Council of Enviro Excellence

Topic :-

The evolving thermal power generation portfolio with a focus on cleaner fuel options, including gas, and reassessing the role of coal in the long-term energy mix

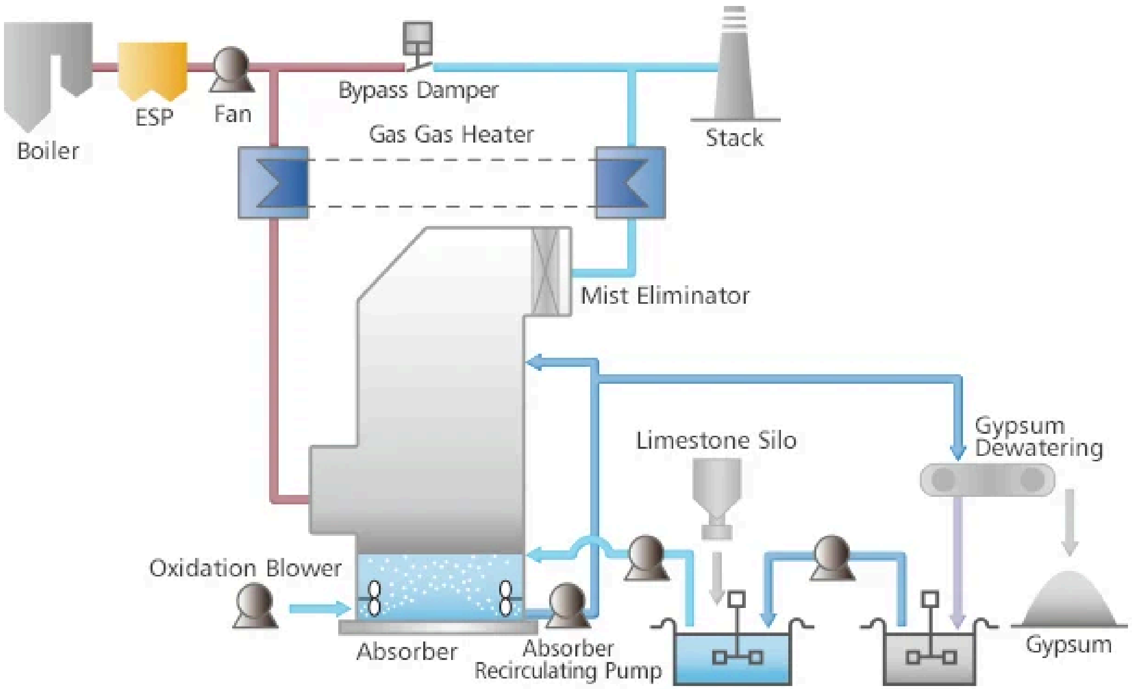
ENvX
3rd NATIONAL POWER-GEN ENVIRONMENT EXCELLENCE SUMMIT & AWARDS 2024

Speaker :-

Shailendra Kumar,

AGM - Project Management Group at L&T-MHI Boilers Private Ltd

The Power Plant Transformation With FGD System



By:

Mr. Shailendra Kumar

Assistant General Manager

ISGEC, Boiler (Project)

Timeline of Emission Standard Notification, Its dilutions and Extensions for Coal-Based Power Station Over the Past Seven Years

2015

- Dec-2015: For the first time, MOEFCC notifies emissions standards for SO2, NOx & Mercury. Mandates all TPPs to comply by Dec 2017
- Oct 2017: MoP submits revised Action Plan seeking MOEFCC to shift deadline to 2022 and staggering FGD implementation
- Dec 2017: The first deadline is missed by most TPPs
- Feb 2018: MOEFCC accepts MoP plan. Submits affidavit before the Supreme Court to revise the deadline to Dec 2019 for NCR and Dec 2022 for the rest
- Jun 2018: MOEFCC amends rules to relax water consumption norms and revises stack heights
- Dec 2019: Most NCR TPPs miss the deadline.
- Oct 2020: MOEFCC amends rules to relax Nox norms for some TPPs
- Mar 2021: MOEFCC amends rules to extend deadline upto Dec 2025 without seeking approval from the Supreme Court
- Apr 2021: Taskforce constituted for classifying TPPs into three categories: A, B and C and staggering implementation of FGDs
- Sep 2022: MOEFCC amends rules to extend deadline for all TPPs by another 2 years to Dec 2027 without any approval from the Supreme Court

2022

Latest Emission Standard and Extended deadline for all TPP

MoEF regulation on Air Emission, Dated: 7th Dec'2015

MoEF Notification for Category wise Timeline for FGD implementation, Dated: 2nd Sep'2022

No.			(Non-retiring units)		units for exemption from compliance	
			parameters other than SO_2 emissions	SO_2 emissions	parameters other than SO_2 emissions	SO_2 emissions
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Category A	With 10 km radius of National Capital Region or cities having million plus population[1].	Up to 31st December 2022	Up to 31st December 2024	Up to 31st December 2022	
2	Category B	With 10 km radius of Critically Polluted Areas[2] or Non-attainment cities[2]	Up to 31st December 2023	Up to 31st December 2025	Up to 31st December 2025	Up to 31st December 2027
3	Category C	Other than those included in category A and B	Up to 31st December 2024	Up to 31st December	Up to 31st December 2025	

Current Status of SO2 Concentration

As per Study conducted by Centre for Atmospheric Sciences, IIT Delhi, Jun 2017 to assess the compliance of thermal power plants in India to new SO2 emission norms (2015) and lay out phased plan for FGD implementation, SO2 concentration reported by AURA Setalite of NASA for the duration of 2005-2019 as below:

