

OVERVIEW OF CEMS & PROGRAMME STRUCTURE

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JULY 2022



INTERNATIONAL CENTRE FOR
SUSTAINABLE CARBON

PRESENTATION OUTLINE

- CEMS –status
- Regulatory perspective
- Challenges
- Roadmap
- Relevance of training agenda



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Technology Collaboration Programme
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STATUS OF IMPLEMENTATION

- Indian stakeholders now have 8-9 years of experience of Real time pollution monitoring- CEMS, CEQMS, CAAQMS
- Emerged as a big and diverse market- continues to grow.
- **Around 30,000 installations in 6,000 industries** across 17 categories of highly polluting industries (3000+), GPls (700-800) and other Red category industries have installed the real-time monitors (CEMS, CEQMS or Camera/Flow meter for ZLD) and sending data to CPCB.
- **Additionally, a vast number installed/being installed/have potential to be installed** across countries, based on local rules, regulation and programmes (Star Rating, PM ETS etc). These supply data to respective SPCBs.
- **INR 6000-7000 crore (USD 800-900million) already in the market.** Considerable amount adding up for AAQ monitoring network



REGULATORY PERSPECTIVE – RULES

- Direction for installation in 17 categories industries and waste treatment facilities in Feb 2014
- CEQMS in Ganga Basin GPI (~800) in March 2015
- Guidelines for CEMS in August 2017; revised in June 2018
- Additional installation in all RED categories (beyond 17 categories) in Delhi-NCR in July 2018.
- [Compliance reporting protocol in March 2018](#) Levels: **Yellow, Orange, Red, Purple**
- [Notice for remote calibration in April 2018](#)
- Ministry designated CSIR-NPL to develop certification of CEMS, CAAQMS in August 2019
- Upgradation of central DAHS is underway

Sl. No	Category	Effluent Parameters	Emission Parameters
1	Aluminium	pH, BOD, COD, TSS, Flow	PM, Fluoride, Flow
2	Cement	-	PM,NO _x ,SO ₂ , Flow
3	Distillery	pH, BOD,COD,TSS, Flow	PM, Flow
4	Dye and dyeintermediate	pH, BOD,COD, TSS, Cr, Flow	-
5	Chlor Alkali	pH, TSS, Flow	Cl ₂ , HCl, Flow
6	Fertilizers	pH, flow, Ammonical Nitrogen, Fluoride	PM, Fluoride, Ammonia, Flow
7	Iron&steel	pH, Phenol, cyanide, flow	PM,SO ₂ , Flow
8	Oilrefinery	pH, BOD,COD,TSS, flow	PM,CO,NO _x ,SO ₂ , Flow
9	Petrochemical	pH, BOD,COD,TSS, flow	PM,CO,NO _x ,SO ₂ , Flow
10	Pesticides	pH, BOD, COD, TSS, Cr, As, flow	-
11	Pharmaceuticals	pH, BOD, COD, TSS ,Cr ,As, Flow	-
12	Power Plants	pH, TSS, Temperature	PM, NO _x , SO ₂ , Flow
	Thermal Power Plants	pH, TSS, Temperature	PM, NO _x , SO ₂ , Total Mercury(Gaseous), Flow
13	Pulp&paper	pH, BOD, COD,TSS ,AOx, Flow	-
14	Sugar	pH, BOD,COD,TSS, flow	-
15	Tannery	pH, BOD, COD, TSS, Cr, Flow	-
16	Zinc	pH, TSS, flow	PM, SO ₂ , Flow
17	Copper	pH, TSS, flow	PM, SO ₂ , Flow
18	Textile(GPI)	pH, COD, TSS, flow	-
19	Dairy(GPI)	pH, BOD,COD,TSS, flow	-
20	Slaughter House	pH, BOD,COD,TSS, flow	-
21	Boiler	-	SO ₂ , NO _x , Flow

Notes:

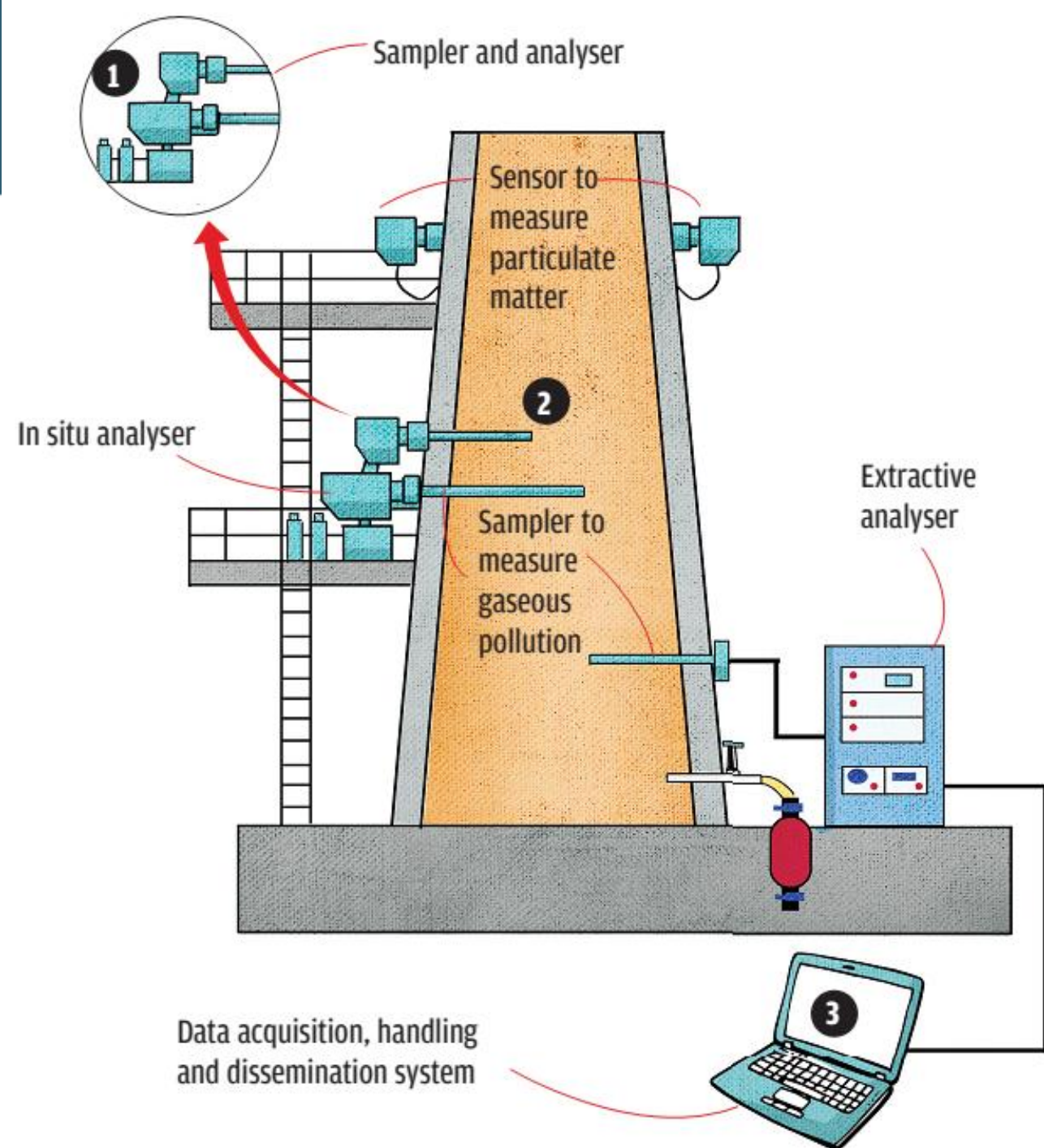
- CEM Systems must have Flow (Velocity) measurement device installed
- Direct measurement systems for O₂ or CO₂ as prescribed in respective standards shall be installed.
- For hazardous waste incinerator and Biomedical waste incinerator O₂, CO₂, and CO are important parameters to be monitored online.
- Any dilution extractive system must have CO₂ measurement facility at source and measuring point to prove the correctness of the selected dilution ratio.



