INVESTOR BRIEFING:

Water shortages cost Indian coal power companies over $500 million in revenues

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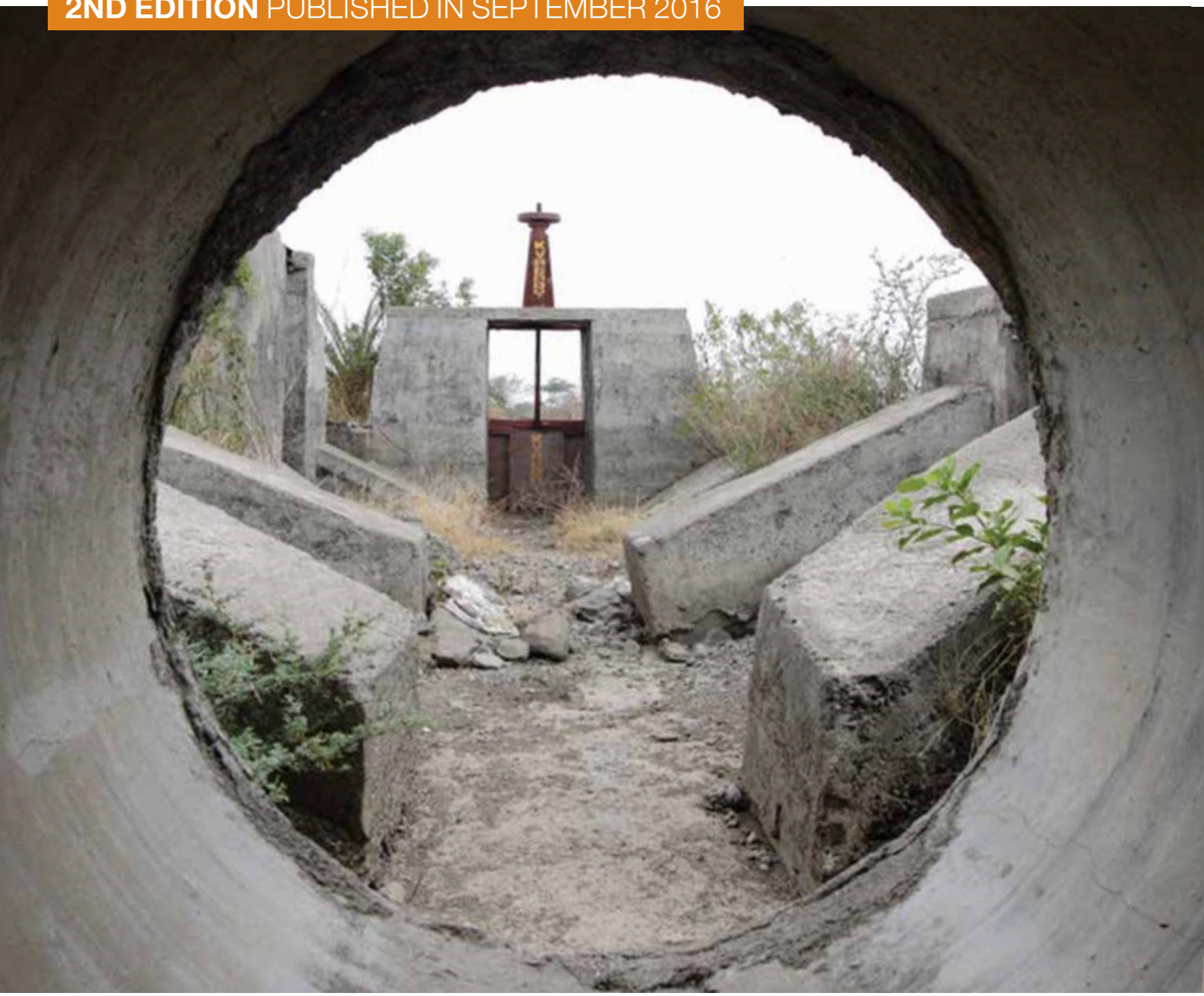

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INVESTOR BRIEFING:

Water shortages hit coal company revenues

Drought-related water shortages have curtailed Indian coal power companies' revenue by over $560 million in first six months of 2016; financial risk will intensify with additional projects being planned in water scarce areas.

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Cover image Incomplete Canal in Wardha Region in India
Only one small session of this sub canal in Pulgaon has been almost completed. This region was one of the worst affected during the 2012-13 drought and despite high promises the situation of the canal system has hardly changed in the last six odd years since it was first conceived.

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Executive Summary

Large parts of the Indian subcontinent faced a severe drought in the summer of 2016. The drought led to migration, agricultural distress, a drop in industrial output and significant lost revenues for the coal power sector, revealing coal's vulnerability in water stressed areas. With growing variability in rainfall patterns due to climate change, and growing demand for water from a growing population, this vulnerability will increase.

- Nearly 11 billion units (kWh) of coal power, with an estimated potential revenue of ~US$560 million was lost between January 1 and July 10, 2016 due to lack of water for cooling.
- NTPC and Adani Power are amongst the companies worst hit.
- NTPC's Farakka plant in West Bengal has lost generation of approximately 1.1 billion units, translating into lost revenue of over $ 58 million (at an estimated tariff of INR.3.5/kWh or 5c/kWh).
- Adani's Tiroda power plant in Maharashtra was forced to shut down one unit on May 5, 2016, and three more on May 16, through till June 30, translating into lost potential generation of 3 billion units equivalent to revenue of nearly $162 million at 5c/kWh.
- Mahagenco's Parli 1320 MW power plant in Maharashtra, built at a cost of hundreds of million dollars, has been shut down for a large part of the last four years due to recurring water shortage.
- Across India, coal power plants consume an estimated 4.6 billion Cubic metres (BCM) of freshwater per year, mostly for cooling purposes. This water would be enough for the basic water needs of 250 million people.
- Lenders and shareholders are exposed to increased financial risk with over 50 GW of new coal power plants planned in areas of high water stress – NTPC, Lanco, GMR, Adani Power and Reliance Power are among listed companies at risk. These 50 GW of new plants could consume up to 1.1 billion Cubic metres (BCM) per year,[1] enough for the basic needs of 65 million people.[2]

A 1 GW Indian coal power plant that is forced to close down for as little as 15 days in a year due to water shortage, faces an annual loss in revenue of over $20 million.