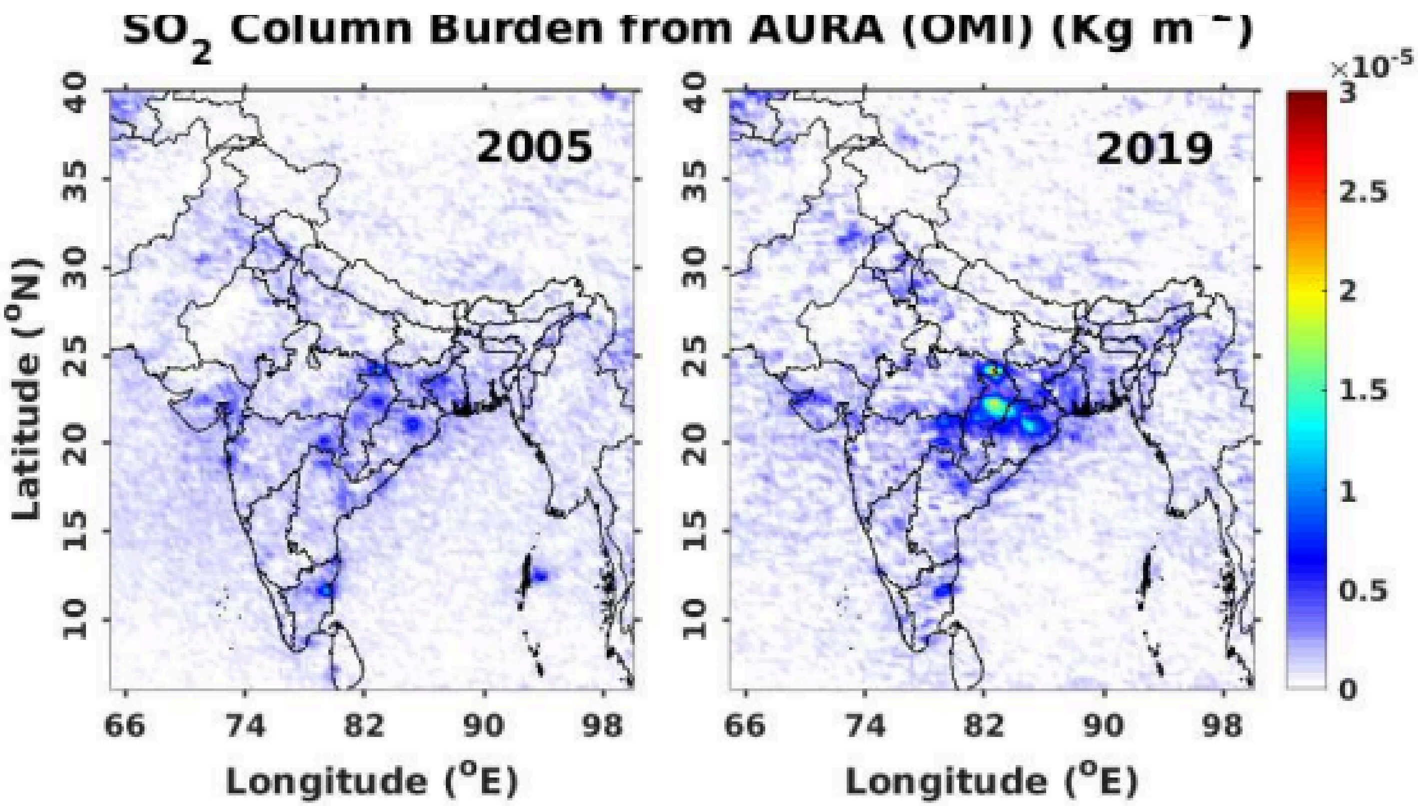


Figure 3.1: Annual mean SO_2 column burden (in Kg/m^2) data from OMI/Aura observations for the years 2005 and 2019

Challenges for FGD Implementation

The biggest challenges for implementation of the new norms are:

Capital Investment:

1. Significant Capital Investment to integrate FGD with existing units
2. Exhaustive work for Capex Calculation due to below factors:

- Plant Size and Configuration
- Coal Composition
- Limestone requirement and Handling system
- Technology Selection: **Wet Scrubbing, Spray Dry Scrubbing, Sorbent Injection, Regen. Process etc.**
- Design and Engineering
- Resource estimation for Installation
- Installation and Schedule for Installation
- Overhead towards Execution and Project Management
- Construction of New Stack or Modification in existing stack based on Wet or Dry FGD System

Challenges for FGD Implementation

- Cost of Equipment and Raw Material: Imported/Domestic supply
- Water and Wastewater System Installation

Site Enabling:

Feasibility Study and Challenges for Site Enabling activities are time consuming due to below reasons:

- Lack of space and insufficient time. Even if space is available approximately 3 years is required for implementation work.
- Increased in water consumption which necessitates a revision in the norms for specific water consumption
- Limestone Handling and Storage system
- Facilities and Disposal of gypsum
- Complexity in Integration of FGD Control with existing Plant Control System, i.e. lying Piping, Cabling, Control & Monitoring, Integration with Central Control Room etc.

Challenges for FGD Implementation

Operation:

Major Areas of operational challenges are:

- Aux Power Consumption: *Increase due to additional auxiliaries*
- Effect on Plant efficiency: *Reduce due to additional Aux Power consumed*
- Plant Load Factor: *Reduce due to increase aux power consumption and dependability on additional system*
- Impact on Power Tariff: *Incremental tariff will be subjected to approval from regulators*
- Maintenance of BOP Equipment: *Frequency of maintenance of balance plant equipment will increase due to additional load*
- Plant equipment life
- Chances of Grid Outage due to phase out of large capacity plants