A TYPICAL CEMS

- Sampler: Collects sample
- Analyzer/ Sensor: Measures parameters
- Software and Hardware: collects data, encrypts, transfers, translates into readable formats, analyses, sends alarms, produces report

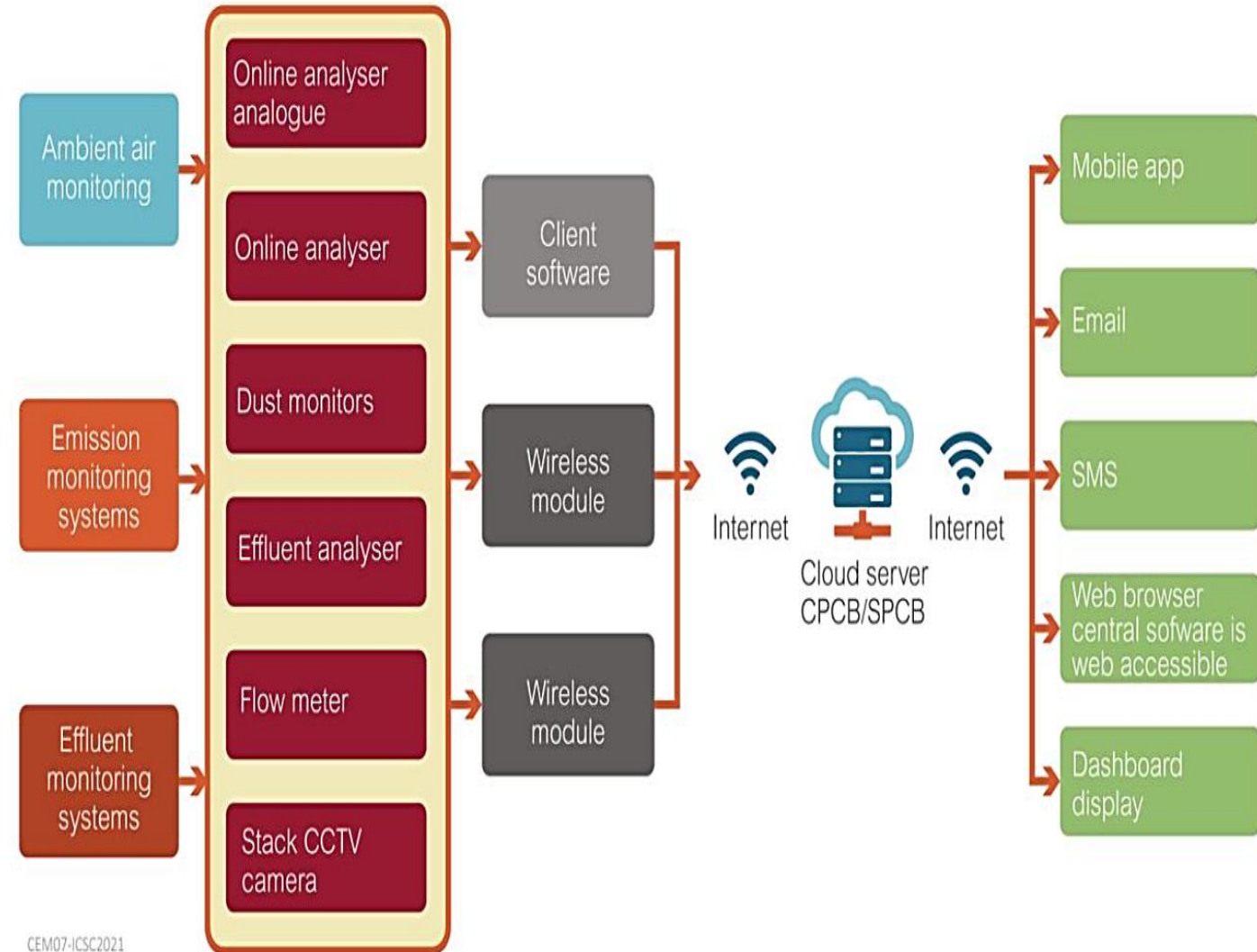
Can be installed on stack (preferably) or duct





A TYPICAL DATA CONNECTIVITY FOR CEMS

- Data from CEMS is directly collected from the analyzer and through data logger/IoT, is sent to the CPCB and SPCB server
- Two-way communication
- Industry gets access in parallel
- No intermediate access is not allowed
- Going ahead, change in DAS system, more automation under regulatory control is expected.



