

# Environmental issues and challenges for coal/lignite based thermal power plants and mitigation measures

*The world is undergoing a massive energy transition. Over the next decades, there will be radical changes in the way we produce and consume energy. The conventional energy infrastructure being set up now would be abandoned ever before their economic life is over. A quarter of India's population have no access to electricity and our per capita consumption of electricity is very low at almost one third of world average with millions getting power a few hours a day. Surprisingly the plant load factor (PLF) for thermal power plant have steadily declined over the last four years and was only 63.6% in Sep. 2015. Breakthrough in solar plant technology posed a challenge for fossil fuel based thermal power plants. In April 2017, the tariff of utility connected large solar power projects in India hit a record low of Rs.3/kWh. This is the same as the average tariff of coal based power. At this tariff, solar plants are cheaper than a large number of new and old coal fired power plants in India.*

*Stringent pollution norms add to the cost of generation of thermal power. Several projects in the power sector have become unviable on account of states like Andhra Pradesh, Uttar Pradesh and Karnataka have either cancelled the power purchase agreement or reworking on them. Few more states may follow in cancellation of power purchase agreement (PPA). Distribution Companies (DISCOMS) are reluctant to sign PPA because of high tariff, demand uncertainties, long duration of PPA and need to take the responsibility of fixed charges for the life of PPA. This will lead to creation of non-performing asset (NPA) worth Rs.1.5 lakh crores and to the extent the bank loans will be at risk.*

*Some mitigation measures are suggested to meet the challenges in operation of coal/lignite based thermal power plants.*

**Keywords:** Power purchase agreement, plant load factor (PLF), DISCOMS

## 1.0 Introduction

In India, which is home to the largest population without access to modern energy services, 300 million people do not have access to electricity and our per capita

consumption of electricity is very low at almost one third of world average. The government has announced to provide electricity connection to all by 2018.

The government is keen on installing 175 GW renewable energy by 2022. As per NITI Aayog, there is a need to install 100GW green energy by 2019-20 to achieve the centre's ambitious target of 175 GW renewable energy by 2022.

With India's commitment to climate change mitigation and expected growth from renewable energy sources in the next decade, the energy mix is likely to alter significantly. This has got serious impact on fossil fuel based thermal plants posing very high challenges in the survival of the thermal plants.

- Challenges for thermal power plants due to environmental issues
- Overcapacity in coal power sector and low plant load factor (PLF)

Central Electricity Authority (CEA), India's main electricity planning authority is empowered to publish electric power survey (EPS) once in five years and chart the road map for growth in power sector. CEA consistently forecast very high growth rate in the electricity demand which resulted in over capacity in the coal power sector. The implications of higher demand forecast lead to over capacity installation.

During the 12th Five Year plan (2012-17), capacity of 99,209 MW was commissioned against a target of 88,537 MW from conventional sources. If the renewable energy installed during 12th Plan is added, then as of April 2017, the installed capacity achieved in India is 327GW against a peak demand of 160GW. Consequently, the coal based power plants operated at plant load factor (PLF) of around 60%.

## DEMAND FORECAST BY CEA

CEA had forecasted the demand with steady increase year after year from 2013-2017 in the 17th EPS which was published in 2007. The same strategy was adopted in the 18th EPS also which was published in 2012. While publishing the 18th EPS, CEA overestimated the demand for electricity for 2021-22 and 2026-27 by a wide margin as given in the Table 2.

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TABLE 1: DEMAND FOR ELECTRICITY IN 17TH EPS PUBLISHED IN 2007

Year	Energy demand forecast in 17th .EPS (Billion units-BU)	Actual energy requirement (BU)	Peak energy load demand forecast in 17 th. EPS (GW)	Actual peak energy load demand (GW)
2013-14	1085	1002	156	136
2014-15	1168	1069	169	148
2015-16	1258	1114	184	153
2016-17	1392	1142	218	160

Source: Central Electricity Authority

TABLE 2: DEMAND FOR ELECTRICITY IN 18TH EPS PUBLISHED IN 2012 AND 19TH. EPS PUBLISHED IN 2017

Year	Energy demand (BU) in 18th EPS (BU-Billion units)	Energy demand forecast by 19th. EPS(BU)	Peak energy load demand forecast in 18th. EPS(GW)	Peak energy load demand forecast in 19th. EPS(GW)
2021-22	1905	1566	283	226
2026-27	2710	2047	397	299

TABLE 3

Country	PM (mg/Nm <sup>3</sup> )	SO <sub>2</sub> (mg/Nm <sup>3</sup> )	NO <sub>x</sub> (mg/Nm <sup>3</sup> )	Mercury (mg/Nm <sup>3</sup> )
India				
Current standard	150-350	None	None	None
Proposed norms				
For units installed before 2003	100	<500MW units –600 >500 MW units –200	600	>500 MW units –003
For units installed after 2003	50	200	100	0.03
For units installed 2017 onwards	30	100	100	0.03
Other key countries				
China	30	100	100	0.03
U.S	14.5	100	110	0.0017

The reason behind low PLF as there has been a sharper increase in total capacity compared to the growth in demand. Coal shortage, grid problems, transmission constraints are also responsible for the low PLF. In the overcapacity scenario, raising PLF for meeting the demand will have serious environmental issues.