Types of FGD Technology

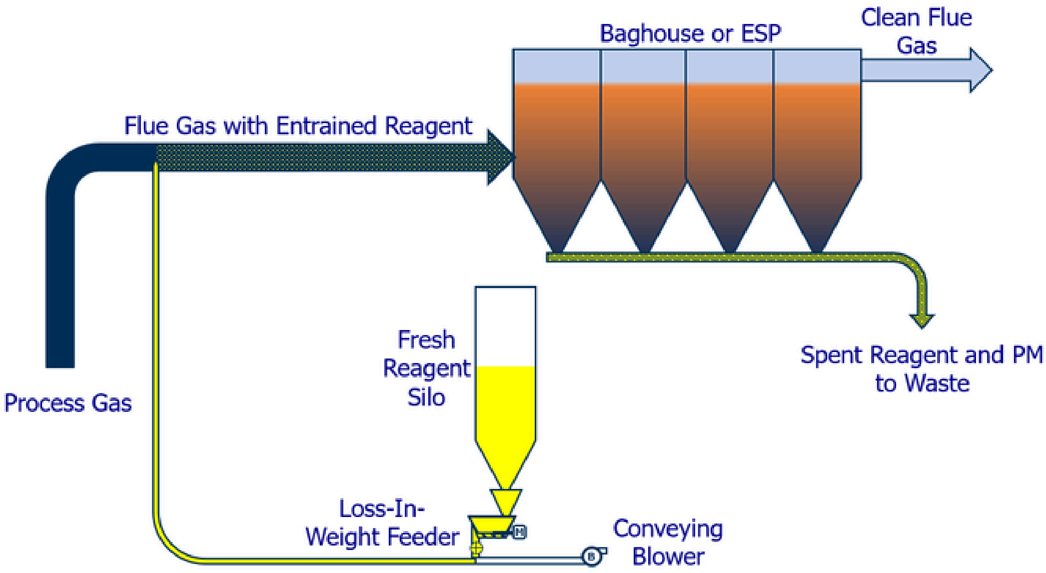
Dry Sorbent Injection

A Dry Sorbent Injection System is a simple system with low capital cost and high reliability. There are multiple reagents available: Hydrated Lime: Ca(OH2), Sodium Bicarbonate: NaHCO3 and Trona: NaCO3, for acid gas mitigation. Dry Sorbent Injection Systems are generally applied when lower removal efficiencies are required, or on smaller plants where the capital cost for other scrubber types may not be justified. DSI Systems typically provide removal efficiencies for SO2 up to 60% an

$2NaHCO_3(s) + heat \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$

$Na_2CO_3(s) + SO_2(g) + 1/2(O_2) \rightarrow Na_2SO_4(s) + CO_2(g)$

$Na_2CO_3(s) + SO_3(g) \rightarrow Na_2SO_4(s) + CO_2(g)$



Types of FGD Technology

Wet Limestone Based

99% reduction in SO2

$CaCO_3(s) + SO_2(g) \rightarrow CaSO_3(s) + CO_2(g)$

$Ca(OH)_2(s) + SO_2(g) \rightarrow CaSO_3(s) + H_2O(l)$

$CaSO_3(aq) + 2H_2O(l) + \frac{1}{2}O_2(g) \rightarrow CaSO_4 \cdot 2H_2O(s)$ (Gypsum)

Cost :

Doosan Lentjes: 50-60 $/kW (INR 0.42 – 0.504 Cr./MW)
Project under execution: Mejia TPP (DVC)

BHEL: INR 0.50-1.20 Cr./MW

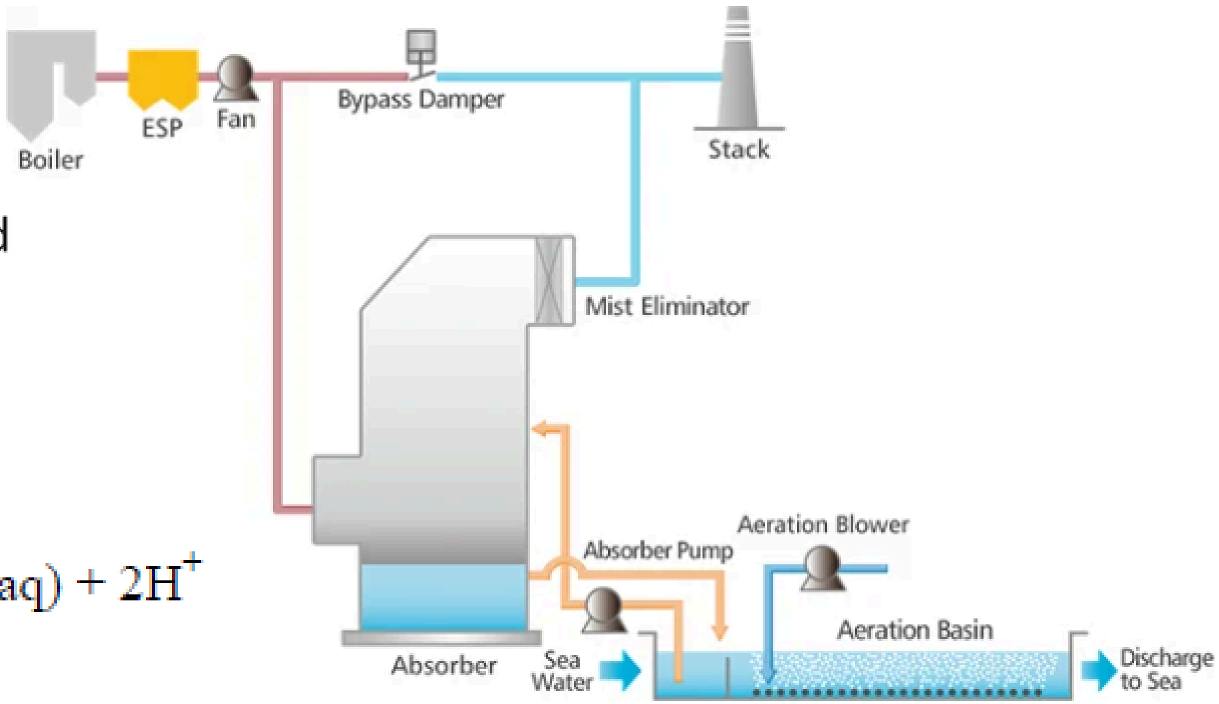
GE Power India Ltd.:
INR 0.65 Cr./MW (min 2 unit configuration full EPC for >500 MW)
INR 1.10 Cr./MW (min 2 unit configuration full EPC for <300 MW)

Types of FGD Technology

Sea Water Based

The principle of our process is to make use of the natural alkalinity of seawater instead of using limestone solution to absorb acidic substances in the flue gas. The SO2 is first converted into sulphite. Then the sulphite is oxidated to form sulphate in the aeration basin in order to maintain the pH, raise the DO (dissolved oxygen), and reduce the COD (Chemical Oxygen Demand). In the meantime, CO2 formed by the neutralization reaction is stripped by aeration membranes.

