



# Expediting Implementation of New Norms

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# About Centre for Science and Environment

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Founded in 1980, CSE researches into, advocates for and communicates the urgency of development that is both sustainable and equitable

>165 staff working on a wide array of environment & development issues – water, waste, industrial pollution, climate change, energy, forestry, environmental health etc

Programs to engage, train and communicate with various stakeholders

Publishes India's largest selling Science and Environment Fortnightly  
– **Down To Earth**

# Green Rating Project

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Green Rating Project (GRP) - public tool to benchmark present industrial performance of industries

Pushes towards desirable goals

Public disclosure crucial – spur credible action

Various sectors covered since 1999 – pulp and paper, chlor alkali, cement, steel

Thermal power one important area – large polluter, much scope for improvement in India (2015)

# The Context



# New pollution norms

## **CSE conducted 2-year study of coal-based power sector's operating and environment performance (February 2015)**

- Research design and Analysis guided by panel of experts (former CPCB officials, electricity generators, power equipment manufacturers etc)
- Sample: 47 plants comprising 54 GW capacity - around half of the thermal power sector capacity in operation at that time
- Diversified by ownership & location
- Unit sizes: 30% -210MW units; 25% - 500MW units or larger
- Age – 25% - past full life (over 25 years); 25% - exceeding mid life
- Data collection:
  - participating plants provided detailed operational data; supplemented by environment reports, CEA, tariff applications etc
  - Plant audit and management interviews
  - Survey of neighbouring community, local media, NGOs, employees

# New Norms – Overview

- **Power sector responsible for inordinate pollution load – 30-60% of all major industrial emissions (PM, SO<sub>x</sub> and NO<sub>x</sub>)**
- **Draws around 24 BCM annually; around half of TOTAL domestic water use in India**
  - Under CREPS, in 2003, industry had committed to improve its env. performance (meeting 100 mg/m<sup>3</sup> particulate matter levels; SO<sub>x</sub>/NO<sub>x</sub> standards to be implemented by 2005/06), BUT made no progress
  - Meanwhile, ECs given since 2008 already require plants to meet tighter PM norms (at 50 mg/m<sup>3</sup> for 500 MW size units and space for FGD since 2003)

mg/Nm <sup>3</sup>	Unit size	Installed before Dec 31st, 2003 *	Installed between 2004 and 2016 *	Installed Jan 1, 2017 onwards
PM	All	100	50	30
SO <sub>2</sub>	<500MW	600	600	100
	>=500MW	200	200	100
NO <sub>x</sub>	All	600	300	100
Hg	All	0.03 (>500 MW)	0.03	0.03

- **Existing plants – comply by Dec 2017**

## Water Use:

OTC plants convert to CT;

CT plants to cut water use to 3.5 m<sup>3</sup>/MWh; New plants to use 2.5 m<sup>3</sup>/MWh



# New Norms – Overview

- New norms in line with the global standards.
- China has introduced even tighter standards for metro and highly polluted areas (PM 10 mg/Nm<sup>3</sup>, SO<sub>x</sub> 35 mg/Nm<sup>3</sup> and NO<sub>x</sub> 50 mg/Nm<sup>3</sup>).