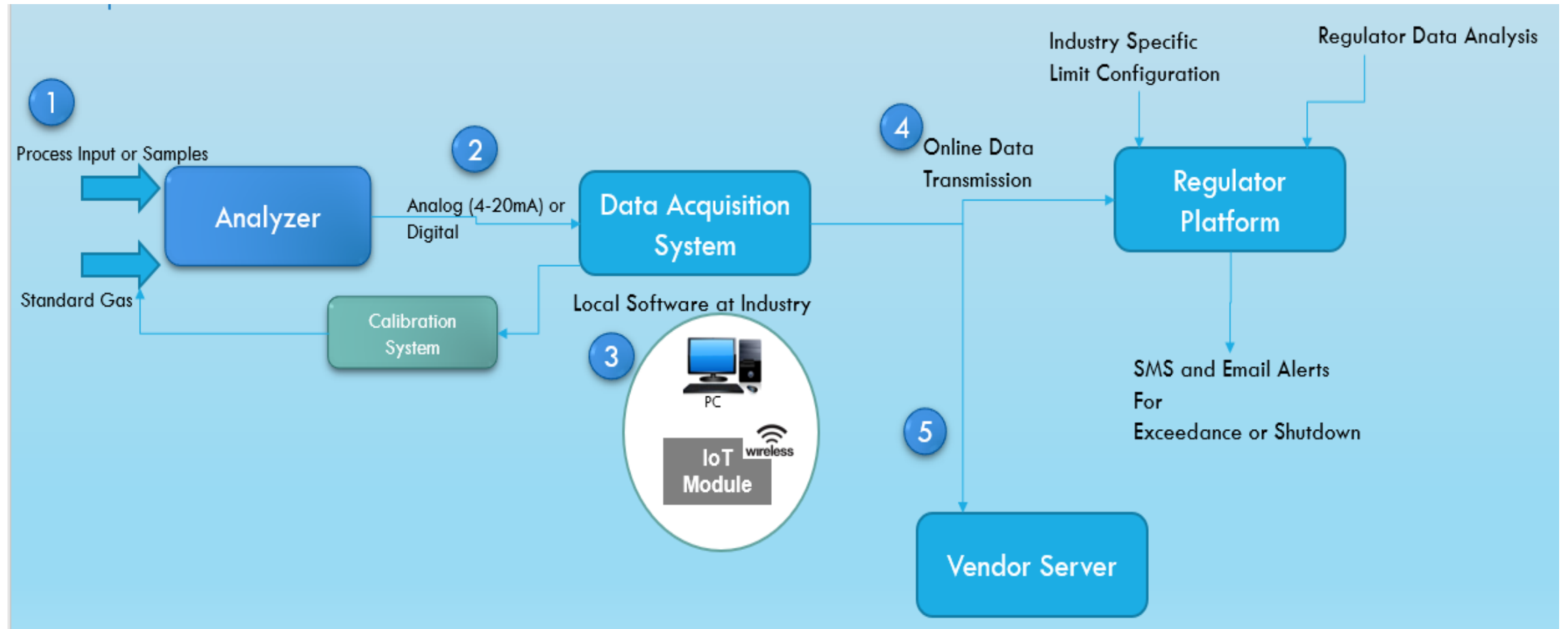


A TYPICAL DATA CONNECTIVITY FOR CEMS IN INDIA

Integrated advance DAS, Direct – two way data transfer

Concept of Remote calibration for Gaseous CEMS

Central DAS under re-development to make it more intelligent and secure





GUIDELINES

Guidelines follow both the European and the USA system

- Quality assurance EU process- QAL1, QAL2, QAL3, AST
- Quality assurance using USEPA method of Performance check- RATA, RRA
- Certified equipment to install
- Post Indigenous certification system set-up, all manufacturer to get it within 12 months
- Till then, non-certified ones to undergo performance check in the field- calibration function, variability, data comparison with data quality objective, establishing calibration function with SRM
- Performance specification of gaseous analyzer, PM analyzer to meet stipulated range- Zero/Span/Linearity $\pm 1\%$ (for PM $\pm 2\%$), performance accuracy $\pm 10\%$ of reference measurement

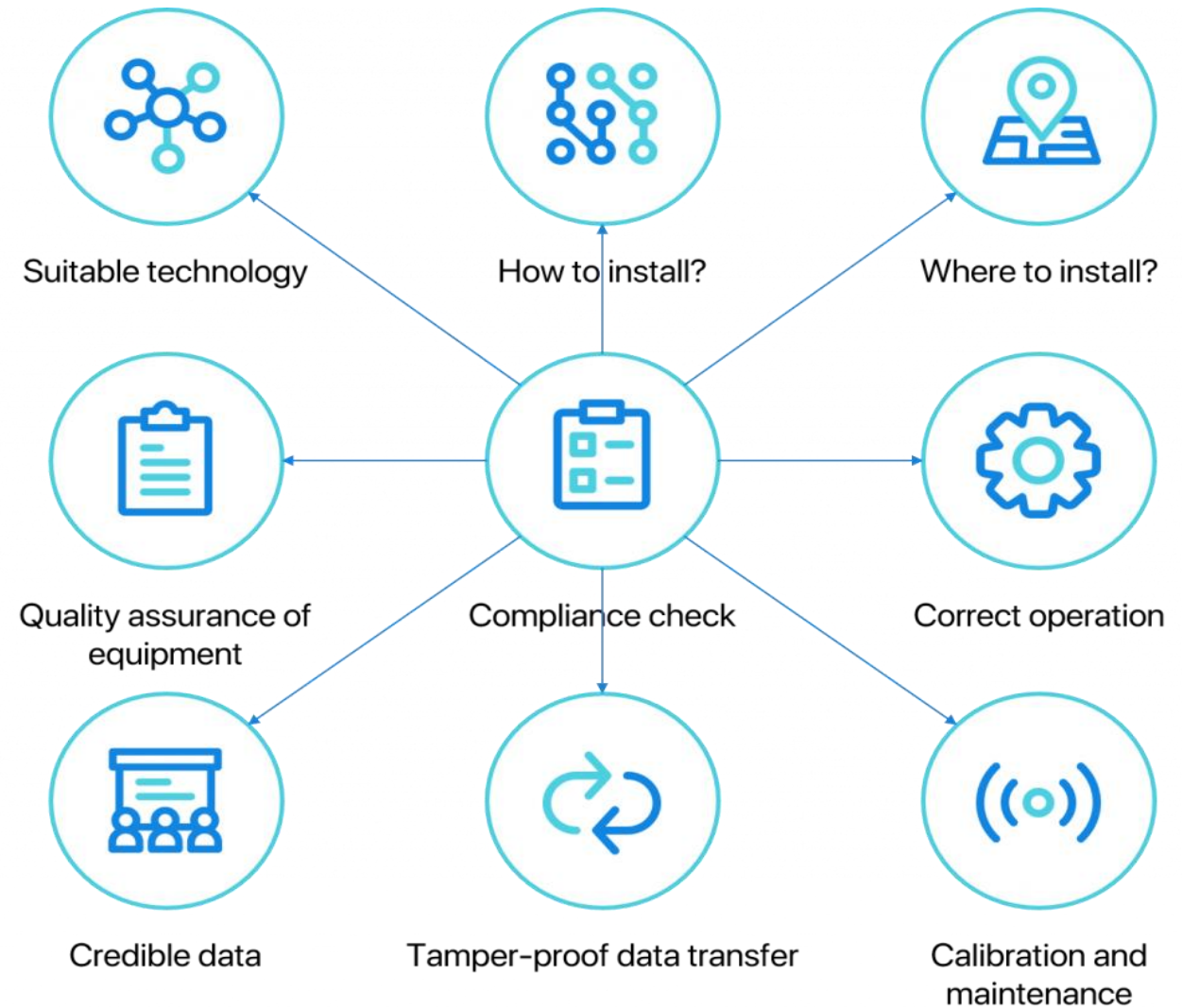
S. No.	References
1.0	CPCB's CEMS related Documents i) Direction for installation of CEMS and CWQMS in 17 Categories Industries, CETP, HWI, BMWI ii) Draft Notification on CEMS and CWQMS iii) Minutes of Meeting with Industries on Online Monitoring iv) List of Parameters for CEMS and CWQMS v) First hand information on list of suppliers vi) CPCB/e-PUBLICATION/2013-14 on "Specifications and Guidelines for Continuous Emissions Monitoring Systems (CEMS) for PM Measurement With Special Reference to Emission Trading Programs"
2.0	USEPA Documents related to CEMS a) Continuous Monitoring Manual b) 40 CFR Part 75: CEMS Field Audit Manual c) USEPA CEMS Performance Specification i) PS – 2 : Performance Specification for SO ₂ and NO _x ii) PS – 3 : Performance Specification for O ₂ and CO ₂ iii) PS – 4 : Performance Specification for CO iv) PS – 4A: Performance Specification and Test Procedure for CO v) PS – 4B: Performance Specification and Test Procedure for CO and O ₂ vi) PS – 6: Performance Specification and Test Procedure for Emission Rate vii) PS – 8A: Performance Specification and Test Procedure for Hydrocarbon (TOC) viii) PS – 11: Performance Specification and Test Procedure for PM CEMS ix) PS – 15: Performance Specification for Extractive FTIR CEMS x) PS – 18: Performance Specification for HCl – CEMS d) Quality Assurance (QA) Documents i) Procedure 1: QA Requirement for Gaseous CEMS ii) Procedure 2: QA Requirement for PM CEMS iii) Procedure 5: QA Requirement for Total Gaseous Mercury (TGM) CEMS and Sorbent Trap e) 40 CFR part 180 f) COMS (Continuous Opacity Monitoring System)
3.0	EN Documents i) EN 15267 – Part 1: Certification of AMS (CEMS) ii) EN 15267 – Part 2: Certification of AMS (CEMS) iii) EN 15267 – Part 3: Certification of AMS (CEMS) iv) EN 14181 – Quality Assurance of AMS (CEMS) v) EN 14884 – Test Method AMS (CEMS) for TGM
4.0	UK Documents a) RM:QG-06: Calibration of PM CEMS (Low Concentration) b) MCERTS : BS EN 13284: PM CEMS
5.0	Standard Operating Procedure for Compliance Monitoring using CEMS – Abu Dhabi