- Outstanding for various fuels
- Up to 99% SO2 removal
- No by-products
- Seawater as absorbent
- Open spray tower technology and packed tower design
- Low operating and maintenance costs
- High availability



$$SO_2(g) + H_2O(l) + \tfrac{1}{2}O_2(g) \rightarrow SO_4^{2-}(aq) + 2H^+$$

$$HCO_3^- + H^+ \rightarrow H_2O(l) + CO_2(g)$$

Resource Requirement for FGD

Land Requirement:

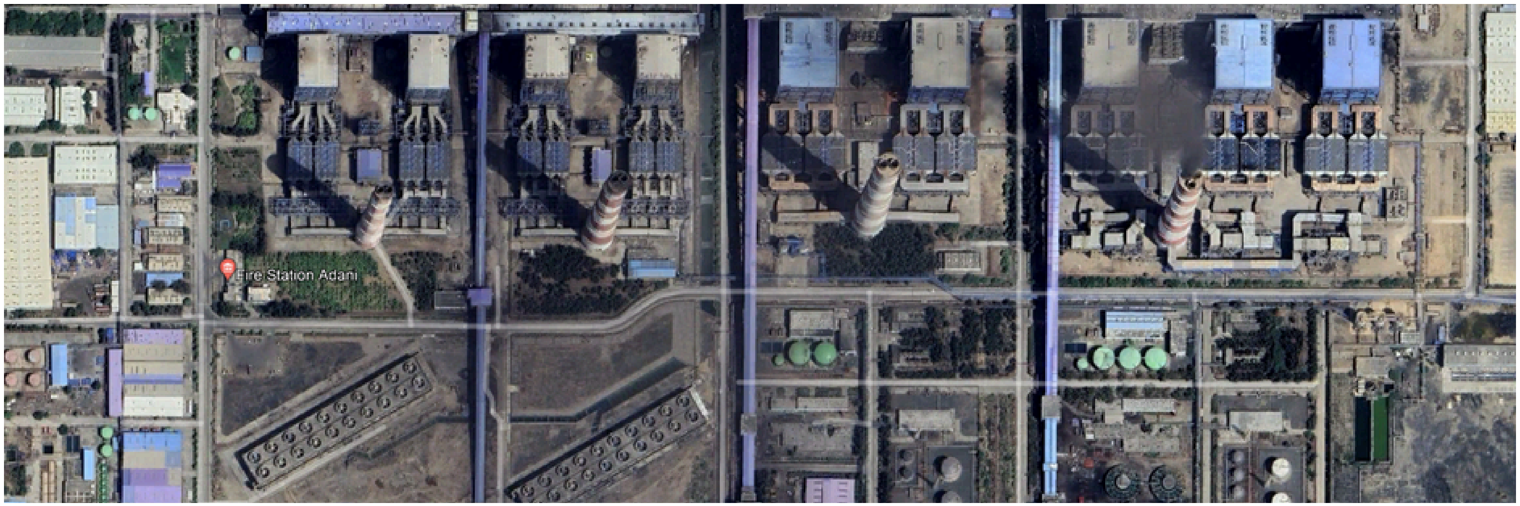
As per CEA Land Requirement report, Dec'2007, the area required for FGD Installation is

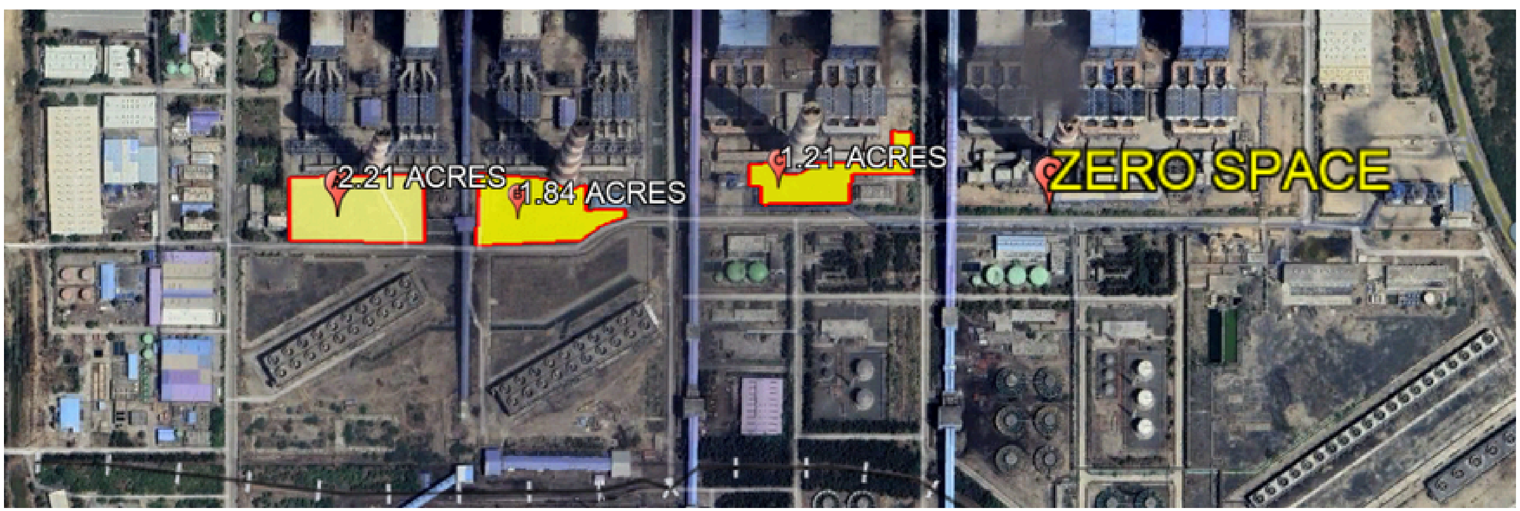
	2x500 MW	3x660 MW	5x660 MW	6x660 MW	4x800 MW	5x80[illegible] MW
	7	14	20	27	17	21