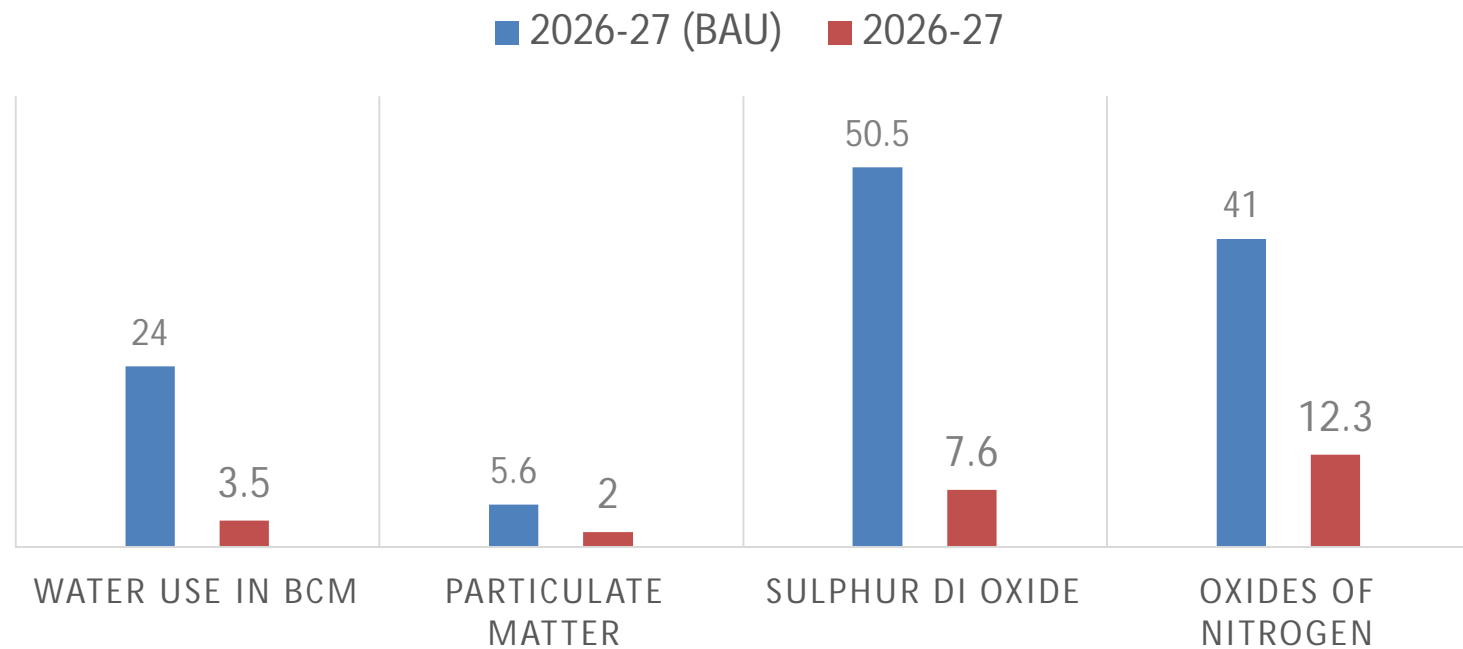
## Global comparison

mg/Nm <sup>3</sup>	PM	SO <sub>2</sub>	NO <sub>x</sub>
<b>China</b>	10	35	50
<b>Japan</b>	50	Permit	200
<b>USA</b>	14.5	100	110
<b>EU</b>	30	200	200

# New Norms – Benefits

Reduction in pollution (BAU vs. New norms) assuming generation in 2026-27 as per CEA's draft Electricity policy, December 2016

- Water use – 85% reduction – largely due to conversion of OTC to CT
- PM emissions – 65%
- SO<sub>x</sub> – over 85%
- NO<sub>x</sub> – almost 70%



\*Emissions in lakh tonnes



# CSE Research and Intervention

- **Initially, pushback from industry citing concerns:**
  - Technology
  - Tariff recovery/Investments
  - Timelines
- **To recommend solutions for the issues inhibiting progress – CSE organized series of meetings and policy workshops during 3Q-4Q 2016**
- **Engaged with all key stakeholders:**
  - MoEF &CC and MoP
  - CPCB and various state PCBs
  - **Tariff Regulators:** CERC, State ERCs (Haryana and Odisha)
  - **Industry:** APP, NTPC, Tata Power, Reliance, State power plants
  - **Suppliers:** BHEL, GE-Alstom, Thermax, Doosan & Mitsubishi
  - **Industry experts:** Anil Razdan, ex-Power Secretary; DK Jain – ex-NTPC Director
- **Several policy recommendations emerged**



# Technology

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- Pollution control technology – mature; suitable for Indian coal; sufficient global supply
- Not a major impediment.
- **ESP**
  - Vast majority needs fine tuning/minor ESP up-gradations,
  - some may need to add fields
- **SO<sub>x</sub>**
  - FGD – only for larger units
  - Other units – low cost solutions like partial FGD, limestone injection, etc.
- **NO<sub>x</sub>**
  - Existing boilers – burner modification, low NO<sub>x</sub> burners, combustion optimization
  - SCR/SNCR will not be necessary for existing power stations

# Issues - Timelines

- Timelines were achievable when the norms were announced
- But little progress – pre-execution work such as technology identification and tariff application could have been done
- Meeting PM, NOx, water use norms still possible given procurement time of less than 6 months.
  - installation can be done during scheduled shut down or need less than 1 month shut down
- Procurement of FGD could take up to 24 months.
- Additional time will now be needed

Technology	Construction time	Downtime
Electrostatic precipitator (ESP)	~ 3–6 months	~ 20–30 days
Flue gas desulphurization (FGD)	~ 18–24 months	~ 30–90 days
Selective Catalyst Reduction	~ 5 months	~ 30 days
Selective Non-Catalyst Reduction	~ 4 months	~ 7 days
Low NOx burner, OFA etc.	~ 1 month	~ 15–20 days

# Manageable Costs

- **CEA/ERC REVISED COSTS ARE LOWER THAN THEIR PRIOR ESTIMATES (40-90 Paise Per Unit)**
- CEA Chaired Committee's estimates of costs and tariff
  - NOx: investment range between Rs 1-10 lakh/MW for boiler upgrade (7 paise/unit)
  - PM: investment Rs 13 lakh/MW (9 paise/unit)
  - SOx: investment of Rs 50 lac/MW on FGD (CEA report says 32 paise/unit based on 15 year life, which is a miscalculation; our estimates is around 20 paise/unit).
- **Importantly, costs are dropping as predicted by CSE. Suppliers have told CSE that FGD bids are 35- 40 lacs/MW.** UPRVUNL Harduaganj contract was lower, we believe

