plan should also include a time bound action plan for its implementation. This is a significant improvement from the previous EIA practices and makes it binding on power producers to ensure optimization of their water usage.

Moreover, now power plants are also required to include a detailed plan for rainwater harvesting, its proposed utilization in the plant, plan for optimization of cycles of concentration, along with a plan for recirculation of ash water and its implementation. Standard terms of reference also stipulates that thermal power plants cannot be located within 500m from the high flood level (HFL) of river system/ streams, and natural drainage pattern of the area shall not be disturbed.

Some of the policies which the power plants have to abide by in terms of pollution control and management include Water (Prevention and Control of Pollution) Act, 1974 amended 1988; Environmental (Protection) Rules, 1986 (Amendments in 1999, 2001, 2002, 2002, 2002, 2003, 2004). These are broad regulatory requirements for the establishment and environmental clearance of the thermal power plants. Recognizing the increasing water stress in the country and the water guzzling nature of thermal power plants, MoEF & CC has stipulated in 2016 that power plants should reduce their specific water consumption and bring it down to the below prescribed standards:

- All plants with once through cooling (OTC) shall install a cooling tower (CT) and achieve specific water consumption up to a maximum of 4 m^3/MWh (cubic meter per Mega Watt Hour) within 2 years period from the date of notification.
- All existing CT-based plants shall reduce specific water consumption up to maximum of 3.5 m^3/MWh within 2 years period from date of notification.
- New plants to be installed after January 01, 2017 shall restrict specific water consumption up to a maximum of 2.5 m^3/MWh and achieve zero liquid discharge.
- Additionally, there are some specific mandates that have been declared by the government, which power plants have to follow. Most of the regulations discussed are suggestive of discharge standards, except the recent orders in the form of amendments (vide notification dated 07.12.2015) to the Schedule I of the Environment (Protection) Rules 1986.
- Recently, Government of India has notified new Tariff policy on 28.01.2016 wherein it is mandated that the thermal power plant (s) including the existing plants located within 50 km radius of sewage treatment plant of Municipality/ local bodies/ similar organization shall, in the order of their closeness to sewage treatment plant, mandatorily use treated sewage water produced by these bodies and the associated cost on this account be allowed as pass through in the tariff.

Policy Gaps

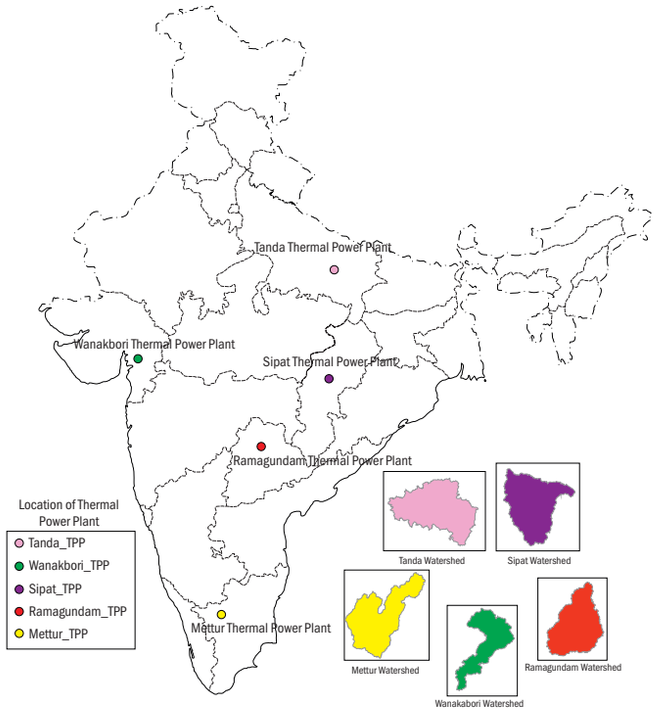
Regulatory

The standard given by MoEF&CC for specific water consumption is more than what CEA suggests. CEA guidelines recommend water use of 3.6 m^3 /MWh (for plants in 1st year of operation) and 3.0 m^3/MWh for all thermal power plants[4]. While ToR given by MoEF&CC

4 CEA Report on Minimization of Water Requirement in Coal Based Thermal Power Station, January 2012

CASE STUDY

TERI under its project supported by Shakti Sustainable Energy Foundation studied the applicability of concept of water neutrality for power plants in India. For the study, five thermal power plants were selected in four geographical zones of the country-north, west, south and east. These power plants differ in their capacity and in their consumptive water requirement. Being located in different hydro-meteorological zones, rainfall patterns, and water demand from other sectors surrounding the power plant also differ.