s ; dimensions in metres]

Resource Requirement for FGD

Projects Layout challenges: as per equipment layout major challenges observed is to fit the FGD system in space available in running units



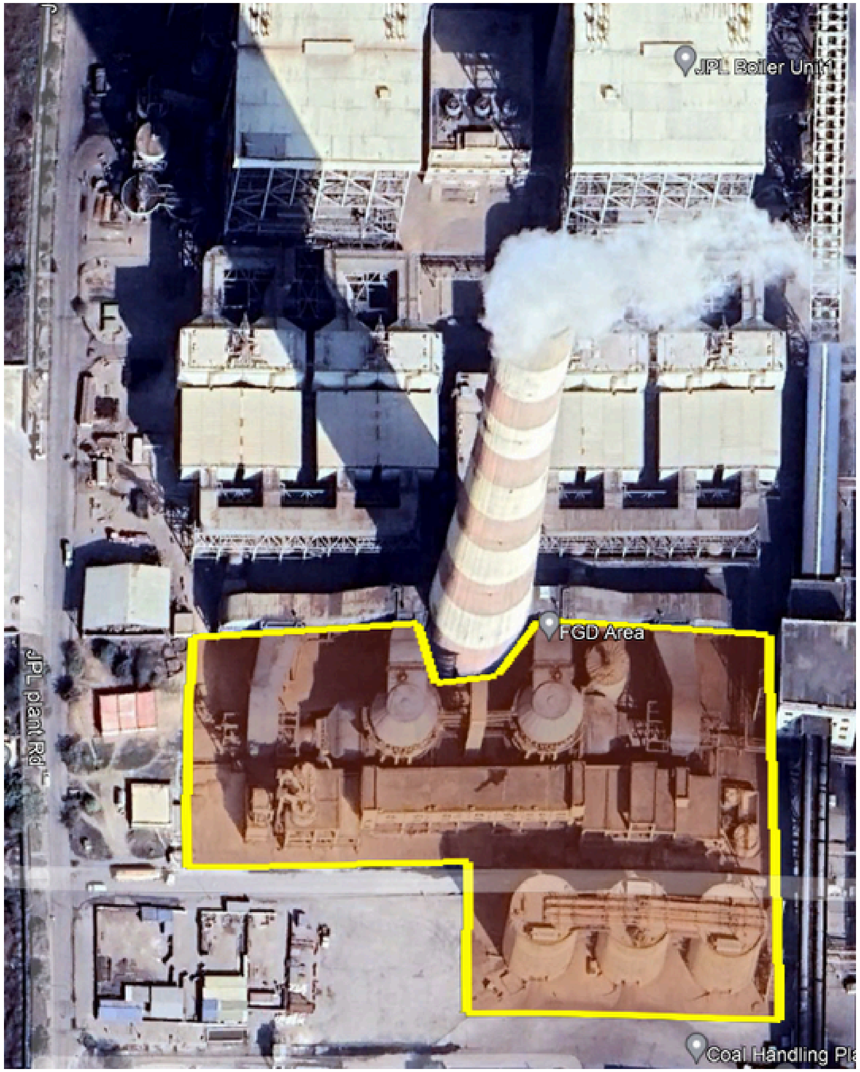


ADANI POWER MUNDRA STPP

Space is not available in the vicinity of chimney area

Resource Requirement for FGD

TATA POWER MUNDRA 5 UNIT STPP FGD UNDER IMPLEMENTATION



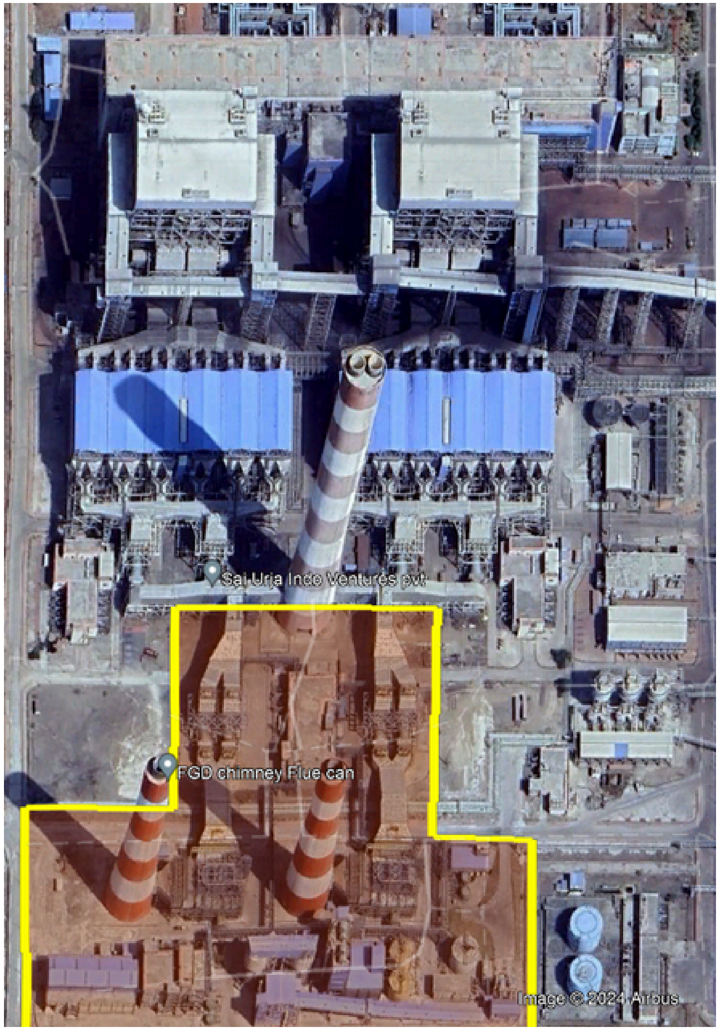
CLP JHAJJAR STPP FGD SYSTEM

Resource Requirement for FGD

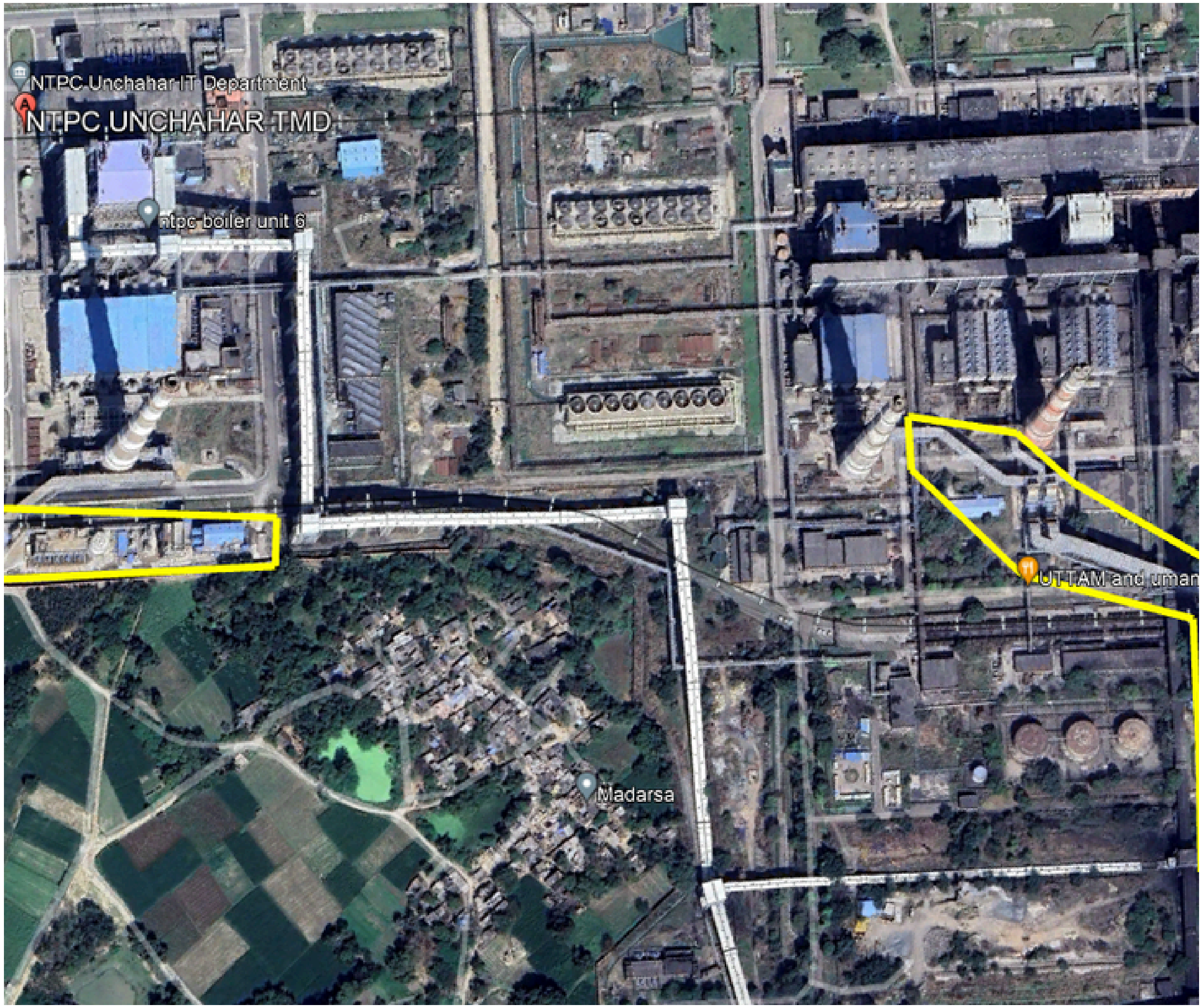
NTPC JHAJJAR STPP FGD SYSTEM

NTPC KANIHA (TALCHER, ANGUL DISTRICT, ODISHA)6x500 MW FGD UNDER IMPLEMENTATION

Resource Requirement for FGD



NTPC KHARGONE 2X660 MW STPP FGD



NTPC UNCHAHAR STPP FGD IMPLEMENTATION

Constraint On FGD Installation

Constraint on Flue Gas De-Sulphurisation (FGD)

Constraints w.r.t the following components which are special materials for chimney flue lining and are imported

- Titanium or C276 alloy
- Titanium Gr2 clad / sheets
- Alloy 59, Haste Alloy C22, Alloy 31
- Bromo-butyl rubber lining
- Borosilicate lining

Absorber Lining Material:

SS317/Alloy 31/Hastelloy C22/C 59/C276 OR Rubber Lining/ Flake Glass Lining

Some specialised systems involved in FGD

- Gypsum Dewatering system
- Slurry recirculating pumps
- Agitators
- Mist Eliminator

Although manufacturing capability of 70 to 80% FGD components is available in India, the balance 20 to 30% of FGD components are being imported from other countries.