Technology required	Approx. cost *
ESP upgradation	Rs 5–15 lakh/MW
Partial FGD	Rs 25–30 lakh/MW
FGD	Rs 40–50 lakh/MW
De-NOx	Rs 10–15 lakh/MW
SCR/SNCR**	Rs 20–25 lakh/MW

\* Based on estimates provided by leading global suppliers (GE-Alstom, Mitsubishi, Doosan, Andritz etc)

\*\* SCR/SNCR is not needed for existing capacity



# Post Research Developments



# Implementation – Status (Recent update)

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- Discussions with plants, suppliers, experts etc. indicates unsatisfactory progress.
  - Even the current emissions data of most plants is incorrect
  - Other basic data still unavailable – for e.g. changing information about plants that have space for FGD
  - State owned plants don't have sufficient expertise – for e.g. to write specs;
  - Crucial step that will allow plants to raise financing
  - Most plants in pipeline are continuing construction without any changes to their plans
    - Retrofitting later may be even more costly
    - **Urgent action is required to ensure compliance by plants being commissioned now**
- **Still no confirmation from CERC that investments in pollution control will be covered under “Change of Law”.**

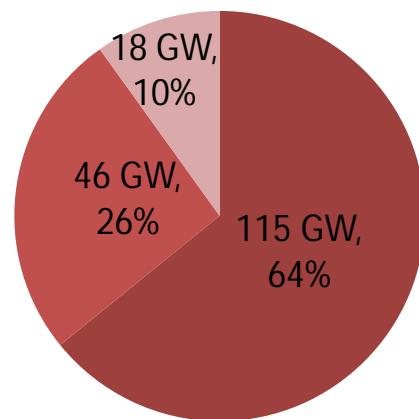
# Implementation – Positive news

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- Few plants making good progress
  - Review of NTPC's Eastern region report showed both positive momentum and also reasonable strategy
    - Some ESPs already upgraded, some in progress
    - Certain old units that can't install FGD to be operated in a "flexible" manner
    - UPRVUNL uploaded FGD in Harduaganj plant; implementation underway for others
- Some progress on tenders being floated for FGDs (Inputs from supplier)
  - Approx. 70 GW for FGD tendering over a 6 month period starting July 2017
  - NTPC announced e-bids of around 17 GW
- Two state PCBs – Haryana and MP – have expressed interest in working with CSE to track and push implementation.

# CEA Report: Requirements

- MoP formed CEA-led Committee (CPCB, NTPC, POSOCO, various ministries) in Sep 2016 to prepare phase-in plan for installing new equipment to meet new norms.
- Findings indicate manageable installation and upgrade requirements
- **Particulate Matter:**
  - Two thirds of the capacity meets new PM norms
  - Only 25% capacity requires ESP up-gradation
  - Another 10% capacity will meet the PM norms after FGD installation



- Capacity meeting new SPM norms
- Capacity identified for ESP up-gradation
- Capacity identified for FGD installation

- **Oxides of nitrogen:** Requires boiler up-gradation– Relatively minor and inexpensive change for most plants; can be done during the next overhaul



# CEA: FGD Needs Evolving

- **1<sup>st</sup> CEA Analysis:** 96 GW of capacity (54%) has space for FGD installations
- **2<sup>nd</sup> CEA Analysis:** 123 GW has space for FGD
- **Recent update**
  - **FGD Planned – 146 GW**
  - **Compliant (FGD, CFBC etc.) – 16GW**
  - **Shutter, Non Compliant – 25 GW**
- **Unacceptable that even basic data is unavailable after 2 years**
- We believe, based on new information from suppliers, that “space for FGD” is not a problem
  - Ducts can be extended to install FGD at a distance – cost of installing new stack will be \$5MM, however, no need for lining the existing stack
  - In US and Europe, 70-80% of FGDs are retrofits. In none of these countries regulations required space to be kept for FGDs.
  - This information has been given by suppliers to CEA/industry

# CEA/RPC Plans: Significant Delays

- Preliminary timelines indicated in the REVISED phasing plans prepared by RPCs still have unreasonable timelines
- **FGD - Only 6GW will install FGD by 2019, rest as late as March 2023**
- **PM – Of 46 GW needing upgrade only 8GW will be done by 2019**

Year	ESP	FGD
2017	2.4	-
2018	3.3	-
2019	2.5	6.1
2020	3.6	21.1
2021	2.1	48.6
2022	1.0	31.4
2023	0.4	15.5
Not specified	19.2	-
Total	34.4	122.7

*Timelines for ESP upgrades are as per the 1<sup>st</sup> CEA/RPC analysis ; These did not cover approx 40 GW of capacity, of which around 12 GW may need to upgrade their ESP.  
Timelines for FGD are as per the 2<sup>nd</sup> CEA/RPC analysis.*