Analysis of data from NTPC, filings with the Bombay Stock Exchange and India's Central Electricity Authority for 2016 has shown that shutdowns due to a lack of cooling water supply have cost coal power companies over $560 million[3] in lost revenue in just six months between January 1 and July 10, 2016 (assuming a conservative average tariff of Rs 3.5/kWh, based on NTPC's average tariff in 2015-16).[4]

Company	Plant	Million units generation foregone, January 1-July	Potential revenue foregone (million $) January 1-July 10, 2016
NTPC	Farakka	1,119	58.4
Adani Power	Tiroda	3,104	162
GMR	Emco Warora	590	30.8
Sterlite	Jharsuguda	259	13.5
OP Jindal	Raigarh	78	4
KPCL	Raichur	367	19
Mahagenco	Parli	5,207	272
Total		**10724**	**559.7**

** 1 lac = 100,000*

*** Assuming Parli remains shut until June 15, 2016 at a minimum. The likelihood of the plant remaining shut beyond June 2016 is high.*

**** Calculation of revenue lost is based only on lost generation. Penalties, if any, for failure to fulfil contracts have not been considered.*

Two successive years of below par rainfall have hit the coal power sector hard. 2016 has seen shutdowns at Parli (Mahagenco), Raichur (KPCL), Farakka (NTPC), Tiroda (Adani), Warora (GMR), Jharsuguda (Sterlite/ Vedanta) and Tamnar (OP Jindal). At several points in March, April, May and June 2016, over 4 GW of coal power was shut down due to insufficient cooling water.

Despite the risk that water scarcity poses to the financial viability of coal power projects, companies have not backed away from plans for future coal projects in areas of significant water stress. Both national and local governments have failed to exercise sufficient scrutiny over the issue of water availability before granting water allocations and project permits. This poses a serious risk to lenders to specific projects and their parent companies, and also to company shareholders.

Greenpeace's analysis[5] based on data on existing and proposed coal-fired power plants as of the end of 2013, shows:

- 24% of the Indian coal plant fleet (36 GW) is in areas suffering from over-withdrawal of surface water. Another 52 GW of coal power plants are planned in these water over-withdrawal areas.
- 38 GW of coal capacity is located in areas with high or extremely high water stress. Withdrawal of high volumes of water in such areas often show serious ecosystem impacts by depleting available surface water. A further 122 GW of coal capacity is planned in these areas.

2016 has seen severe drought in large parts of the country, with stories of distress migration, water trains being sent to alleviate the misery of entire districts. and widespread civil unrest and conflicts between competing users of water.

Given the precarious water situation in large parts of India, the fact that generating electricity from coal requires significant quantities of water is a clear financial risk multiplier. Financial risks from water scarcity could range from physical constraints, where plants will experience water shortages leading to shutdowns, to regulatory risks with increased constraints on water use, the restriction or cancellation of permits and tighter technological requirements to curtail water use. Civil unrest because of the conflict between power generators and local farming communities over access to water will further reduce companies' social license to operate, and bring reputational damage to financiers of new coal projects.

This could result in abrupt policy changes, as policy makers realise that water consumption based on existing policies is unsustainable, and as pressure for action from the agricultural and other powerful political lobbies mounts.

Companies with the highest exposure to future water risk

Greenpeace analysed Platts' World Electric Power Plants Database[6] of under construction or planned projects. This was cross referenced with Coalswarm's database of existing and proposed coal plants to exclude projects that have been cancelled since 2013. It was categorised by project proponent and location to determine which companies had the most projects located in water-stressed areas (areas categorised as having high to extremely high water stress by the World Resources Institute).[7]

The analysis also looked at projects in moderate to high water stress zones.

Company	Operating coal plants in high/ extremely high water risk areas	Under construction/ planned coal plants in high/extremely high water risk areas	Operating/under construction/ planned coal plants in water risk areas as a percentage of total proposed coal capacity
NTPC	6.2 GW	12.0 GW	22%
Adani Power	4.6 GW	1.6 GW	25%
Lanco Infratech	1.2 GW	2.6 GW	32%
Reliance Power	5.1 GW	3.3 GW	62%
RattanIndia	0.5 GW	2.1 GW	50%
Mahagenco	2 GW	0.9 GW	16%
KPCL	1 GW	2.2 GW	49%

NTPC:

Construction at NTPC's Solapur and Mouda plants in Maharashtra has been delayed on account of water availability issues (see Case Study 1). Exposure to water scarcity could be critical to NTPC's coal portfolio as the company has a large number of planned or under construction projects in areas with the highest water risk.

Over 6,200 MW of NTPC's operational plants and over 12,000 MW of NTPC's under construction or proposed plants lie in high to extremely high water stress regions. These include the Solapur and Mouda plants in Maharashtra, Barethi, Khargone and Gadarwara plants in Madhya Pradesh, Nabinagar in Bihar, Kudgi in Karnataka and Tanda in Uttar Pradesh.

NTPC has lost potential revenue of $58 million due to repeated water-scarcity related outages at its Farakka plant in 2016.

Adani Power:

Adani has about 4.6 GW of operational power plants in areas of high or extremely high water stress. It has plans for another 1.6 GW in extremely high water stress areas, and 2.9 GW in moderate to high water stress areas. Proposed plants include Pench in Madhya Pradesh and Korba and Kawai expansions in Chhattisgarh and Rajasthan. Proposed plants/ expansions in Dahej, Bhadreshwar and Udupi have been excluded on the presumption that they will use only sea water.

Adani's Tiroda power plant in eastern Maharashtra was shut down from May 6, to June 30, 2016, leading to the loss of potential revenue of over $160 million.

Lanco Infratech:

Lanco has one plant, the 1200 MW Anpara plant in a region of extremely high water stress. It is constructing or has proposed 2640 MW more in high or extremely high water stress areas – Wardha in Maharashtra and Ramabai in Uttar Pradesh.

Reliance Power:

Reliance Power has over 5 GW of operational coal in extremely high water stress areas, with plans to expand this by another 3300 MW through expansions of Sasan and Rosa, both located in water-stressed regions in the central and northern states of Madhya Pradesh and Uttar Pradesh respectively.

RattanIndia Power:

RattanIndia Power has plans to expand its existing plant in the water stressed region of Nasik in Maharashtra by over 2GW, though it plans to use treated sewage water.

Among state owned utilities, the existing and proposed portfolios of Mahagenco and Karnataka Power Corporation Limited have been badly affected by water scarcity.

