**EMBARGOED TILL WEDNESDAY 15 DECEMBER 4:00 AM IST**

# Nitrogen Dioxide Levels: An Analysis of States crossing safety standards



## BACKGROUND

### What are NOx gases and their sources

Nitrogen Oxides are a family of toxic, highly reactive gases which form when fuel is burned at high temperatures. NOx pollution is emitted by automobiles, trucks and various non-road vehicles like construction equipment, boats, etc. Industrial sources of NOx are essentially fossil-fuel based power plants, incineration plants, wastewater treatment facilities, glass and cement production facilities and oil refineries. It is not only during combustion processes that nitrogen oxides are released, but also when working with nitric acid. Agriculture is also becoming increasingly relevant as a NOx emission source.

### Winter Implications on Nitrogen Dioxide (NO2) levels across India

An analysis of air quality monitoring data from the Continuous Ambient Air Quality Monitoring System (CAAQMS) across the 23 states and non-attainment cities, listed in the National Clean Air Programme (NCAP), has clearly highlighted that winter season has not only resulted in high particulate matter (PM) levels, but also impacted polluting gases like nitrogen oxides (NOx). In India, the meteorological condition is highly conducive for rapid conversion of the precursor gases like nitrogen dioxide and sulphur dioxide (NO2 and SO2) to secondary PM2.5. Hence, to control PM2.5, the emission control of the precursor gases is necessary. Local level exposure to NO2 leads to a range of environmental and health impacts as well.

### The health impacts of NO2

Nitrogen dioxide (NO2) is an irritant gas, which at high concentrations causes inflammation of the airways. NOx reacts to form smog and acid rain as well as being central to the formation of PM and

ground level ozone, both of which are associated with adverse health effects. A recent study identified that annual average concentrations of NO2 due to fossil fuel consumption in transport across states in India puts vulnerable people on the streets -- like hawkers, vendors and the homeless -- at higher risk during the COVID-19 pandemic.

High levels of nitrogen dioxide are also harmful to vegetation—damaging foliage, decreasing growth or reducing crop yields. Nitrogen dioxide can fade and discolour furnishings and fabrics, reduce visibility, and react with surfaces.

## THE DELHI CASE STUDY

### Annual trajectory

A deeper dive into Delhi's annual NO2 levels since 2013 revealed that the national capital has not been able to maintain levels within CPCB's annual average limit of 40 ug/m3 in the period for which data was analysed. The graph below shows that in the last 8 years between 2013 and 2020, Delhi's average annual NO2 levels ranged from 61-73 ug/m3. While 2020 is the only year when the annual average NO2 in Delhi was 61 ug/m3, the lowest in the last 8 years, it is worth noting that despite the complete nationwide lockdown which halted all transport, industrial activity and many other NO2 emitting sources for three months, the year's average could not be anywhere close to the CPCB safety limit of 40 ug/m3. 61.7 ug/m3 levels in 2014 seem to be lowest in the last eight years. From 2015 to 2018 there's a clear y-o-y incline in levels, with 2018 and 2019 experiencing 73.66 and 71 ug/m3 respectively.