# CSE Study : Upcoming Units

- **95% of 73 GW upcoming coal-based units has no plans of pollution control equipment**
- **28 GW starting operation this year have already obtained CTOs from PCBs.** Gaps in CTO
  - CTO from state PCBs did not ask power stations to adhere to new norms
  - Air Act, 1981 and Water Act, 1974 – open ended on when CTO should be issued – SPCBs have mostly granted consents
  - Power stations cite difficulty in incorporating changes in designs to accommodate pollution control devices as these in advanced stages

Year	Capacity in MW
	Commissioning
2016	
2017	28,185
2018	13,935
2019	6,500
2020	3,300
2021	2,640
NA	5,915
Total	60,340

**Note:** Work is stalled in projects of capacity 12,640 of 72,980 MW



# CSE Report: Technology Requirement

<i>Unit size</i>	<i>Unit size distribution in GW</i>				
	<i>+25 years</i>	<i>1990–2003</i>	<i>2004–08</i>	<i>2009–16*</i>	<i>Total</i>
<i>up to 250 MW</i>	28.6	16.3	2.1	5.8	52.8
<i>&gt; 250 and &lt;500 MW</i>	-	5.4	3.8	20.8	30.0
<i>500 MW and above</i>	5.5	9.5	6.0	82.8	103.8
<i>Total</i>	34.1	31.1	11.9	109.4	186.6

- Units over 25 years (34.1 GW capacity) should be shut/replaced with SC
- PM: Post-2008 capacity – 50 mg/Nm<sup>3</sup> norms for most in EC, therefore only a small fraction (46 GW) needs to upgrade ESP
- SO<sub>x</sub>: 103 GW capacity needs to meet tighter standard; FGD installation can be focused on post-2003 larger size units (89 GW)
- NO<sub>x</sub>: Not considered a challenge

# Recommendations to MoEF

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## Particulate Matter:

- **115 GW** (65%) to comply **by December 2017**. (CEA report already indicates compliance – worst case, some minor upgrades needed)
- Of remaining **65 GW**:
  - 46 GW is scheduled (over the next 2 years) for ESP upgradation and 16 GW is expected to comply by installing FGD
  - *CSE view: 13 GW is over 25 years old and should be gradually shutdown instead of upgrading ESP or installing FGD*

## Oxides of Nitrogen:

- Nearly **half the capacity** should meet NO<sub>x</sub> norms **by March 2018**
  - Annual maintenance plan (AMP) of RPCs for 2017-18 include 82.6 GW of capacity – their outage duration should be expanded as required
- **Remaining 50%** capacity should be scheduled for outages in the next year's AMP, such as compliance is ensured by **December 2018**

# Recommendations to MoEF

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## Sulphur Di Oxide:

- **89 GW** – over 500 MW size units installed in 2004-16 – **compliance by Dec 2019**.
  - About 1/3<sup>rd</sup> by Dec. 2018; 1/3<sup>rd</sup> by June 2019 and 1/3<sup>rd</sup> by Dec. 2019
  - 79 GW has space for FGD; remaining can locate FGD at a distance
- **Norms for units of 500 MW and above installed 1990-2003 (9.5 GW) should be relaxed to 600 mg/Nm<sup>3</sup>; 5.5GW is older than 25 years and should be shut**
- Units smaller than 500 MW installed in 1990-2016 (54 GW) – some already in compliance, others need additional measures

## Water:

- **All CT-based plants** to comply with water use limits **by December 2017**
- **All old OTC-based plants (11.9 GW) should be shut:** Two remaining fresh water OTC-based plants (CSE data; CEA to confirm) – MPPGCL, Birsinghpur and TNVL, Tenughat – to convert to CT by **December 2018**

# Recommendations

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- **Strengthen Monitoring of Existing Plants:**

- Develop baseline emissions data
- CPCB and state PCB should urgently get project status from plants and understand implementation plans/status
- Direct power stations to submit 'Action Plans' within three months for implementation of the new norms
- CPCB and state PCBs need to develop a regular monitoring plan
- Penalties and plan of action should be devised for plants that fall behind schedule
- **Any extension in timelines should happen with bank guarantee**

- **Strengthen Monitoring of Upcoming Plants:**

- Ensure that plants under construction should meet the standards from day 1 since later modification may be disruptive. (Retrofitting to meet the norms within the next two years may be permitted if there are techno-economic benefits.)
- Review 'consent to operate' and 'EC' document of power stations.