Mahagenco:

Mahagenco has over 2GW of operational plants located in highly water stressed parts of the western state of Maharashtra, including the Parli power plant that has been shut for nearly a year due to lack of water. The company has a further 7GW of operational coal in moderate to high water stress areas such as Amravati, Nagpur and Akola districts in that state. The company is currently building another 250 MW in Parli. There are proposals for a further 8 GW to be built in Dhule, Gondia, Chandrapur, Akola and Jalgaon districts in Maharashtra, all of which are categorized as moderate to high water stress areas.

KPCL:

KPCL's 1,700 MW Raichur power plant has been badly affected by water shortages in March 2016. Raichur falls in a zone of moderate to low water stress according to the WRI classification, yet it has experienced significant water shortages in 2016. KPCL's 1,000 MW operational plant at Ballari in Karnataka lies in a zone of extremely high water stress. A 700 MW expansion is currently under construction at Ballari.

Greenpeace India has looked in detail at two areas, Solapur in the western state of Maharashtra, and the Krishna basin in the southern state of Karnataka, to explore how water shortages are impacting the financial viability of existing and proposed projects. The companies involved in these areas are NTPC, KPCL and JSW.

Implications for proposed projects

Several projects (for example, Farakka and Raichur) that have experienced water-related shut downs in 2016 are actually not in high or extremely high water stressed areas, per the WRI classification. This is an indication that the water problem is in fact more widespread and that upcoming thermal power projects even in areas of "moderate water stress" face a financial risk in terms of water availability over the plant's productive lifetime, particularly as demands from agriculture and basic household consumption grow.

This should be a matter of concern to lenders, shareholders and company leadership as the potential financial implications are serious.

A 1 GW coal power plant that is forced to close down for as little as 15 days in the year (in itself a conservative estimate going by shut downs in 2016), faces an annual loss in revenue of over $22 million (assuming a conservative prospective tariff of Rs 4/ kWh). The annual plant load factor will be affected by 4%. Over the first ten years of a plant's lifetime, this would amount to significant lost revenue, affecting the internal rate of return and ability to service debt. It must be reiterated that this is a conservative estimate, with 2016 having seen several plants shut down for a month or more.

A more extreme scenario would be to consider that a new coal power plant is as badly affected as the Parli thermal plant in Maharashtra (which did not run on average 44% of all days between 2013 and 2016) - this would mean 144 billion units of lost power annually and huge lost revenues.

As we have seen from the drought of 2015-2016, this is no longer an unrealistic scenario.

The water stress experienced by existing coal power plants is likely to increase. Since January 2014, the Ministry of Environment, Forests and Climate Change has granted Environmental Clearance to approximately 17GW of new coal plants. Terms of Reference (the first step in India's environmental clearance process) have been issued to a further 33GW of coal power plants.

Questions for banks and lenders to coal-based power projects

1) To what extent has water risk been quantified in revenue models for proposed power plants?

2) What models are used to assess the viability of coal power projects coming up in areas likely to face water challenges?

3) Given lack of government foresight in granting water permits to power plants, what due diligence do banks undertake to ensure proposed projects have guaranteed water availability to function?

4) What is the implication on project economics where alternative methods of cooling (use of sewage water/ air/hybrid cooling) are deployed? Can such projects compete on an equal footing with other power technologies?

Questions for planners

How realistic is India's planned expansion in coal power given the very real constraint in terms of available water supplies?

Questions for state and central government authorities

Should all further permits for water withdrawal to coal power plants be halted in areas that have experienced water stress?

BOX 1: Parli thermal power station, Maharashtra

Parli has emerged as the poster boy for the waste of taxpayer money due to a lack of resource planning and foresight. Since 2013, the plant's record of closure (unit-wise) is as follows:

Days idle due to water shortage

	2013	2014	2015	2016*	Total 2013-2016
Unit 3	365		180	210	755
Unit 4	239	90	180	210	719
Unit 5	215	30	180	210	635
Unit 6	150	30	180	210	570
Unit 7	130	30	180	210	550

***CEA's March outage reports indicate the earliest Parli's units could be restarted as August 2016*

As the data shows, the Parli power plant, built at a cost of over five thousand crores, has been idle for a significant part of the last four years due to water shortage. Despite this, another 250MW unit 8 at Parli is under construction.

image Parli power plant in Beed district, Maharashtra.
© Subrata Biswas / Greenpeace

Methodology and data bases

This analysis relies on Platts 2013 database of coal power plants in India, cross referenced with Coalswarm's 2016 list of Indian coal power projects to eliminate projects that have been cancelled since 2013. Plants that use seawater for cooling have been excluded.

Data on environmental clearances for new coal power plants granted by the Ministry of Environment, Forests & Climate Change are based on the Ministry's website.

Data on coal power plants that have had to shut down due to lack of water is based on CEA's data on daily outage reports of thermal units, and on the basis of replies to Right to Information requests from NTPC.

Around March 12 2016, NTPC's Farakka plant was reported to have shut down due to insufficient water in the canal. NTPC has confirmed this in writing. However, the CEA reports the reason for shut down as "CW pump problem". We have considered the March Farakka shut down to be the result of water shortage, given that it has been well reported in the media and has been confirmed by NTPC. Farakka has in fact had several shut down episodes in 2016 – first in February, another that was widely reported in March and attributed to a lack of water, and yet another around April 21 and 23 until May 1 (units 2,4 and 5) that was not reported in the media. The CEA's reports attribute the April 21/23 shut down as also due to a 'Cooling Water Pump Problem'. If in fact the April shut down is also due to a lack of water, then the total loss of revenue to NTPC is much higher.

Many other shut downs were reported from water-related problems "Water wall tube leakage", "DM Water problem" etc. These have been left out of this analysis. If in fact these outages were due directly or indirectly to a lack of water, the water risk factor for coal power plants is even more pronounced.

Existing and proposed plants from the above databases were also cross-referenced with World Resource Institute's Aqueduct tool, which categorized India's available fresh surface water into catchments based on the ratio of total water withdrawal for all human uses (m3/year) to total water available before any uses are satisfied. This does not refer to or include groundwater. Based on this categorization, water stress is defined in categories ranging from low (<10 %), low and medium (10-20%), to medium and high (20-40%), high (40-80%) and extremely high(80-100%). Greenpeace has also categorized overwithdrawal (>100%) separately, with permission from WRI Aqueduct team.

Case Study 1:
Pipe dream? Water woes could derail NTPC's Solapur power station

NTPC's Solapur power plant in the western Indian state of Maharashtra is an example of how poor water planning and foresight poses a financial risk to coal power companies, lenders and shareholders. The plant, being built at a cost of over $1.5 billion9 is currently facing significant commissioning delays and operational uncertainties over its ability to secure sufficient cooling water to operate.