It was found that specific water consumption of power plants varied from 4.5 – 7.0 m^3/ MW. After implementation of MOEF&CC directives their annual water consumption would be in the range of 20-70 million m^3 depending on plant's installed capacity. To make them water neutral, the study assessed potential of returning equivalent amount of water to the nature, through two modes: (1) Water conservation measures like rainwater harvesting and aquifer recharge and (2) reduction in water demand of agricultural and domestic consumers by improving water use efficiency.

The study revealed that bringing about 10000 hectare of agricultural land under 3 most water intensive crops (rice, wheat, cotton/ sugarcane) under Micro-Irrigation System (MIS) can reduce water footprints of a typical 500 MW thermal power plant by 60%. This will require an investment of about 100 crore at the current commercial price of micro-irrigation systems, which is more than 10 times the cost of raw water paid by it. This will be discouraging on the part of power plants to invest on MIS. However, considering the cost of installation of power plants (~2500 cr/ 500 MW), environmental cost associated with huge water extraction and the long term potential benefits in water balance of the watershed, incurring this cost will be an economically wise investment. Moreover, reorientation of CSR strategies towards integrated watershed management could result in mutual benefits across different stakeholders.

Additionally, investing in interventions such as construction of rainwater harvesting structures, farm ponds, etc. can bring in additional water into the watershed. Undertaking a suitable mix of such interventions, power plants can offset the impact of their water footprint and can gradually achieve the goal of water neutral electricity generation. This ultimately will help to reduce the overall water stress in the country and would set an example for many other water intensive industries.

mentions that water requirement should not be more than that stipulated by CEA and the latest amendment given by MOEF&CC itself provides different values. So there is ambiguity on specific water consumption values because of different regulatory guidelines.

As per new TOR for EIA study, upcoming power plants have to submit source of water and its sustainability in lean season. Concern about water source is a promising move. However, for the existing power plants, no such regulation exists and it has been seen that some of the power plants have to be closed during the peak summers owing to unavailability of water. These power plants are aggravating the situation of water stress in the region. For existing power plants, there is no environmental regulation concerning withdrawals and sustainability of water source by undertaking interventions at watershed level to improve water situation in the surroundings.

Environmental

For getting environment clearance, upcoming power plants have to submit hydro-geological impact study along with mitigation measures. The objective of this study is to assess the impact of upcoming power plant on the local hydro-geology. There is uncertainty with respect to time frame of this impact. Operations of plant over the years along with increasing water demand from other sectors would alter the hydro-geological regime of the region. This could be a challenge for sustainable operations of the plant. As it has been witnessed some power plants were shut down after years of operation due to unavailability of water. Therefore assessment of impact of power plant operations on hydro-geology and source of water for short and long-term is of importance and should find a clear mention in regulatory guidelines.

Technological

The policy directive of having supercritical plants from the year 2017 onwards would mean that the upcoming power plants would be more efficient and would require less amount of water. But supercritical technology requires better quality of coal for operation, which is not available in India. In absence of good quality coal, available alternative is to thoroughly wash coal. This would impact the overall water footprint of coal based power generation. Extensively washed coal will increase the overall water footprint. Thus supercritical technology would reduce the water consumption at plant level but would increase the water consumption at washery level, thereby increasing the overall water footprint of coal based power generation.

Several technological development efforts are focused on increasing Cycle of Concentration (COC) which may reduce the requirement of make up water. Several methods have been developed with this perspective like, sulphuric acid treatment to inhibit corrosion, ozone treatment to control organic contaminants and side stream filtration to remove airborne particulates. However, increasing COC beyond a certain limit (generally 6 times) has very limited improvement in reducing specific water consumption (generally 3-7% if COC is increased from 6 to 10). But it significantly reduces the reusability of reject water, increasing the water footprints of power plants.

Additionally, because of the amendment in Tariff Policy to use treated sewage waters, efficiency of power plants will get affected. Treated sewage, increases the blowdown requirement as compared to fresh water and thus it becomes more challenging to maintain the standard norm of 2.5 Cum/MWh.

Policy Recommendations

Recent regulatory steps by the Government clearly mark the embarking of power sector on water efficient path, but these are not sufficient to solve the regional water imbalance created due to operation of power plants in an area. A more holistic approach dealing with the reduction and offsetting the impacts of direct water footprints of thermal power plants is required.