Action Plan for FGD Installation

Considering the challenges involved in FGD installation of FGD in all TPPs across the country simultaneously, it has been decided to follow graded plan for phased implementation.

Implementation proposed in 5 phases with completion of all phases by Jul'2034

Phase-1: in around 40 TPPs

TPPs with power production capacity greater than 750 MW within 3 years starting from Jul 2022 to Jul 2025.

Phase-2: in around 49 TPPs

Jul 2026 to Jul 2029, with TPPs having power production capacity less than 750 MW

Time duration between Phae-1 & 2 will provide sufficient time for observation of:

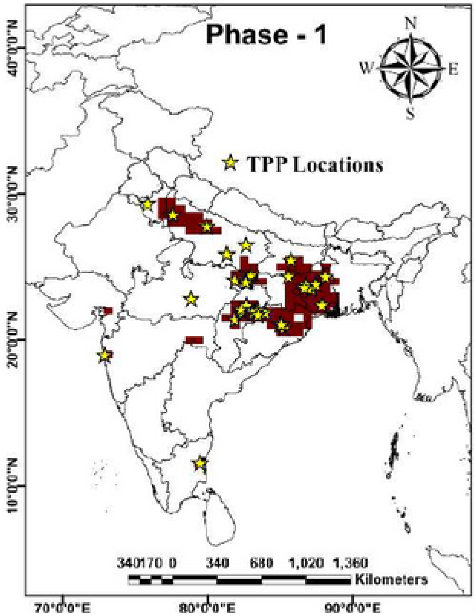
- Emergence in new FGD Technology
- Less water consumption and Low Green House Gas (CO2) emission
- Domestic Manufacturing of FGD components (Atma-Nirbhar Bharat)
- Time taken to implement FGD may less than 24 months

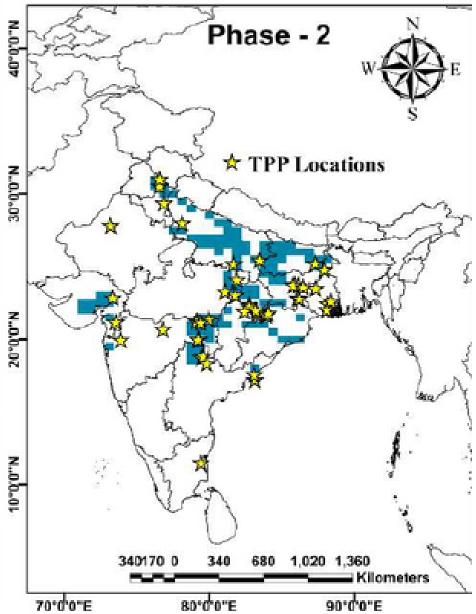
Phase-3: in 27 TPPs (Jul 2029 to Jul 2031)

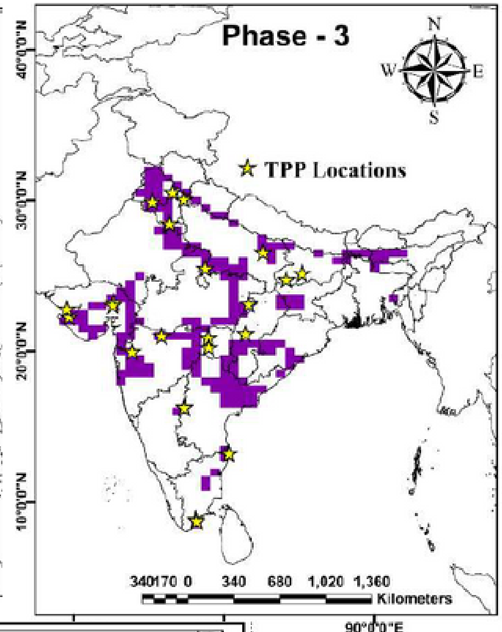
Phase-4: in 21 TPPs (Jul 2031 to Jul 2033)

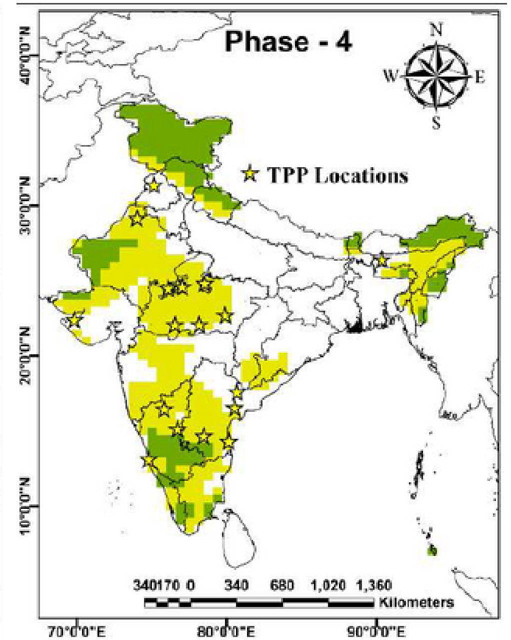
Phase-5: in 7 TPPs (Jul 2033 to Jul 2034)

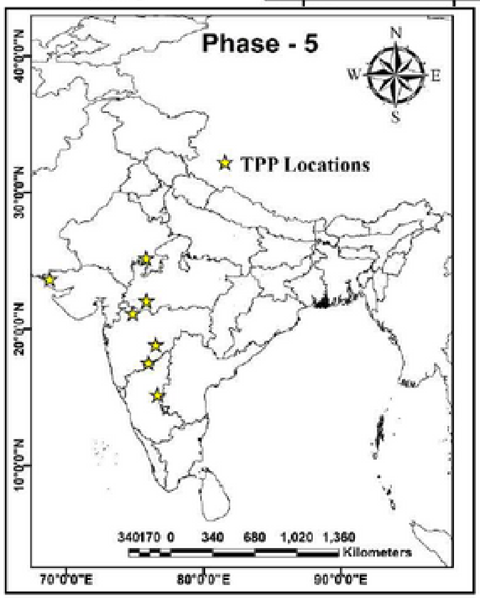
Location of TPPs for Phased Implementation











Socio Economic Benefits of Implementing FGD in Power Plant

Estimating the Health Impacts of SO_2 Emissions from Power Plants

Estimation of health benefits of one FGD unit by estimating SO2 emissions from a plant without FGD unit and then translating those emissions into changes in ambient air quality using Eulerian Photochemical Dispersion Model (CAMx) that allows SO2 to form fine sulfate particles (PM2.5) in the atmosphere.