Summary:

- NTPC's 1320 MW Solapur power plant is facing commissioning delays due to problems surrounding its pipeline to supply cooling water.
- The plant depends on the Ujani Reservoir which is facing serious water shortages.
- Solapur district has over 2,00,000 ha of sugarcane farms and about 32 sugarcane factories – both major consumers of water from the Ujani reservoir.
- Disputes between upstream and downstream water users in Maharashtra have reduced water inflow to the reservoir.
- The state government has asked NTPC to use treated sewage from Solapur city instead of fresh water from the reservoir, causing further delays, operational complications and possible cost escalations.
- Bhima sub basin, in which the reservoir is located, has been categorised as a high water stress region by the World Resources Institute.[8]

NTPC's 1320 MW Solapur super critical thermal power station received environmental clearance in December 2010. The plant lies 20 km southeast of Solapur city. The plant has almost completed construction, barring its raw water intake pipeline. This pipeline is one of the longest in the country to deliver water to a power plant, stretching a distance of about 110 km. from the Ujani reservoir.

The power plant will supply power to the states of Maharashtra, Madhya Pradesh, Chhattisgarh, Goa and the Union territories of Daman & Diu and Dadra and Nagar Haveli. Maharashtra has agreed to purchase power from NTPC at the cost of Rs. 4.07 per unit.[9]

Delays in commissioning:

The plant's commissioning has been delayed. According to the Central Electricity Authority,[10] Unit-1 (660 MW) should have been commissioned by July 2016 and Unit-2 (660 MW) by January 2017. However, delays in the construction of the raw water pipeline and in the supply of generators have pushed back the commissioning dates for Unit 1 and 2 to May and October 2017 respectively.

The plant was granted permission[11] for 52.6 million cubic metres (Mcum) of water from the Ujani dam by the State government's Water Resource Department in May 2008. The state government also waived the irrigation restoration cost, which is the cost of reduced irrigation potential due to the diversion of water meant for irrigation to industrial uses. The Solapur coal power plant will consume water that would have irrigated 12,000 hectares and the irrigation restoration cost for the plant could have been Rs. 60 crores at the rate of Rs. 50,000 per hectare. The irrigation restoration cost has been subsequently increased to 1,00,000 per hectare in 2009.

The cost of the 52.6 Mcum water is assessed on the basis of the tariff orders[12] of the Maharashtra Water Resources Regulatory Authority (MWRRA), and it works out to about 16.83 crores each year.

Water woes threaten NTPC Solapur's financial viability

Ujani is one of the largest dams on the Bhima River, a part of the Krishna basin, but the reservoir has had insufficient water for several years in a row. Ujani has a live storage capacity of 1517 Mcum and dead storage capacity of 1802 MCum. The non-irrigation water allocation of the reservoir is 150 Mcum per the revised approved report of Bhima Project.[13]

As the table below shows, Ujani reservoir has had no live storage in the month of May since the year 2013.

The reservoir has been receiving very little water even through the 2015 monsoon season and remained below dead storage level till as late as September 2015.[14] The water storage in the reservoir did not exceed 60% as of 15th October 2015.

In January 2016, the MWRRA ordered the release of 85 Mcum of water from Bhama Asked and Chaskaman reservoirs upstream of Ujani to cater to the water needs of downstream users in Solapur district. An earlier order for the release of 283 Mcum was appealed in the High Court by authorities from the district of Pune, citing a lack of adequate drinking water for Pune city.

Some reports[15] indicate that about 60% of the live storage of Ujani reservoir is used to irrigate sugarcane. The district has about 32 sugar factories as of 2014-15[16] which also increases the water consumption from Ujani reservoir.

To complicate the water scenario further, there are additional water demands on the Bhima-Ujani irrigation scheme. The proposed Krishna Marathwada Irrigation Scheme intends to use 433.7 Mcum of water from Ujani reservoir and 75.3 Mcum water from the free catchment downstream of Sina Kolegaon Project.

As of November 2015, the Maharashtra government had listed 15,747 villages in 21 districts as drought affected. In early 2016, the state government included another 11,962 villages in Vidarbha region, taking the total number of drought-affected villages to 27,000 - almost half of the total villages in the state. Solapur district was added to this list in early March 2016.

Water levels in Ujani dam:[19]

Live capacity (Mcum)	Water level as on date (Mcum)				
	20th May 2016	20th May 2015	20th May 2014	20th May 2013	20th May 2012
1517	0	0	0	0	708

Water pipeline issues:

Analysis of tenders issued by NTPC for the water pipeline and related infrastructure give estimates of the total cost of the pipeline of at least $57 million (Rs.386 crores).[20]

To mitigate water conflicts, the state government has asked NTPC to use treated sewage water from Solapur Municipal Corporation (SMC) and many media reports[21] have indicated that the issue has been under discussion since September 2015. On 24th November 2015, the Chief Minister Devendra Fadnavis, SMC and NTPC had a meeting in Solapur to discuss this issue, with the following official agreements being reached:[22]

- Solapur Municipal corporation will hasten the construction of sewage treatment plants which can provide 75 Million Litres per day (MLD) of water to NTPC by March 2016.
- 75 MLD of water from the Ujani dam will be provided by NTPC to SMC, via the pipeline originally built to transport water to the plant. NTPC has been accorded 52.6 Mcum of water from Ujani, which works out to approximately 144 MLD. NTPC can utilize the balance of 69 MLD from Ujani dam.
- SMC will have to appoint a project consultant for laying a pipeline to collect water from the various sewage treatment plants for tertiary treatment and delivery to NTPC.
- The tertiary treatment plant for sewage water will be handled by SMC. The water will be treated in accordance with NTPC's requirements and will be provided to NTPC "as per required quality and standard rates on daily basis".
- A tri-party agreement will be signed to execute the supply of treated water by SMC to NTPC involving a private contractor.

From the little information available on this issue we can assess that the supply of treated sewage water to NTPC Solapur from SMC has been delayed beyond March 2016. This could delay the commissioning of the plant even further and will increase costs with impacts on timeframe for return on equity and loan repayment. Additionally, it's not clear whether NTPC will be paying any charges for the treated water in addition to the costs already agreed with the Water Resource department. In the event that NTPC goes ahead with using its entire allocation from Ujani, there is potential for future disruptions in water supply and political unrest, particularly in a below-par monsoon year. Further, the reliance on a tri-party agreement between NTPC, SMC and a private contractor increases the chance of potential delays on the part of the private contractor.