## 2.0 Revised environmental norms as per Environment (Protection) Amendment Rules 2015

Ministry of Environment, Forest and Climate Change (MoEF&CC) has notified amendment to Environment (Protection) Rules 1986. As per these rules, the standards for specific water consumption and maximum suspended particulate matter (SPM) have been made more stringent. Further, standards for maximum limit for SO<sub>2</sub>, NO<sub>x</sub> and mercury emissions by thermal plant have been introduced.

### 2.1 POLLUTION CONTROL MEASURES AND IMPACT

Comparison of proposed norms in India with other key countries (Table 3)

Coal based power plants consumed 530 million tonnes of coal in 2014-15 which is around 3/4th of total coal used in the country. India's coal is of poor quality which contains almost 40% ash.

This means the thermal plant burns 0.74kg/kWh power generation which is 41% higher than global average. Poor coal means more pollution.

As a result coal based power plants are significant contributor of pollutants such as particulate matter (PM) and SO<sub>2</sub>, NO<sub>x</sub>. New plants would also need to install pollution control equipment such as flue gas de-sulpharisation (FGD) and low NO<sub>x</sub> burners to meet the standards. Older plants would need to meet lower standard (100/50 mg/Nm<sup>3</sup>) based on the age due to both economic consideration and technical issues.

Retrofitting of FGDs in the existing plant will cost in the range of 1-2 crores per MW of installed capacity. In addition to capital cost, operation and maintenance cost of emission control equipment would further increase the power cost.

Hence, the power tariff in the country is expected to rise gradually by anything between 50 paise to Rs.1.25 per unit depending upon the current tariff formula of each state DISCOMS to pay for retrofitting to reduce pollution.

## 2.2 WATER USE

Power plants in India were found to be inefficient in using fresh water. Their average fresh water consumption is around twice that of the U.S and Chinese plants. Thermal power sector cumulatively withdraws around 22 billion cubic metre (BCM) of water annually, a significant usage considering the country's total domestic needs which is estimated at 43 BCM.

As per the Notification, existing plant shall meet a specific water consumption of 3.5m<sup>3</sup>/MWh and new plants to be installed from January 2017 onwards shall meet maximum specific water consumption of 2.5m<sup>3</sup>/MWh and zero waste water discharge.

The new norms can have a remarkable reduction in fresh water withdrawal by thermal plant from 22 BCM in 2011-12 to around 4.5BCM in 2016-17. The norms will require all fresh water based once through cooling (OTC) system plants to install water efficient cooling tower that consumes up to 4m<sup>3</sup>/MWh. Further, existing cooling tower based plants will need to restrict water consumption to 3.5m<sup>3</sup>/MWh and plants that will be set up after January 2017 have to achieve 2.5m<sup>3</sup>/MWh.

Retrofitting of cooling towers and recycling of water to restrict fresh water usage of the existing plant will add to generation cost.

## 3.0 Hike in coal price

Coal is the raw material for thermal plant and any hike in price of coal will seriously affect the revenue of thermal plant.

Use of imported coal for power generation against domestic coal has an impact in cost of generation. Indonesian coal price has jumped by 44% in August 2016. On account of this, the ultra mega power station at Mundra owned by Tata Power in Gujarat met with cumulative loss in revenue. Domestic coal contains very high ash content and moderately higher sulphur content. As per CEA norms, the boiler is designed for 70:30 ratio coal mix (domestic coal and imported), use of 100% domestic coal to offset the hike in imported coal will add to serious environmental issues.

TABLE 4

Month	2016(\$/Tonne)	2017(\$/Tonne)
March	51.62	81.9
April	52.32	82.51
May	51.20	83.81
June	51.87	75.46
July	53.0	78.95
August	58.37	83.97

Indonesian thermal coal price (Table 4)

Adani power also suffered loss on account of hike in imported coal price. There is very little hope from regulating authority and for legal relief.

## 4.0 Disposal of ash

As Indian coal contains 40% ash, the quantum of ash generated after burning the Indian coal poses a big problem of disposal. Since the utilisation of fly ash from power plant has been far below the 100% target, the Government introduced draft amendment in March 2015 to push fly ash use. The proposed notification mandates construction activities (buildings, roads, fly over, reclamation and embankment) within 500 km of power plant to use only fly ash. It also requires power plant to provide fly ash for free to construction agencies and to transport it at their own cost up to 100 km for private users and up to 500 km for government projects. This is an additional burden on the power plant operator and adds to cost of generation.