# Other Recommendations

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## **Shutting of Old Capacity:**

- 34 GW of more than 25 years old should be asked to shut down by 2020 (no need to meet standards)
- Plants with firm retirement/ replacement plans may be allowed to operate in the interim (for maximum 2 years)
- Plants replacing old units with SC/USC units should not need fresh ECs.
- Old plants undertaking life extension works should be required to meet tighter standards

## **Adjust Existing Norms:**

- Stack height regulation – meant to disperse  $\text{SO}_2$  – needs to be revised in light of FGD requirement
- Specific water consumption standards for coastal plants should be different than plants using fresh water. (For coastal plants a low CoC (~2) CT may be recommended - specific water consumption of about 10 cu.m/MWh)
- Consider relaxing  $\text{SO}_2$  norms to 600 mg/Nm<sup>3</sup> for the all over 500 MW size units, installed prior to 2003.



# Recommendations: CERC/CEA

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- **Incentives/Relief:**

- Urgent confirmation by MoP/CERC that CAPEX for pollution control will be considered under “Change of Law” to calculate tariff.
- CEA needs to promptly prepare a technology benchmark report which ERC/CERC should use as guidance to approve CAPEX
- Dispatch order should be scrupulously followed to ensure cleaner and efficient plants are scheduled first.
- Mechanism of tariff incentives/penalties based on pollution cuts achieved should be established to ensure investments result in tangible/quantifiable benefits.

# Pushing for Implementation

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- CSE drafted a detailed questionnaire to be filled by plants to track progress – shared with State PCBs as well as CPCB.
  - Most State pollution control boards we contacted have not collected data on implementation progress yet
  - Odisha got details; Karnataka tried but didn't get response
- Organized RT with senior PCB officials from states (Odisha, Jharkhand, Chhattisgarh, MP, Maharashtra, Gujarat, TN etc.) with sizable coal capacity
  - Officials have only a basic understanding of pollution control technologies – capacity building is essential
- Organized a training program in Bengaluru for mid-level PCB officers of 4 Southern states responsible for monitoring.
- **Key conclusion**
  - **Need to track progress closely**
  - **PCBs need to develop an enforcement plan (perhaps under CPCB guidance) – show cause, committed action plan, bank guarantees etc.**

# The Pollutants Under Question



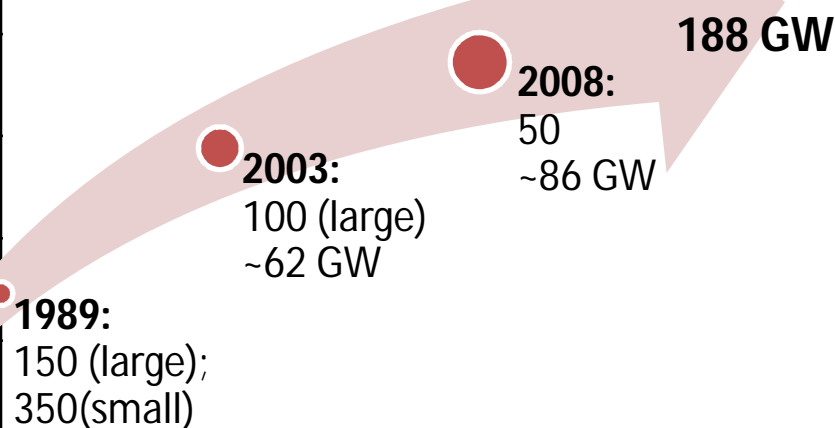
# **PARTICULATE MATTER**

# Current emission levels: Particulate matter

- Most plants under compliance – standards have remained mostly unchanged
- Performance most likely understated – 2/3<sup>rd</sup> in violation (MIT study in Gujarat similar conclusions)