NTPC is also exposing its operations to considerable risk since it will be dependent on the Solapur Municipal corporation for timely delivery of water, of a quality that meets NTPC's parameters. Failure on either of these fronts could result in operational difficulties for the plant.

NTPC's Mouda coal power plant, also in Maharashtra state, with a total capacity of 2320 MW similarly has been permitted to withdraw 100 Mcum (about 273 MLD) of water from Gosikhurd reservoir, 24 km away from the plant. As of now, the stage-2 (2 X 660MW) of Mouda plant is still under construction while the stage 1 (2 X 500 MW) is operational. Recently,[23] NTPC agreed to take treated sewage water from the Nagpur Municipal Corporation's Bhandewadi treatment plant, instead of fresh water from Gosikhurd dam. Mahagenco, the state owned generation company has also been committed[24] treated sewage water from Nagpur Municipal corporation for its Koradi coal power plant.

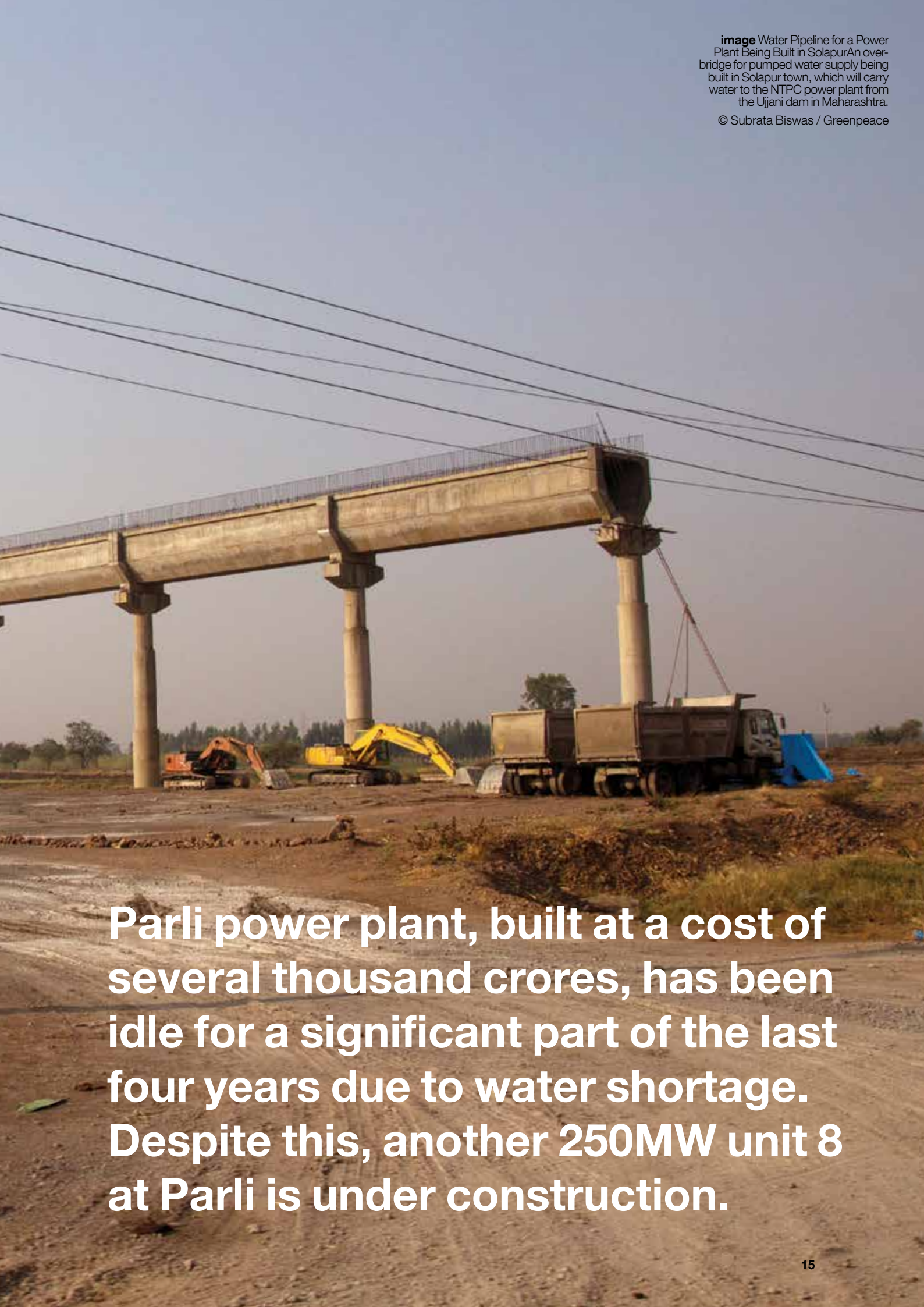


image Water Pipeline for a Power Plant Being Built in SolapurAn over-bridge for pumped water supply being built in Solapur town, which will carry water to the NTPC power plant from the Ujjani dam in Maharashtra.

Parli power plant, built at a cost of several thousand crores, has been idle for a significant part of the last four years due to water shortage. Despite this, another 250MW unit 8 at Parli is under construction.

Case Study 2:
No water for coal power plants in Karnataka's Krishna Basin

Karnataka's Krishna basin is an example of the manner in which permits and finance have been extended to coal power projects without due diligence on the water constraints that existing plants face, or the fact that such constraints will intensify. In 2016, the Raichur, Ballari and Kudgi power plants have all faced temporary shut downs due to water shortages. Another 11,000 MW of power plants are under construction or proposed for this basin, raising the question of whether these plants will have sufficient water available to ensure financial viability.

Summary:

- Krishna basin in Karnataka presently has 3850 MW of coal power plants. There are active proposals to increase this almost 4 times to 14670 MW.
- All the coal power plants depend on 3 reservoirs, Tungabhadra, Almatti and Narayanapur which together have a combined irrigation target of 10 lakh hectares.
- The 3 reservoirs often go dry in the summer months, forcing power plants to shut down.
- The 14 coal power plants (existing, under construction and proposed) in Karnataka's Krishna basin are all located within 150-200 km of each other increasing the intensity of water demand and consumption.
- NTPC's 4000 MW Kudgi Super thermal power station, KPCL's 1720 MW Raichur thermal power station and the 1000 MW Ballari thermal power station have all faced problems due to water shortages during the summer of 2016.
- Tungabhadra sub basin has been categorised as an extremely high water stress region(>80%) and upper and middle Krishna Sub basin as a high water stress region by the World Resources Institute.