CHALLENGES IN IMPLEMENTATION- INITIAL

- Insufficient knowledge base
- Wrong installation
- Wrong technology selection
- No quality assurance
- No lab accreditation/ empanelment system
- Tamperproof data reporting, transfer and validation system is missing

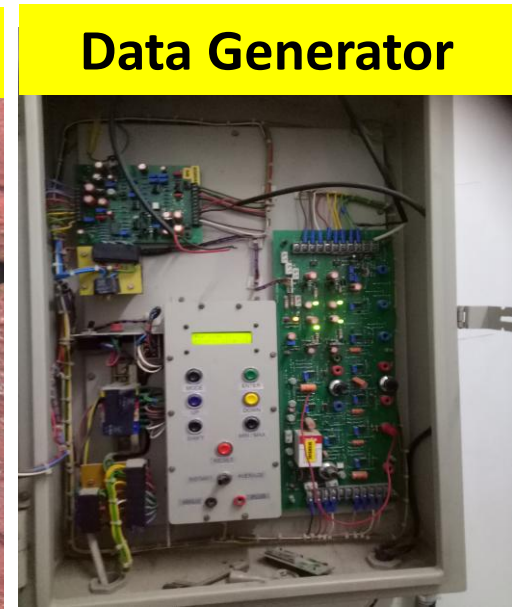
Initial challenges were mostly superficial and identified with time. Large number of industries are yet to rectify those.





CHALLENGES IN IMPLEMENTATION- INITIAL

- Incorrect technology selection was, first, initial problem- mostly due to lack of knowledge and guidance
- With time, industry have mostly replaced incorrect ones
- Buyers, now, through consultant or guided by the supplier, choses specification/technology in compliance to the CPCB guidelines
- Smaller industries, with limited skills, still get misguided to wrong technology as a cheaper option and pseudo-compliance.