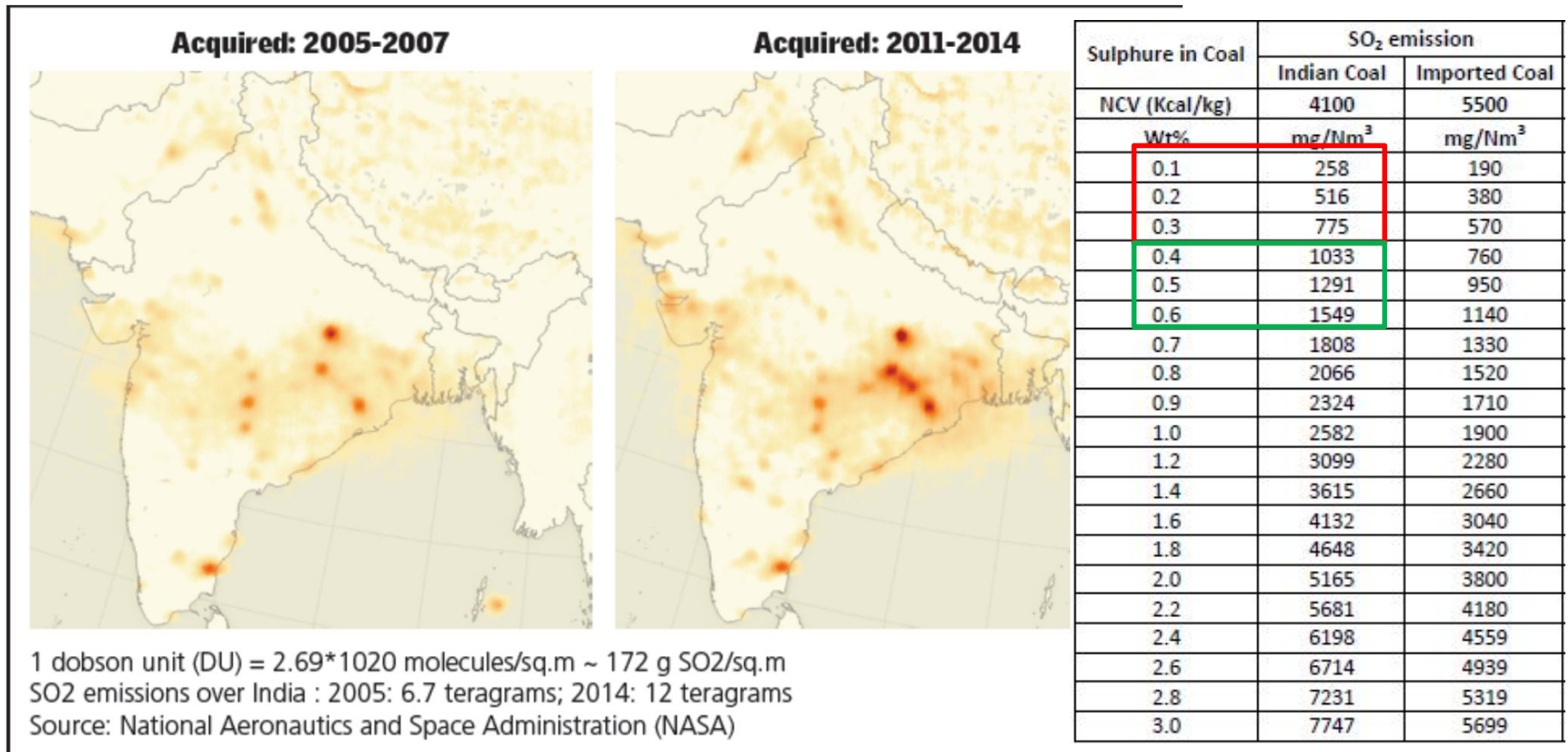
Emissions in mg/Nm <sup>3</sup>	Capacity in MW	Prior 2003	Post 2003
0-50	98,548	3,147	95,401
50-100	27,335	14,880	12,455
100-150	34,173	28,953	5,720
150-250	9,553	7,133	2,420
250-500	8,398	8,398	
500+	2,493	2,493	

- Most ESPs designed to meet 50mg/N.cu.m – however underperforming - largely refurbishments required.