The Krishna River in the southern Indian state of Karnataka is a part of a larger basin that covers Maharashtra, Karnataka, Telangana and Andhra Pradesh. Tungabhadra, Bhima and Krishna are some of the major rivers that make the Krishna river basin. Some of the major reservoirs on the Krishna basin are Koyna and Ujjani in Maharashtra, Alamatti, Narayanapura and Tungabhadra in Karnataka, Srisailam in Andhra Pradesh and Nagarjuna Sagar on the Telangana-Andhra Pradesh boundary.

Overall, the Krishna basin across all the four states supports the water needs of about 12 major coal power plants representing about 22,500 MW (16940 MW proposed and 5860 MW operating). This case study focusses on the proposed and under construction coal power plants in Karnataka that will depend on the Krishna basin within Karnataka for water.

Coal power plants in the Karnataka-Krishna basin

There are about 10 coal power companies cumulatively representing about 3850 MW of operating coal power plants, 5120 MW of coal power plants under construction and 5700 MW of proposed coal power plants which are proposed - a total of 14670 MW.

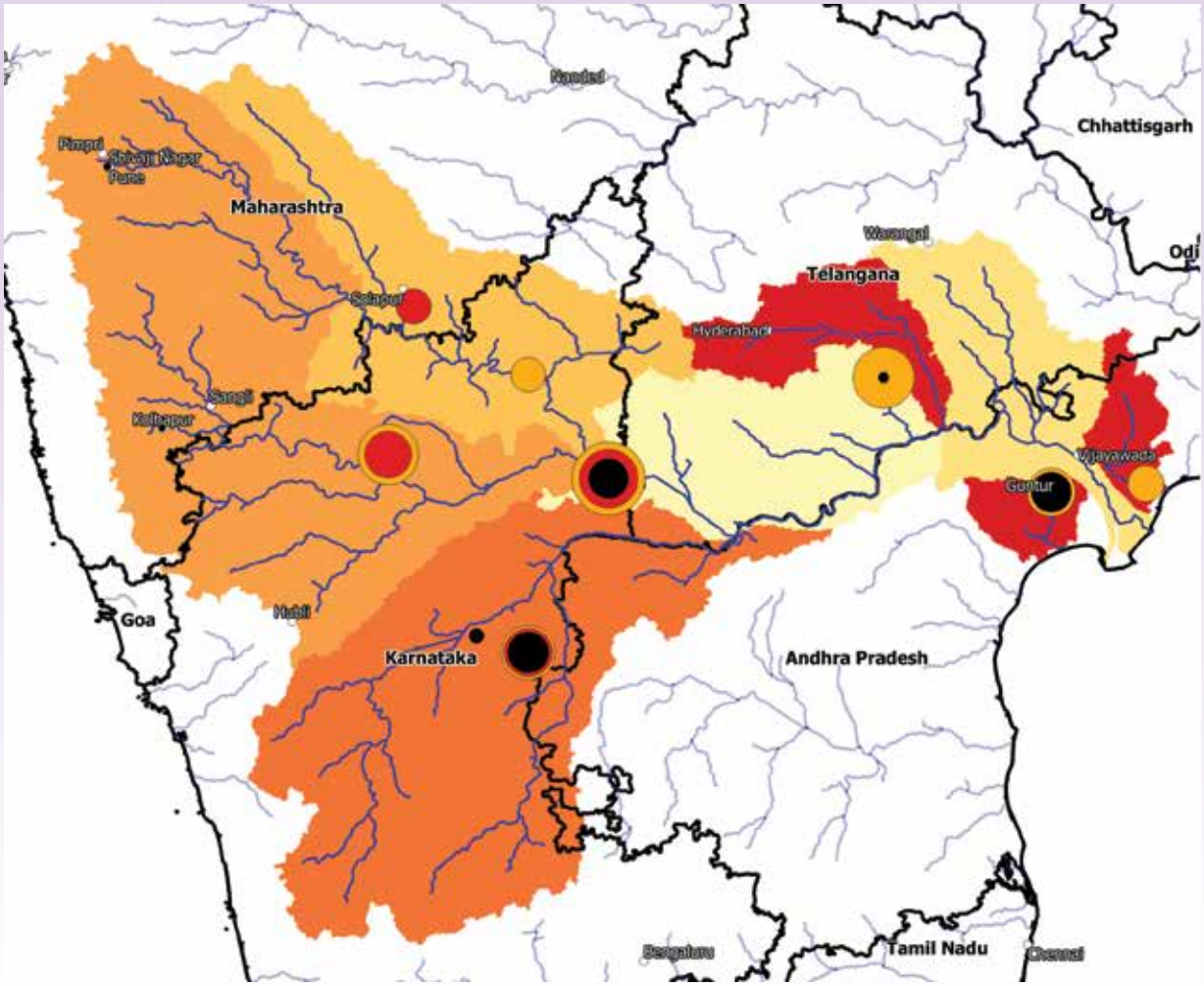
All of these plants are situated within about 150-200 km of each other, relying on the Krishna and Tungabhadra river systems for water. Most of the coal power plants directly depend on the three large dams in the region - Almatti, Tungabhadra and Narayanpur dams, while a few like KPCL's Ballari and Raichur thermal power stations depend on barrages built on river courses to store water for their needs.

Analysis of the storage capacity of the major dams raises questions over whether these coal power plants will have enough water to operate in the dry summer months. The summer of 2016 shows that existing power plants have struggled to find water to operate without interruptions - the addition of new projects in the region will worsen the water crisis.