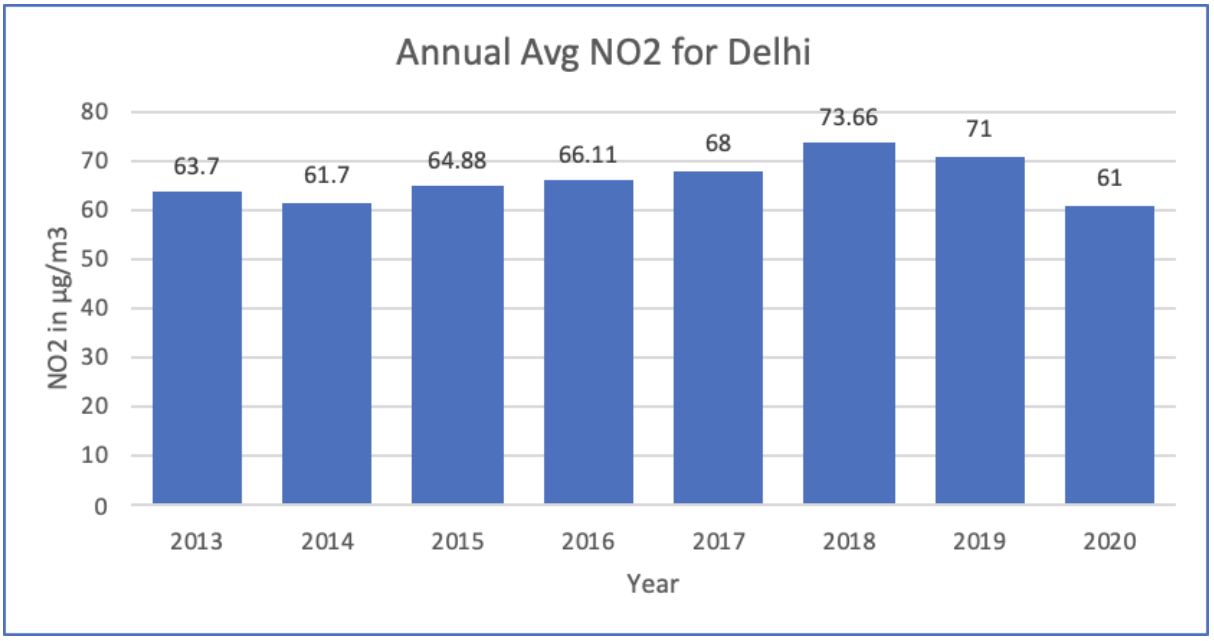



*Image: Annual average Nitrogen dioxide (NO2) concentration in Delhi from 2013 to 2020 (In ug/m3)*
*Data Source: National Ambient Monitoring Programme. Compiled by Respirer Living Sciences*

### Transport Sector

Delhi's air quality control measures for vehicular emissions, like introducing CNG autos, country's largest and busiest metro rail network, introdcuing BSVI fuel since early 2018 and scrapping vehicles older than 15 years are all progressive policies. However, the data undoubtedly shows that the

increased volume of transport has thrown a spanner on these efforts. Delhi's progressive EV policy released in 2020, requires more focus on mass mobility with public transportation and last-mile connectivity solutions. Since India's PUC programme does not capture tiny particles and NOx, the monitoring of emissions from vehicles is very weak and largely uncontrolled.

On Supreme Court's directive to investigate Pollution Under Control (PUC) centres not just in Delhi but also NCR, a report in 2017 was submitted by the Environment Protection Control Authority (EPCA), which was dissolved in 2020 to replace it with the Commission for Air Quality Monitoring in Delhi NCR and Adjoining Regions (CAQM). The report raised "serious quality concerns" in the way PUC tests are conducted and equipment are maintained at these centres across the NCR region. The weaknesses in compliance are evident due to lack of regulation of a very decentralised setup. The failure rate of PUC tests was reported as very low – in Delhi only 1.68 per cent of diesel vehicles failed the smoke density tests and about 4.5 per cent of the petrol vehicles failed the CO and HC tests. Thus, this programme is not even designed to catch 15 to 20 per cent most grossly polluting vehicles in the fleet. Comparatively, the tests prescribed for petrol vehicles are more evolved and complex. In diesel vehicles, the one and only test is the smoke density test.

**NO2 emissions from Thermal Power Plants surrounding Delhi**

A 2021 study by IIT Delhi's CERCA analyses NO2 emissions from nine thermal power plants around the world's most polluted megacity, Delhi. The study establishes that it is easy to distinguish the individual NO2 plumes emitted from specific sources such as thermal power plants (TPPs) and over the Delhi city and adjoining satellite towns, where transport is the other critical emitting sector.