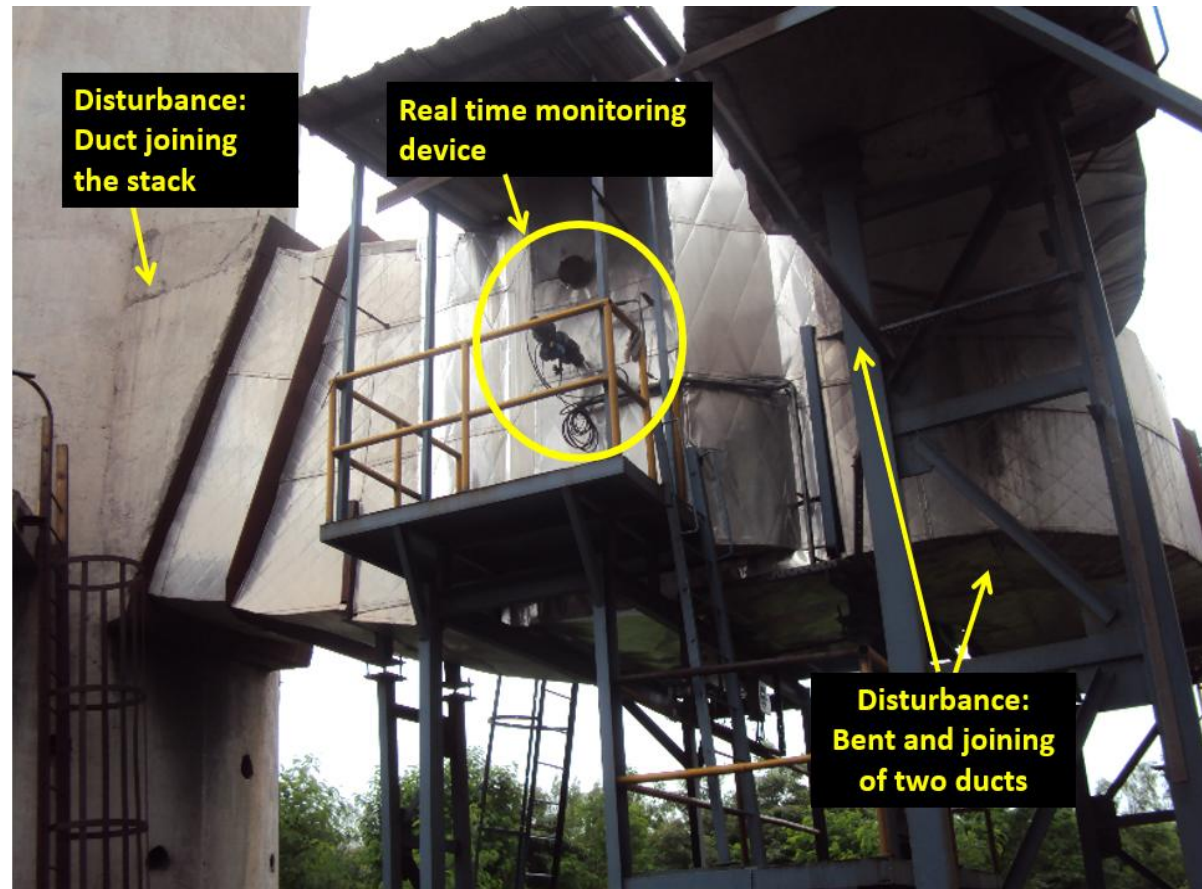




CHALLENGES IN IMPLEMENTATION- INITIAL

Incorrect installation is most common and widespread problem, affecting most

- 1) In stack or duct ?
- 2) Point of installation?
- 3) Probe length?
- 4) Correct sample line?
- 5) Alignment of light source and receptor?
- 6) Position with respect to other monitors?





CHALLENGES IN IMPLEMENTATION- INITIAL



Analyzer Cabin



CHALLENGES IN IMPLEMENTATION- INITIAL

Not only in CEMS, the issues are across the CEQMS and CAAQMS also.

Inadequate guidance, instruction and knowledge have been the key reasons.

Major industries with enough resources fixed such problems in time, the smaller industries are not so lucky.





CHALLENGES IN IMPLEMENTATION- INITIAL

Lack of knowledge, also made industry prone to be misguided on certification of the CEMS.

ZERTIFIKAT ■ CERTIFICATE ■ CERTIFICADO ■ CERTIFIKAT ■ CERTIFICATE ■ 認證證書 ■ CERTIFICATE ■ ZERTIFIKAT



CERTIFICATE

The Certification Body
of TÜV SÜD Management Service GmbH
certifies that

including the sites and scope of application
see enclosure

has established and applies
a Quality Management System.
An audit was performed, Report No. 70018126.
Proof has been furnished that the requirements according to
ISO 9001:2008
are fulfilled.
The certificate is valid from 2016-08-12 until 2017-08-11.
Certificate Registration No.: 12 100 17506 TMS.






Product Compliance Management
Munich, 2016-08-12
Page 1 of 2

TÜV SÜD Management Service GmbH • Zertifizierungsdienstleistungen • Reddenstraße 65 • 80329 München • Germany
www.tuv-sud.de/certificate-validity-check





CERTIFICATE

Manufacturer : [REDACTED]

Product : DCEM 2100 In-situ Cross Duct Opacity/Dust density Monitor

Measured Components & Measured ranges : 0-100% Opacity, 0-999 mg/m3, 0-999 mg/Nm3, 0- 3.0 Extinction & 0-5 Ringlemann.

Measuring Principle : Dual beam high intensity LED transmission & Absorption

Calibration Method used: Check Cell filters of known opacity (%)

Parameter	Filter (%) opacity	Analyser Reading	Remark
Opacity	0	0	Within accuracy of +/-2 %
Opacity	17.2	17.1	Within accuracy of +/-2 %
Opacity	0	0	Within accuracy of +/-2 %
Opacity	59.0	59.4	Within accuracy of +/-2 %

The measuring equipment calibration & performance verification (lack of fit) was suitably tested & certified in accordance with EN 15267.

This certificate issued on May 26th 2015

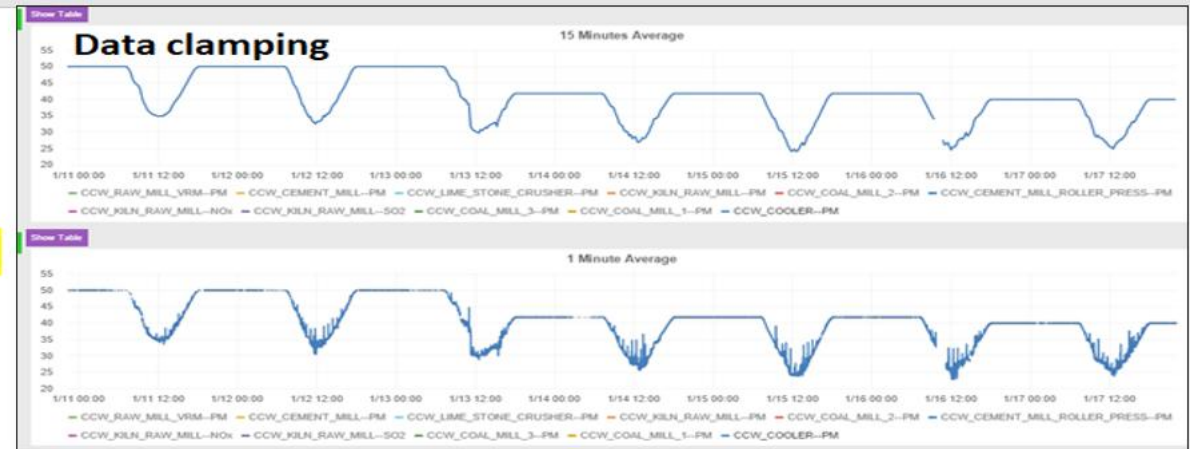
Performed by : Issued by :



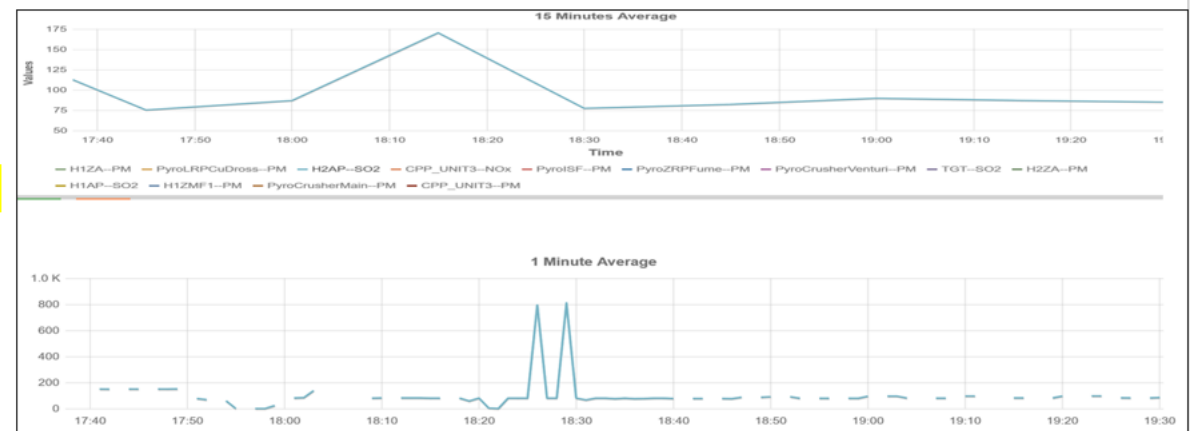
CHALLENGES IN IMPLEMENTATION- INITIAL

Initial challenges with data reporting- Data clamping, Data gaps, Data simulation etc. have been mostly sorted out.