**SULPHUR DIOXIDE**

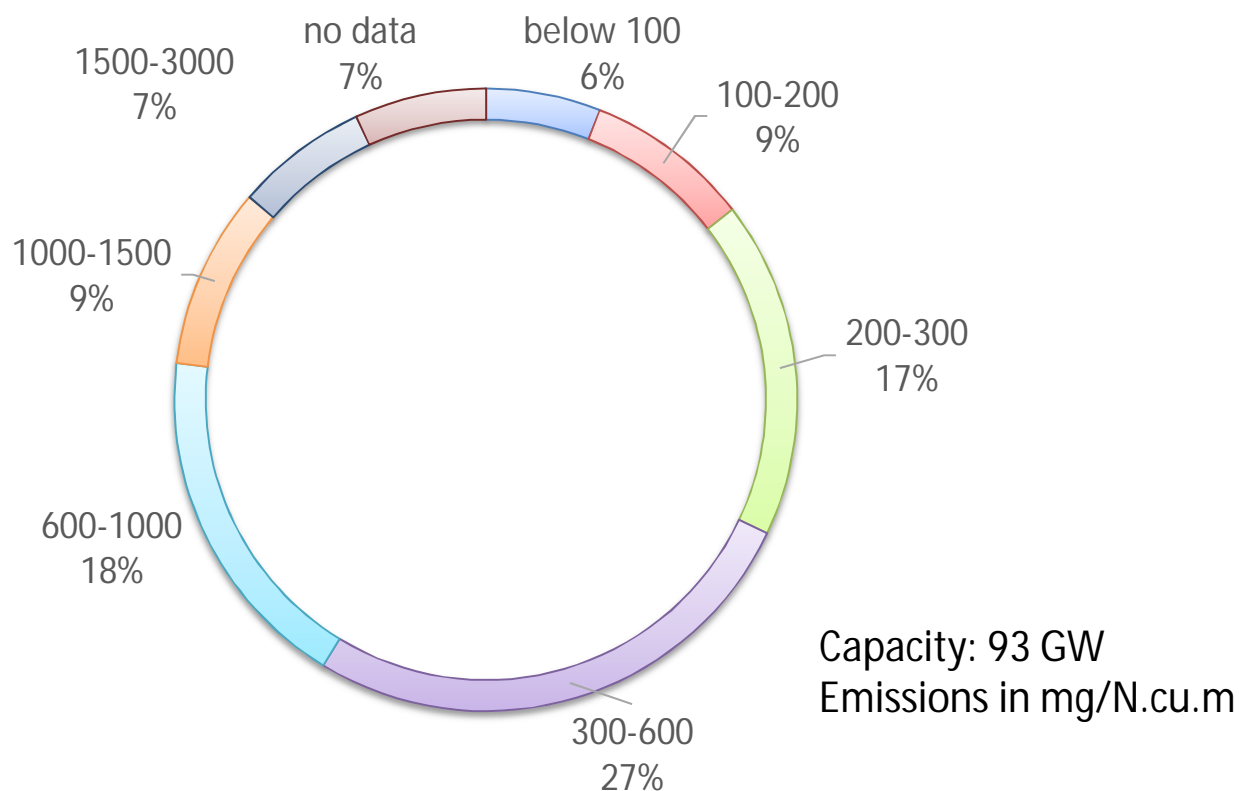
# Sulphur dioxide - Issue



- Images from Aura Satellite showing increasing sulphur di oxide concentration over India
- India's ambient sulphur dioxide concentration has doubled in seven years

# Current emission levels: Sulphur dioxide

- Only 35 percent has reported emissions over 600 mg/N.cu.m
- Data appears grossly under-reported



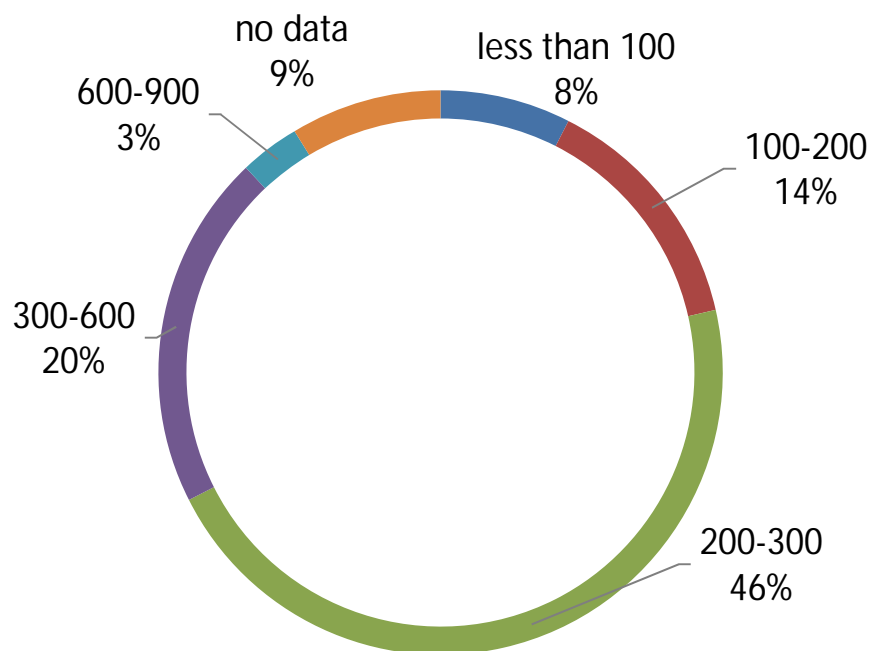
**Source:** Central Pollution Control Board, 2017



# **OXIDES OF NITROGEN**

# Current emission levels: Oxides of nitrogen

- Large number of boilers supplied since 2000, especially units of size 500 MW and above, have low NO<sub>x</sub> burner designs and can operate with emissions less than 400 mg/N.cu.m
- Emissions levels with reasonable control strategy – over-fire air systems, optimized operation etc. is less than 300 mg/N.cu.m – experts
- Co-benefit – improved efficiency, low coal use
- Data appears grossly under-reported