- **Reducing water footprints of power plants:** Considering the future water demand from both upcoming thermal power plants and sectors like agriculture and domestic, reducing specific water consumption will have only a short term effect in improving overall water balance of the country. Adopting a more comprehensive approach, thermal power plants must be asked to reduce the water footprints of their operations. The concept of water neutrality must be made mandatory for power plants, which require them to return back an equivalent amount of water to the hydrological system as consumed by them.
- This will require them to take measures for water conservation and demand management both within and outside their boundary. Measures for promotion and implementation of micro-irrigation systems in agriculture sector, installation of water efficient fixtures in domestic sector, constructing structures for rain water harvesting, etc. will help to reduce the stress on available water resources within the watershed and augment water availability in the region.
- **Watershed management as CSR activity:** Corporate Social Responsibility (CSR) is referred as corporate initiative to assess and take responsibility for the company's effects on the environment and impact on social welfare. Thus, the concept of CSR and reducing water footprints of business activities are in consonance with each other. Hence, integrated watershed management having the potential to reduce water footprints of power plants shall be included within the scope of CSR activities. Interventions improving the water use efficiency in agricultural farms and domestic sector, leading to reduction in overall water demand within the watershed, shall be included within the ambit of CSR activities.

- **Alignment of CSR activities with other ongoing government programs:** Government of India is executing many schemes related to watershed development, micro-irrigation and alternative cropping systems improving the income of farmers. These schemes are generally run by the local authorities including Panchayati Raj Institutions (PRIs), district collectors etc. Association of industries in the execution of these schemes will optimize the use of financial resources and accelerate the achievement of targets, while avoiding any duplication of efforts. Convergence of CSR activities with the government schemes has potential to be more fruitful as compared to efforts taken in silos.
- **Water Audit of thermal power plants** Water audit is an accounting procedure to determine the actual water intake, discharge and its consumption across different processes and sub-processes of an industrial operation. Water audit helps in developing a water balance diagram for the industrial operation, and is useful in establishing a baseline for water usage. This baseline of water consumption guides the measures required for improving water use efficiency, and provides a quantifiable indicator to judge the success of water conservation efforts.
- Thermal power plants across the country should conduct water audit of their utilities, which will help them in understanding the specific water consumption and degree of water use efficiency in their operations. Water audit also helps to find avenues of increasing water use efficiency like identifying the points of water leakages and over flows, which needs to be completely eliminated from the plant's operational cycle.
- **Mandating zero liquid discharge (ZLD)**: ZLD has been made mandatory for upcoming power plants but this should be prescribed for both the existing as well as new power plants. ZLD is treatment process which treats all the wastewater produced by the entity and recycles and reused in the premises, leaving zero discharge at the end. Treated wastewater depending on its quality can be reused for auxiliary usage within the power plant. ZLD process has the potential to reduce the water foot-print inside the plant premises, and help lessen the burden on fresh water resources outside the plant premises. Budge Budge power plant of Calcutta Electric Supply Corporation (CESC) and Torangallu power plant, Karnataka are some notable examples indicating the possibility of ZLD implementation by existing plants also.
- **Water Resource Impact Assessment (WRIA) for existing plants:** Recent standard TORs for EIA by thermal power plants prescribes hydro-geological assessment by an agency of repute to be part of EIA for environmental clearance. However, broadening the scope of hydro-geological assessment, WRIA should be made an integral part of power plant's standard operating procedures. WRIA should be made mandatory for already existing plants also, with specific reporting requirements at regular intervals.
- **Development of Water Management Plan**: It should be made mandatory for all the existing and upcoming power plants to develop a detailed water management plan, which should indicate the strategies they would adopt to conserve water in-situ and ex-situ both. The detailed management plan should provide details of the strategies they would adopt, along with timelines, and monitoring mechanism.
- **Incentivizing the power plants:** to encourage the power plants to achieve more than the prescribed standards, some incentive mechanisms should be in place, which urges the plant to achieve more than the limit set which as per CEA report is possible. This could be in the form of subsidy on water tariff, or some award system to acknowledge the water conscious power plants.

Conclusion

Guidelines given by the government for the power plants to reduce their specific water consumption is a positive step to solve the intensifying water crisis. Also, standard TOR for EIA is a striking example indicating the sensitivity and resolve of the government to ensure sustainable water security for the population of the country. However, considering the future water demand, energy production scenarios and unavoidable water consumption by thermal power plants, it is necessary to move beyond the reduction of specific water consumption, and take necessary steps to reduce overall water footprints of thermal power plants in the country. An approach involving Integrated Watershed Management by thermal power plants offers such an opportunity which could play a significant role not only in reducing water stress but also in reducing negative economic, social and environmental externalities, on a longer term perspective.

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For more information, contact:

Shresth Tayal

The Energy and Resources Institute (TERI)
Darbari Seth Block,
IHC Complex, Lodhi Road,
New Delhi- 110003

Tel: 24682100 or 41504900
Fax: 24682144 or 24682145
Web: www.teriin.org
E-mail: stayal@teri.res.in