Data clamping



Data Gaps



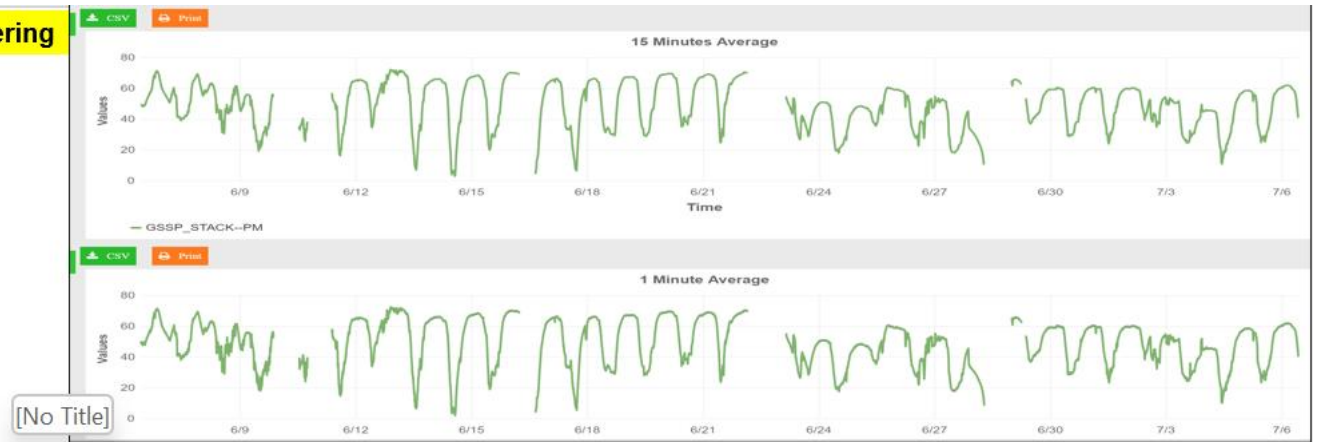


CHALLENGES IN IMPLEMENTATION- INITIAL

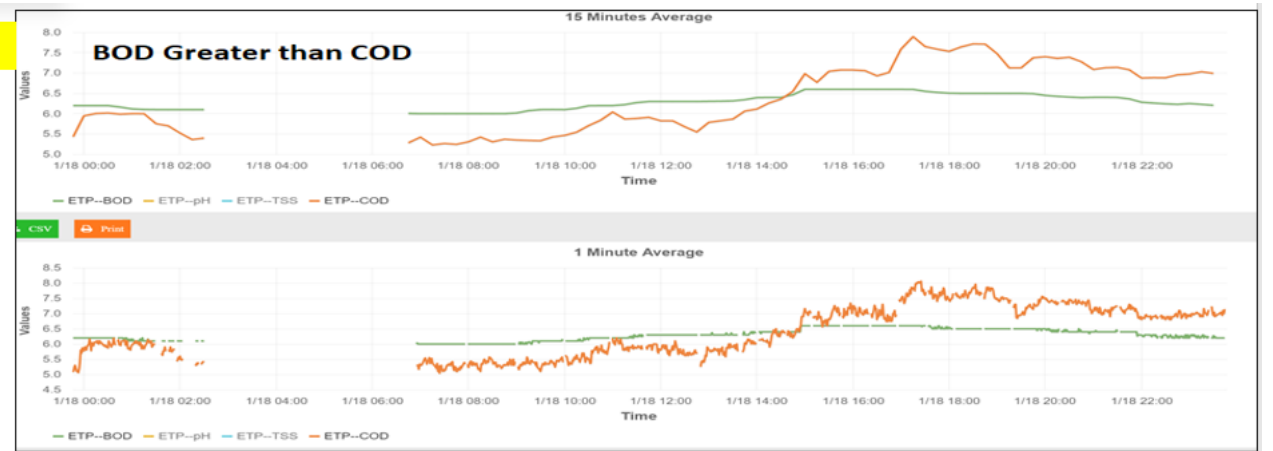
Data tampering issues are not so prevalent as both the regulators and industries have experienced these.

Some of the vigilant boards, if not all, are much experienced in identifying and resolving such issues and are confident.