**Capacity:** 93 GW

Emissions in mg/N.cu.m

**Source:** Central Pollution Control Board, 2017

# Next Steps by CSE

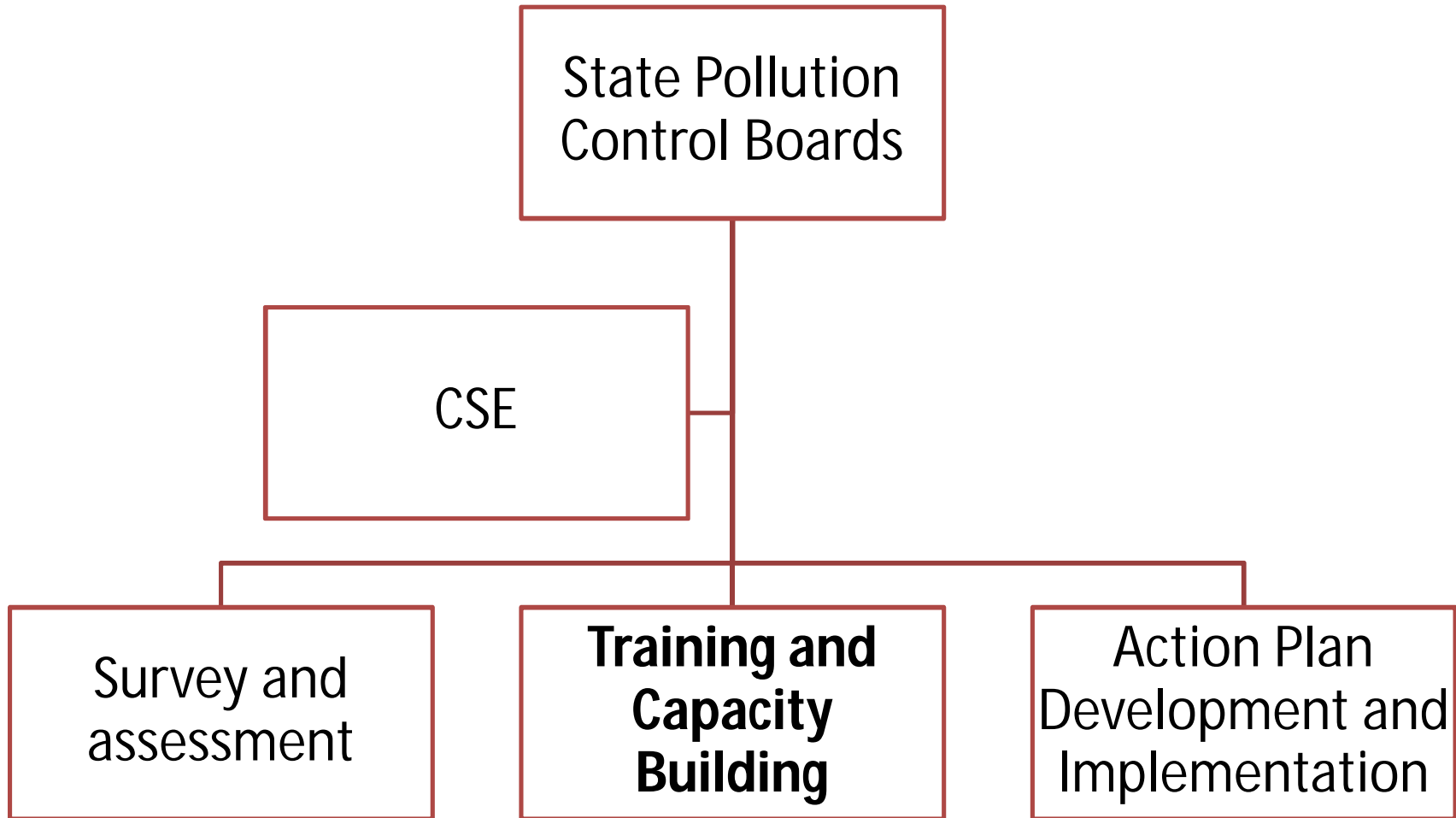


# On the ground engagement

- CSE believes that close hand-holding is required to expedite implementation of the new norms.
- We are planning to target 3-4 states to start – can be model for other states

State	Total Capacity in GW	FGD requirement	ESP up-gradations	Retire
Chhattisgarh	20	12	5	3
Madhya Pradesh	17	13.5	2.5	1
Uttar Pradesh	20	9 + 0.5 (has FGD)	6.5	4
Haryana	5.4	2.7 + 1.2 (has FGD)	1.1	0.4

# Our Strategy



# Survey

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- Visit plants to review progress; be in constant touch with plants provide technical assistance, get data on progress and be in touch with plants
- Organize meetings with PCB officers and CSE along with - empanelled industry experts to review progress, address issues faced by PCB/plants,
- CSE will prepare a report summarizing issues and suggested action steps for PCBs to enable timely implementation
- Work with a sample of plants to directly assist in implementation – review consultant report, give independent advice (panel of CSE experts) – target of around 15 plants
- Act as coordinating person to help PCB or plants get advice from panel of independent experts on questions regarding technology etc.

# Training and Capacity Building

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- **The Aim:**  
To enable officers to better monitor installation of new technologies including CEMS to ensure compliance with new norms
- The program as per timelines, aims to cover:
  - Overview of standards – overall emissions, compliance levels, health impacts, rationale and benefits
  - Comprehensive review of technology options for the 3 key pollutants - PM, SO<sub>x</sub> and NO<sub>x</sub>
  - Assessing project plans of plants
  - Overview of monitoring methods/protocols,
  - Overview of CEMS – issues with installation; gaps in CEMS ecosystem/ infrastructure (certification, calibration); data connectivity/reliability and reporting,
  - Enforcement and compliance issues
  - Site visit

**THANK YOU**