List of the nine coal-fired TPPs with their capacity and estimated annual $NO_2$ emission in 2019 using satellite data.

| Coal-fired TPPs | Capacity (MW) | Mean ($\pm 1\sigma$) $NO_2$ emissions (Kt/Yr) with top-down approach |
|---|---|---|
| Indira Gandhi TPP (IGTPP) | 1500 | $13.68 \pm 8.89$ |
| Panipat TPP (PTPP) | 920 | $23.14 \pm 15.92$ |
| Rajiv Gandhi TPP (RGTPP) | 1200 | $8.30 \pm 5.63$ |
| Yamuna Nagar TPP (YNTPP) | 600 | $8.0 \pm 3.63$ |
| Rajpura TPP (RTPP) | 1400 | $18.86 \pm 15.17$ |
| Guru Hargovind Singh TPP (GHSTPP) | 920 | $12.32 \pm 12.18$ |
| Talwandi Sabo TPP (TSTPP) | 1980 | $13.56 \pm 6.76$ |
| Dadri TPP (DTPP) | 1820 | $30.56 \pm 14.37$ |
| Harduaganj TPP (HTPP) | 605 | $13.62 \pm 6.94$ |

*Image: The 9 Thermal Power Plants analysed in the IIT Delhi CERCA study*

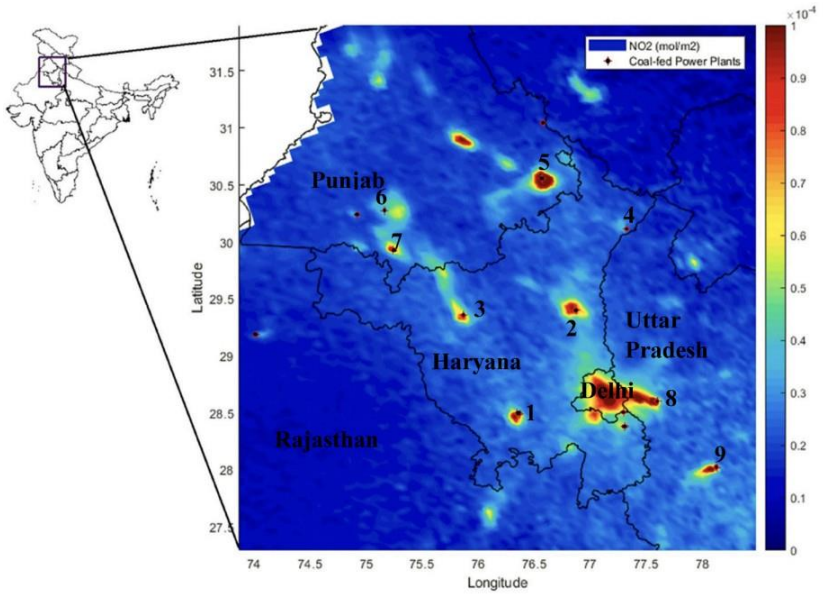



*Image: The 9 Thermal Power Plants analysed in the IIT Delhi CERCA study*

The analysis confirms that emissions from individual TPPs do not conform to their operating capacity. The nine TPPs in the vicinity of the world's most polluted megacity, Delhi emitted NO2 in the range of 8.00–30.56 Kt in 2019. The NO2 emissions vary seasonally and are not uniform throughout the year. However, the possible reasons behind the variation of NO2 emissions across the TPPs may be attributed to the plant's age, its maintenance standard, capacity utilization of the various TPPs, and lesser performance efficiency of the burner compared to the other units of the same category.

The analysis further revealed that NO2 emission reduced significantly (ranging between 41%–290%) during the COVID-19 lockdown period from March 25, 2020, to April 30, 2020, compared to the same period in 2019 due to the reduced operating capacity of the plants. During the lockdown, the NO2 in the city outflow was also significantly reduced due to restrictions on traffic movement.