Data tampering



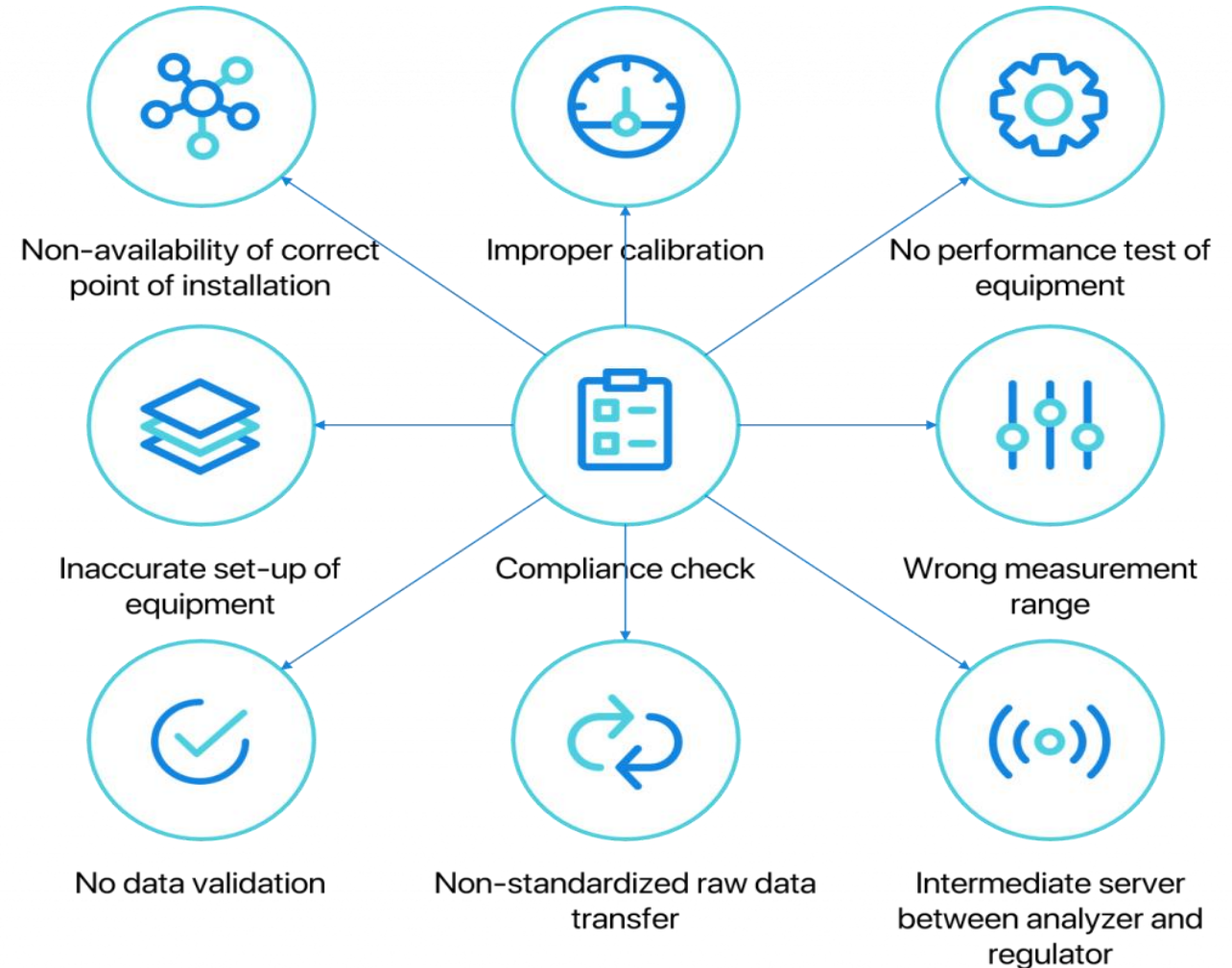
Simulated





CHALLENGES IN IMPLEMENTATION- NEW

- Challenges at present are not superficial- needs in-depth assessment for identification.
- Identification demands adequate knowledge and skill- through trainings & capacity building
- On site inspection for resolving physical installation challenges, measurement setting, proper calibration, proper performance check, data standardization.
- In absence, these affect data quality
- Poor data quality lowering the confidence and delaying the use for compliance check.





CHALLENGES – DATA STANDARDIZATION

Standardization

$$C_{dry} [ppm] = C_{wet} [ppm] \times \frac{1}{1 - [\%H_2O]/100}$$

Conversion from
Wet to Dry

$$C_{dry} [mg/m^3] = \frac{ppm \times MW}{24.45} = f$$

Conversion from
ppm to mg/m3

PV= nRT
P (Pressure) x V (Volume)= n (amount) x R (constant) x T (Temperature)
 N= PV/RT

Temperature
and Pressure
correction

$$C_{dry} [mg/Nm^3] @ \text{Reference } O_2 = \frac{21\% - 10\%}{21\% - \text{Measured } O_2}$$

Oxygen
correction

Standardization- Example

Example: SO₂ = 120 [ppm, wet]; Moisture content = 15% wet

$$SO_{2dry} [ppm] = 120 \times \frac{1}{1 - [15/100]} = 141 [ppm/dry]$$

Conversion from
Wet to Dry

$$SO_{2dry} [mg/m^3] = \frac{141 \times 64.07}{22.4} = 403.3 mg/m^3 \text{ dry}$$

Conversion from
ppm to mg/m3

If Stack Temp. 150°C and Stack Pressure 740mmHg

$$SO_{2dry} [mg/Nm^3] = \frac{423 \times 760}{298 \times 740} \times 403.3 = 587.9 mg/Nm^3 \text{ dry}$$

Temperature
and Pressure
correction

If O₂ = 8.8%

$$SO_{2dry} [mg/Nm^3] @ \text{Reference } O_2 = \frac{21\% - 10\%}{21\% - 8.8} = 0.902$$

Oxygen
correction

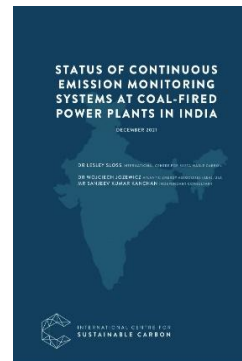
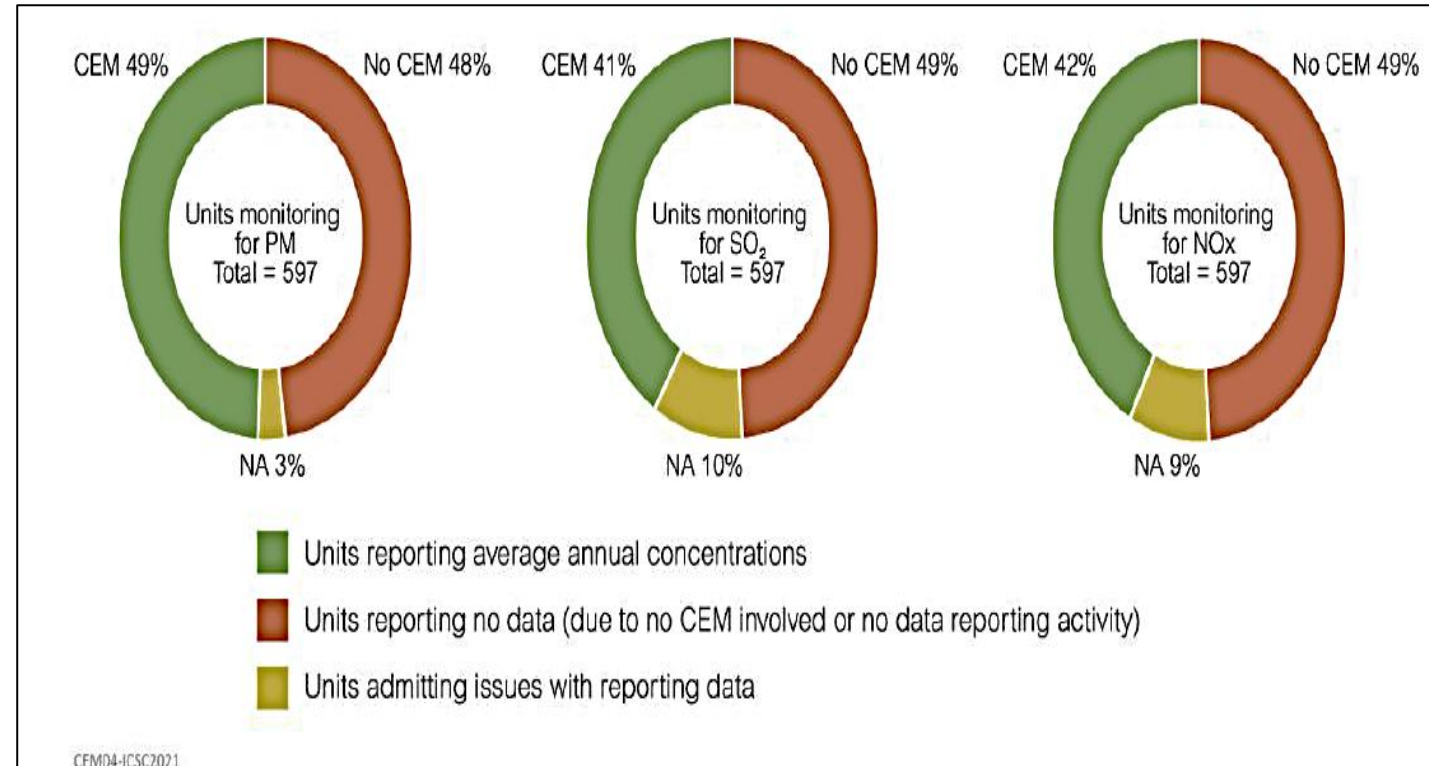
$$SO_{2dry} [mg/Nm^3] @ 10\% O_2 = 0.902 \times 587.9 = 530 mg/Nm^3_{dry} @ 10\% O_2$$