The impacts of PM2.5 on premature mortality are estimated for Ischemic Heart Disease, Stroke, Lung Cancer, Chronic Obstructive Pulmonary Disease (COPD) and Acute Lower Respiratory Infection (ALRI) using the integrated exposure response (IER) coefficient in Burnett and Others (Burnett R T, Pope C A, III M, Ezzati C, Olives S S Lim., others. 2014. “An Integrated Risk Function for Estimating the Global Burden of Disease Attributable to Ambient Fine Particulate Matter Exposure.” Environmental Health Perspectives 122 (4): 397–403).

Socio Economic Benefits of Implementing FGD in Power Plant

Deaths and DALYs Associated with SO_2 Emissions, by Plant

	Deaths			**DALYs**		
Cause	**Mean**	**25%ile**	**75%ile**	**Mean**	**25%ile**	**75%ile**
COPD	18.5	5.5	20.1	351	104	392
Stroke	106	31.4	115	2,230	660	2,490
IHD	58.8	17.4	63.8	1,350	399	1,510
ALRI	29.9	8.9	32.5	1,510	449	1,690
Lung cancer	2.3	0.68	2.6	60.1	17.8	67.1
All causes	216	64	241	5,500	1,630	6,150
All causes, benchmark conditions	249	77.3	301	6,360	1,974	7,690

Note: ALRI = acute lower respiratory infection; COPD = chronic obstructive pulmonary disease; DALY = disability-adjusted life year (One DALY represents the loss of the equivalent of one year of full health) ; IHD = ischemic heart disease (heart weakening caused by reduced blood flow to your heart)

Socio Economic Benefits of Implementing FGD in Power Plant

It is assume that a scrubber will reduce SO_2 emissions by 90 percent. The annual reductions in premature mortality and associated life years lost resulting from use of scrubbers are combined with an estimate of annualized capital and operating costs to compute the cost per statistical life saved and cost per disability-adjusted life year (DALY) averted associated with each FGD unit.

Reducing SO_2 emissions from coal-fired power plants offers additional benefits that we do not quantify. These include improvements in visibility (which yield aesthetic and recreation benefits) and reduced acidic deposition. Acidic deposition can reduce soil quality (through nutrient leaching), impair timber growth, and harm freshwater ecosystems.

Source: Chapter 13 Costs and Benefits of Installing Flue-Gas Desulfurization Units at Coal-Fired Power Plants in India

Injury Prevention and Environmental Health. 3rd edition.
By Mock CN, Nugent R, Kobusingye O, et al., editors.
Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2017 Oct 27.

Socio Economic Benefits of Implementing FGD in Power Plant

As per second prospective report issued by EPA (Environmental Protection Agency, USA) in Mar'2011 which looked at the results of the Clean Air Act from 1990 to 2020, the central benefits estimate exceeds costs by factor of more than 30 to one. Clean Air Act Amendments estimated to have prevented over 230,000 early deaths in 2020. 85% economic benefits are attributable to reductions in premature mortality associated with reduction in Ambient Particulate Matter.

The 1990 Clean Air Act Amendments prevent:

The remaining benefits are roughly equally divided among three categories of human health and environmental improvement: Preventing premature mortality and improving the quality of ecological resources and other aspects of the environment, the largest component of which is improved visibility.

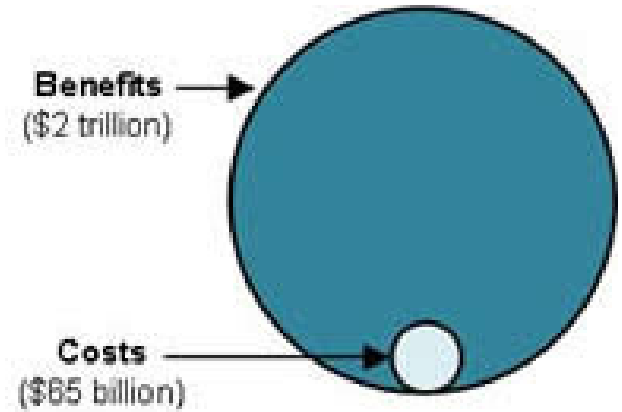
	cases)	cases)
Adult Mortality - particles	160,000	230,000
Asthma Exacerbation	1,700,000	2,400,000
Chronic Bronchitis	54,000	75,000
Emergency Room Visits	86,000	120,000
Heart Disease - Acute Myocardial Infarction	130,000	200,000
Infant Mortality - particles	230	280
Lost Work Days	13,000,000	17,000,000

Socio Economic Benefits of Implementing FGD in Power Plant

A Good Investment

The 1990 Clean Air Act Amendments programs are projected to result in a net improvement in U.S. economic growth and the economic welfare of American households.

Our central benefits estimate exceeds costs by a factor of more than 30 to one, and the high benefits estimate exceeds costs by 90 times. Even the low benefits estimate exceeds costs by about three to one.



This net improvement in economic welfare is projected to occur because cleaner air leads to better health and productivity for American workers as well as savings on medical expenses for air pollution-related health problems. The beneficial economic effects of these two improvements alone are projected to more than offset the expenditures for pollution control.

Thank You

Thanking You
on Behalf of !

Council of Enviro Excellence