The National Clean Air Programme recommends several action points to control emissions from TPPs
1. Conversion of all older coal-based TPPs into natural gas fed power plants
2. Requirement for optimizing the use of existing power plants by emphasizing capacity utilization of natural gas/clean fuel-based TPPs
3. Stringent compliance with the emission norms prescribed in the direction dated December 2017 issued under EPA 1986 by all TPPs
4. Accentuation on improved power dependability to remove diesel generator activities especially in urban areas

Due to hazardous air quality in November 2021, CAQM issued direction on 26th November 2021 directing all power plants except five (Rajiv Gandhi TPP, NTPC Jhajjar; Rajiv Gandhi TPP, RGTPS, Hisar; Panipat TPS, HPGCL; Rajpura TPP, Nabha Power Ltd., and Talwandi Sabo TPS, Mansa) to be under shut-down till 30th November 2021. The directions were further extended till 15th December on 30th November 2021 as the air quality was still in adverse range. There are 12 power plants within a 300 km radius of Delhi, out of which only the Mahatma Gandhi TPP and Dadri TPP have installed flue

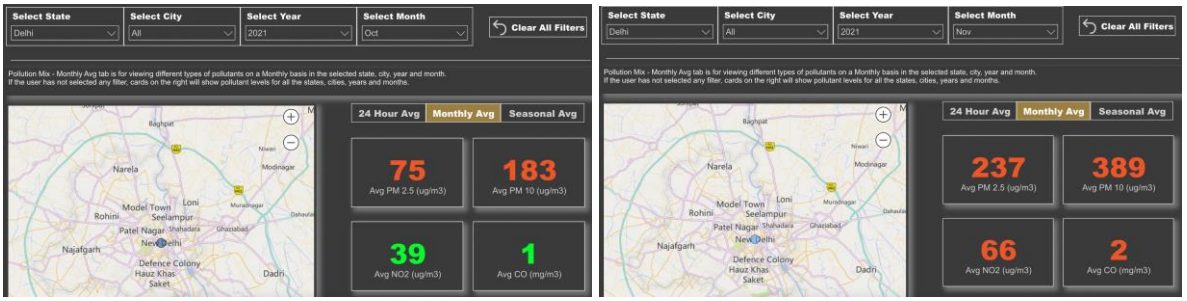
gas desulphurisation (FGD) units to control sulphur dioxide (SO2) emissions. A recent analysis by Centre for Research for Energy and Clean Air (CREA) estimated that If power plants with FGD commissioned (Mahatma Gandhi and Dadri power plant) are operated at 85% plant load factor, these two plants alone will produce around 314 MUs/Day, including other sources, and imports, making a case for shutting down power plants within 300Km during the winter season. While the analysis is focussed on controlling SO2 emissions, a case for shutting down TPPs around Delhi will help control all pollutants including NO2.

## ANALYSIS OF CULPRIT STATES

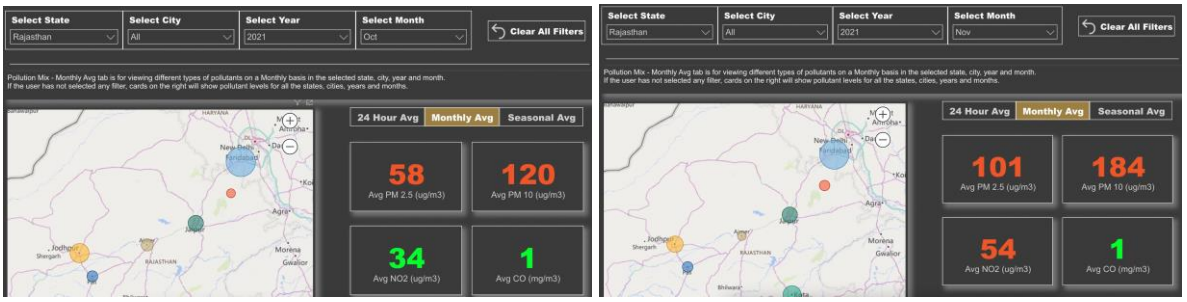
NO2 is one of the criteria air pollutants monitored by the Central Pollution Control Board (CPCB) as part of its nationwide regulatory monitoring.