CHALLENGES AFFECTS DATA QUALITY

Analysis of 2020-21 emission data from coal-based power plants:


- Despite wide installation, nearly half of the equipment are not working or not reporting, majority of them are imported certified products
- The suppliers, irrespective of the brands, need to train the ground staffs and improve support services
- Going ahead towards compliance, site inspection and data evaluation will invite actions.



For detail- Read ICSC, 2022 report
“Status of CEMS implementation in coal-based power plants in India”

Roadmap


Regular operation & maintenance




Self-regulation regime



Compliance check system



Tamperproof data transfer system



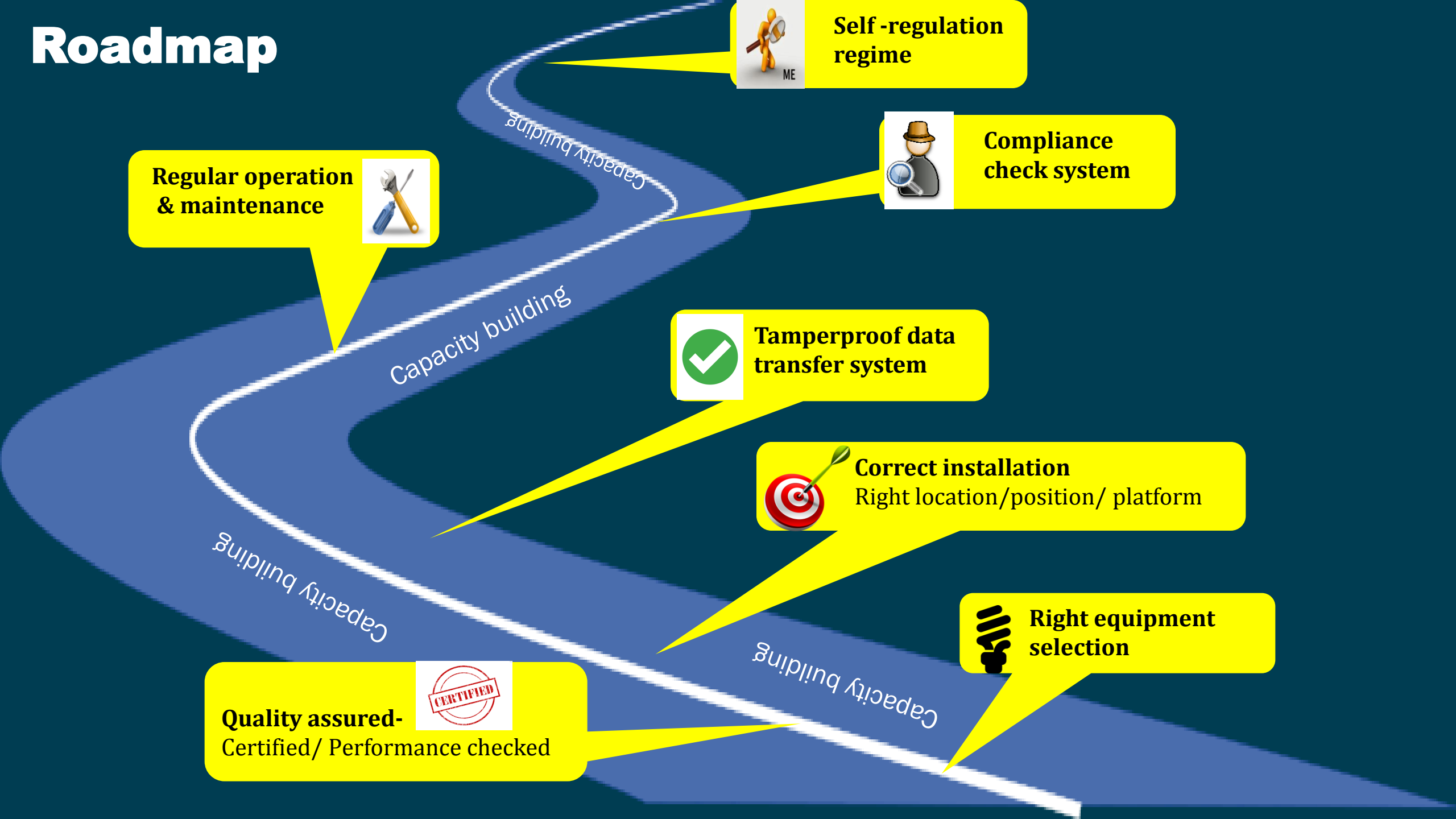
Correct installation
Right location/position/ platform



Right equipment selection



Quality assured-
Certified/ Performance checked





TRAINING & CAPACITY BUILDING (SUPPORTED BY USDOS)

The training and capacity building initiative has been planned for support. Supported/Funded by USDoS, the initiative is being executed by ICSC, UK.

This programme in Bhopal, in collaboration with MPPCB, is intended to impart training on (*refer the agenda*):

- Best Practices
- Best Handling
- Better understanding of Calibration and Tests
- Correct operation and Maintenance
- Correct Implementation
- Problem solving



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THANK YOU

ANY QUESTIONS?