## 5.0 Dysfunction nature of distribution companies (DISCOM)

The power producers are facing a problem of large scale backing down of generating stations due to less demand and availability of cheap power in the market. The fundamental problem is the dysfunctional nature of distribution companies inefficiently run with huge losses. They do not have money to buy power and supply to the people. Meanwhile huge generating capacity is lying idle. DISCOMS shall make a realistic estimate of the requirement of power and the availability of supply and then plan accordingly the procurement. In the absence of adequate demand, the procurement of short term power will result in backing down of power plants.

## 6.0 Power Purchase Agreement (PPA)

DISCOMS who are the buyer of bulk power enter in to an agreement with power producers for procuring power.

When power is available in the market as a commodity at a competitive rate they are left with the feeling that they are paying too much under the existing PPA. The DISCOMS are reluctant to enter into long term PPA with the upcoming power plants for the following reasons.

- High tariff
- Demand uncertainties,
- Long duration of PPA
- Need to take the responsibility of fixed charges for the life of PPA.

State owned distribution companies (DISCOM) which are under obligation to reduce losses as part of UDAY scheme (Ujjwal Discom Assurance Yojana) are keen to buy cheaper power to improve their finance. Three states Andhra Pradesh,

Uttar Pradesh and Karnataka have either cancelled the Power Purchase Agreement or reworking on them.

Few more states may follow in cancellation of Power Purchase Agreement (PPA). This will lead to creation of non-performing asset (NPA) worth Rs.1.5 lakh crores and to the extent the bank loans will be at risk.

### **7.0 Goods and service tax (GST) Act**

Consequent to implementation of GST Act, the capital cost for new thermal projects will go up by about 4% assuming that there is a 30% imported component. Cost of imported coal based generation will go up by 7 paise per unit.

### **8.0 Mitigation measures**

As a part of mitigation measures the following suggestions merit consideration.

#### **8.1 EXISTING THERMAL POWER PLANT**

##### **8.1.1 Reducing the operation expenses (OPEX)**

The plant shall be operated at design parameters to optimise the output. The manufacturers design the boiler for a particular coal for efficient operation. Hence, coal shall be procured for use with specification very close to which the boiler is designed to meet the specific fuel consumption norm for optimisation.

Low load operation shall be avoided. When there is less demand for power, load of one unit may be raised to optimum level and other units may be shut down for maintenance. Stores inventory shall be optimised.

Operation of balance of plants (BOP) shall be completely outsourced. Manpower shall be employed judiciously. Maintenance of units shall be planned to avoid major forced outages.

##### **8.1.2 Financing for retrofitting**

New norms for pollution control issued by environment ministry in December 2015, warrants power producers for retrofitting the pollution control equipment such as flue gas de-sulphurisation (FGD) and low NO<sub>x</sub> burners to meet the standards. There is no clarity on who will bear the financial burden. Under this situation, it is suggested that some allocation of collections from coal cess under National Clear Energy and Environment Fund (NCEEF) shall make to meet the retrofit expenses. At present the government levies coal cess at the rate of Rs.400/tonne for each tonne of procurement by the power producer. It is worth to finance for the retrofitting from the fund.

##### **8.1.3 closure of non viable plants**

As per CEA guidelines, power plants that have exceeded 25 years of life shall be de-commissioned. A greater parity between conventional and renewable energy tariffs justifies closure of unviable old plants which contribute for very high pollution.

#### **8.2 NEW PROJECTS**

##### **8.2.1 Encouraging DISCOMs to sign PPA**

The tariff consists of fixed charges and variable energy charges. DISCOMs are reluctant to take the responsibility of fixed charges for the life of PPA. Recently commissioned thermal units without PPA, can be revived by issue of new norms by power ministry for medium term PPA (5-7 years). At present states buy power at variable cost of Rs.3 per unit and hence the new norm for PPA will consider for variable cost of power producers excluding the fixed cost. With this condition, the DISCOMs may sign PPA with the power producers. This will revive the commissioned stressed coal based asset worth 1.44 lakh crores.

- Stressed asset of recently commissioned units shall be acquired by sound generating companies.
- Changes in design of thermal plant equipment

Future thermal plants shall be with super critical or ultra super critical technology only. Design and manufacture of thermal plant equipment shall be suitable for peak load operation against base load operation with the conventional thermal equipment. Government shall provide clean coal for power producers.

### **9.0 Conclusion**

As technology advances, cheap green power will be made available to society. In view of this, it may be possible to phase out most coal power plants by 2050 and replace them with non fossil fuel plants.

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