Cases of shut down in the Karnataka-Krishna Basin:

- Raichur thermal power station has had a history of shutdowns due to water shortages in the last few years. In March 2016, the 1,700 MW plant was badly affected by water shortages, shutting down for several days. Farmers in the Raichur region and the neighbouring Mahububnagar district in Telangana have protested the provision of water to the thermal power plant at the cost of drinking water for downstream populations.[25] In the last weeks of April 2016, the Raichur thermal power station was provided water from Almatti reservoir via Narayanpur Reservoir in order to enable it to continue operations.
- In February 2016, the 1,000 MW Ballari thermal power station had to be provided water from Narayanpur reservoir to continue power generation. To ensure sufficient water for the plant, a ban was imposed on 'illegal' water withdrawal by villagers from the Tungabhadra left bank canal and prohibitory orders under Section 144 of the Criminal Procedure Code were promulgated for two months in several villages in Gangavati Taluk of Koppal district up to Maralihalla, from where the power station draws its water.[26] As of April 2016, villages in 12 districts of northern Karnataka were in the grip of a severe drinking water crisis.[27]
- Yermarus thermal power station, which is yet to be commissioned, is about 8 km. away from the Raichur Thermal power station and depends upon the same water source for its operation. The commissioning could get delayed by water shortages in the Krishna River. [28]
- Kudgi super thermal power station of NTPC which has a planned capacity of 4000 MW of which about 2400 MW is under construction has had to delay pre commissioning work due to the unavailability of water from the Almatti Reservoir,[29] which had hit dead storage level in April 2016 after releasing water for Raichur thermal power station.[30],[31]

Krishna River Basin, water stress areas with thermal power plants.



Maps for representational use only, boundaries depicted are not authenticated or verified

Legend

Water Stress

- 1) Low (<10%)
- 2) Low to medium (10-20%)
- 3) Medium to high (20%-40%)
- 4) High (40%-80%)
- 5) Extremely high (>80%)
- Arid & low water use
- No Data
- Overwithdrawal

Coal- based TPPs

- Operating
- Construction
- Planned
- 1000MW
- 10,000MW

Following is a summary of coal power plants in Karnataka's Krishna basin, their status and water source as of May 2016.

	Coal power Plant	Total in Mw	Status	Water Source[32]
1	Ballari Thermal power Station	1000	Operating	Krishna River, Maralihalla Nallah, Narayanapur Reservoir
2	Danapuram BMM power station	235	Operating	Krishna River
3	JSW Vijayanagar Toranagallu power station	860	Operating	Almatti Reservoir, Tungabhadra Reservoir
4	Raichur Thermal Power Station	1720	Operating	Krishna River, Googal Barrage
5	Vadlur power station (old)	35	Operating	Narayanapur Reservoir
6	Ballari thermal power station unit 3	700	Construction	Krishna River, Maralihalla Nallah, Narayanapur Reservoir
7	Kudgi super thermal power station	2400	Construction	Almatti Reservoir
8	Vadlur power station	420	Construction	Narayanapur Reservoir
9	Yermarus power station	1600	Construction	Krishna River, Googal Barrage
10	Kudgi super thermal power station	1600	Announced	Almatti Reservoir
11	Torangallu (JSW Vijayanagar) Unit 5	660	permitted	Almatti Reservoir, Tungabhadra Reservoir
12	Edlapura thermal power station	800	Pre-permit level	Krishna River, Googal Barrage
13	Kalaburagi power station	1320	Pre-permit level	Krishna River
14	Kadechur power station	1320	Pre permit level	Krishna River
	Total	**14670**		

Water consumption by these coal power plants

Based on the CEA studies[33] (2012), consumptive water requirement of 3.5-4 cubic metres/Mwh is required for coal power plants based on recent technology. Taking the lower end of this value – 3.5 cubic metres/ Mwh and assuming a normative 85% plant load factor,[34] from all the coal power plants in this region, there will be a total water requirement of about 382 million cubic metres annually.

Water storage capacities vary seasonally due to the monsoons, which deliver maximum rainfall during the July-November months. Storage capacities achieved by reservoirs by November have to be utilised judiciously between the three major consumers of water - agriculture, domestic and industrial sectors. While the needs of the agricultural sector are seasonal, the industrial and domestic sectors need a continuous supply of water all around the year and therefore need reliable water storage.

The existing and proposed coal power plants will need approximately 32 million cubic metres each month for their operations. However, summer water levels in the three main reservoirs in the area raise doubts over the reliability of water supply to these thermal plants. Besides, the lack of underground pipelines for these power plants also increases losses due to evaporation and absorption.

Considering that these reservoirs have been built primarily for irrigation, industrial uses have been allocated a smaller percentage of the total water storage. There are varying studies about the total industrial water need in the Krishna Basin. Some studies have indicated that the total industrial surface water in the Krishna basin of Karnataka has been estimated to be around 329 million cubic metres in 2010 and will grow to 709 million cubic metres in 2025.[35] As coal power plants are not the only industrial activity in the region, the competition for water security is expected to increase with large capacity additions in the region.

Water levels in Almatti, Narayanapur and Tungabhadra reservoirs.[36]

Resevoir	Live storage capacity Mcum	Live Capacity in Mcum during lean months					
Almatti	3104.7	As of 16th May 2016*	Year	As of June 30th	As of May 31st	As of April 30th	As of Mar 31st
		70.39	2015	1363.32	191.28	256.68	324.06
			2014	207.70	214.50	244.79	310.75
			2013	858.55	147.97	192.13	251.87
			2012	n.a	126.74	n.a	n.a
Narayanapur	868.55	147.19	2015	279.12	190.23	191.64	238.35
			2014	287.61	283.37	230.71	247.13
			2013	247.13	206.08	220.80	246.28
			2012	n.a	166.16	n.a	n.a
Tungabhadra**	3685.17	0	2015	645.43	84.33	0	166.14
			2014	311.37	156.80	1.66	83.76
			2013	517.75	0	32.24	159.91
			2012	n.a	89.14	n.a	n.a

** Media reports indicate that Almatti had reached dead storage levels by April 30, 2016 though this is not reflected in the official data above.*[37]

***Tungabhadra dam was commissioned in 1953 and the accumulation of silt since is reported to have reduced the storage capacity by at least 22%.*[38]

While the overall water storages during lean months seem manageable to satisfy domestic, agricultural and industrial water needs, a lower average rainfall year(s) like 2015-16 can result in serious water shortages, affecting coal power plant operations.

References

1 Assuming all power plants have cooling towers, running at 85% efficiency. Water consumption rate for new cooling towers assumed is 3.2 m3/MWh. The Central Electricity Regulatory Commission regulations of 2014 has specificed 85% as the normative plant load factor for most coal power plants till 2019 - see http://cercind.gov.in/2014/regulation/reg21.pdf

2 Based on WHO estimate of 50 liters required per person per day.

3 This calculation assumes a hypothetical 100% capacity factor. Assuming an 85% plant load factor, the hypothetical loss amounts to over 9 billion units with a value of nearly $480 million.

4 http://www.bseindia.com/xml-data/corpfiling/AttachHis/C3645DA0_2910_40BC_9312_B9D5C4D832D5_143806.pdf

5 Cheng, I and H. Lammi, The Great Water Grab, Greenpeace International, 2015. http://www.greenpeace.org/international/Global/international/publications/climate/2016/The-Great-Water-Grab.pdf and Technical report at http://www.greenpeace.org/international/Global/international/briefings/climate/2016/Coal-Water/Technical-Report-Coal-Water-Methods-Results.pdf

6 http://www.platts.com/products/world-electric-power-plants-database

7 The World Resource Institute's Aqueduct tool categorizes India's available fresh surface water into catchments based on the ratio of total water withdrawal for all human uses (m3/year) to total water available before any uses are satisfied. This does include groundwater. Based on this categorization, water stress is defined in categories ranging from low (<10 %), low and medium (10-20%), to medium and high (20-40%), high (40-80%) and extremely high(80-100%). Greenpeace has also categorized overwithdrawal (>100%) separately, with permission from WRI Aqueduct team.

8 Francis Gassert, Paul Reig, Tien Shiao, Matt Landis, Research Scientist, ISciences, LLC and Matt Luck, Research Scientist, ISciences, LLC - April 2015 http://www.wri.org/publication/aqueduct-global-maps-21

9 http://www.mercindia.org.in/pdf/Order%2058%2042/Order_53_of_2012_27_Dec_2012.pdf

10 http://cea.nic.in/reports/monthly/broadstatus/2016/broad_status-03.pdf

11 Minutes of the 16th meeting of the High Powered Committee on water allocations held on 28th May 2008.. Translated from Marathi. , Document obtained through Right To Information Act,2005.

12 http://www.mwrra.org/Volumetric%20BWT%20Order%20English.pdf

13 www.mwrra.org/Case%20No%2016%20of%202015.pdf

14 http://timesofindia.indiatimes.com/city/pune/Ujanis-stock-rises-gets-live-water-storage-in-Pune/articleshow/49053434.cms

15 http://sandrp.in/otherissues/Maharashtra_Sugar_Shackles_PD_March2013.pdf

16 http://www.hindustantimes.com/mumbai/in-a-first-solapur-decides-to-give-up-onsugarcane-cultivation/story-CScBCBdiND66ELPfHl8ReK.html

17 environmentclearance.nic.in/.../EIA/111125125212101Executivesummaryrevised.pdf

18 http://www.livemint.com/Politics/L5GDFov9QZFQKyRsDox8bN/Maharashtra-adds-11962-villages-to-drought-list-in-Vidarbha.html

19 https://wrd.maharashtra.gov.in/portal/content/default/pdf/contents/home/damstorages.pdf

20 Analysis by Greenpeace based on tenders issued on http://ntpctender.com/ for Solapur make-up/ Raw water pipeline and civil works related to the pipeline.

21 http://indianexpress.com/article/cities/mumbai/ntpc-nod-to-use-recycled-waste-water-for-power-plants-cm-devendra-fadnavis/

22 Page 16 , http://smartcities.gov.in/writereaddata/winningcity/solapurAnnexures.pdf

23 http://pib.nic.in/newsite/PrintRelease.aspx?relid=135698

24 http://timesofindia.indiatimes.com/city/nagpur/NMC-looks-to-NTPC-Mahagenco-for-easing-sewage-treatment-burden/articleshow/49458805.cms

25 http://www.thehindu.com/news/national/karnataka/telangana-villagers-demand-krishna-water-from-karnataka/article8393156.ece

26 http://www.thehindu.com/todays-paper/tp-national/tp-karnataka/ban-order-in-villages-along-tlbc/article8181393.ece

27 https://sandrp.wordpress.com/2016/05/07/karnataka-profile-of-2015-16-drought/

28 http://www.deccanchronicle.com/nation/current-affairs/120316/yeramarus-thermal-power-station-may-not-help-karnataka-tackle-power-crisis.html

29 http://timesofindia.indiatimes.com/city/bengaluru/NTPC-plant-stops-power-generation-due-to-water-scarcity/articleshow/52118605.cms

30 http://www.thehindu.com/news/national/karnataka/water-in-almatti-hits-dead-storage-level/article8537964.ece

31 http://www.deccanherald.com/content/542531/water-released-rtps-almatti-dam.html

32 From http://www.kbjnl.com/Water-Utilisation-Industries and the Environment clearances accessed from Ministry of Environment Forests and Climate Change, Government of India.

33 Available at www.cea.nic.in/reports/others/thermal/tetd/min_of%20water_coal_power.pdf

34 Central Electricity Regulatory Commission (Terms and Conditions of Tariff) Regulations, 2014 http://cercind.gov.in/2014/regulation/reg21.pdf

35 Technical consultancy services organization of Karnataka, 2004, Forecast of water needs of industrial units in districts / areas falling under Krishna basin, Government of Karnataka, Bangalore)- cross referred from www.toenre.com/.../2009_11_Karnataka_water_sector_reform_IWMI_MGC.pdf

36 https://www.ksndmc.org/Reservoir_Details.aspx

37 http://www.thehindu.com/news/national/karnataka/water-in-almatti-hits-dead-storage-level/article8537964.ece

38 Integrating Water Resources Management: Interdisciplinary Methodologies and Strategies in Practice: edited by Geoffrey D. Gooch, Alistair Rieu-Clarke, Per Stålnacke ,IWA Publishing, 2010

Glossary

BCM – billion cubic metres
CEA – Central Electricity Authority
GW – Gigawatt
KWh – Kilowatt hours
KWDT – Krishan Water Dispute Tribunal
KPCL – Karnataka Power Corporation Limited
MW – Megawatt
Mwh – Megawatt hours
MWRRA – Maharashtra Water Resources Regulatory Authority
Mcum – Million Cubic Metres
NTPC - National Thermal Power Corporation

GREENPEACE
ग्रीनपीस

Greenpeace is a global organisation that uses non-violent direct action to tackle the most crucial threats to our planet's biodiversity and environment. Greenpeace is a non-profit organisation, present in 40 countries across Europe, The Americas, Asia and the Pacific.

It speaks for 2.8 million supporters worldwide, and inspires many millions more to take action every day. To maintain its independence, Greenpeace does not accept donations from governments or corporations but relies on contributions from individual supporters and foundation grants.

Greenpeace has been campaigning against environmental degradation since 1971 when a small boat of volunteers and journalists sailed into Amchitka, an area north of Alaska, where the US Government was conducting underground nuclear tests.This tradition of 'bearing witness' in a non-violent manner continues today, and ships are an important part of all its campaign work.

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