**The three problem states**

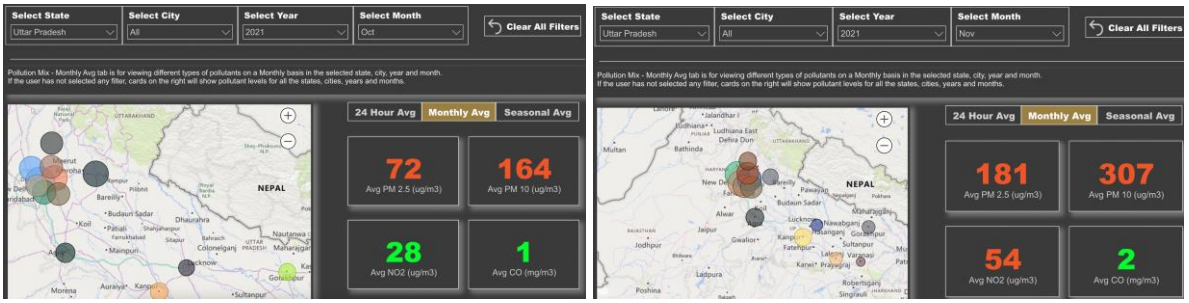
An analysis conducted by NCAP Tracker across all 23 states listed in the National Clean Air Programme (NCAP) showed that average NO2 levels in three (3) states -- **Uttar Pradesh, Rajasthan and Delhi** -- breached the CPCB safety limits in the month of November 2021, in comparison to those in October 2021. The Central Pollution Control Board (CPCB) has set 40 ug/m3 as annual safety limit for NO2 emissions and 80 ug/m3 as the 24hr safe limit, while the World Health Organisation (WHO) limits it to 10 ug/m3 and 25 ug/m3 respectively in its revised 2021 air quality guidelines.




*Images: Delhi average NO2 readings for Oct and Nov 2021 (Left & Right respectively)*
*Source: NCAP Tracker*




*Images: Rajasthan average NO2 readings for Oct and Nov 2021 (Left & Right respectively)*
*Source: NCAP Tracker*




*Images: Uttar Pradesh average NO2 readings for Oct and Nov 2021 (Left & Right respectively)*
*Source: NCAP Tracker*

**Table 1: NO2 trends in Delhi, Uttar Pradesh and West Bengal**

| STATES/ CITIES | Average NO2 levels in Oct 2021 | Average NO2 levels in Nov 2021 | No of CAAQMS monitoring stations in each city/state |
|---|---|---|---|
| **UTTAR PRADESH** | 28 | **54** | |
| Baghpat | 28 | **60** | 1 |
| Bulandshahr | 37 | **59** | 1 |
| Firozabad | 35 | **47** | 1 |
| Ghaziabad | 38 | **70** | 4 |
| Gorakhpur | 2 | 1 | 1 |
| Greater Noida | **42** | **65** | 2 |
| Kanpur | 18 | **62** | 4 |
| Lucknow | 30 | **58** | 7 |
| Meerut | 33 | **59** | 3 |
| Moradabad | 21 | 34 | 1 |
| Muzaffarnagar | 18 | **52** | 1 |
| Noida | 37 | **57** | 4 |
| Gorakhpur | 2 | 1 | 1 |
| Hapur | 7 | 31 | 1 |
| Prayagraj | 17 | 39 | 3 |
| Varanasi | 18 | **41** | 4 |

| | | | |
|---|---|---|---|
| Agra | 18 | 36 | 6 |
| **DELHI** | 39 | **66** | 40 |
| **RAJASTHAN** | 34 | **54** | |
| Ajmer | 26 | 39 | 1 |
| Alwar | 27 | **45** | 1 |
| Bhiwadi | 35 | **63** | 1 |
| Jaipur | **41** | **70** | 3 |
| Jodhpur | 34 | **72** | 1 |
| Kota | 27 | 33 | 1 |
| Pali | 31 | 25 | 1 |
| Udaipur | 37 | **53** | 1 |

*(Note: Number of monitors in each city may differ during Nov 2020 and Nov 2021).*

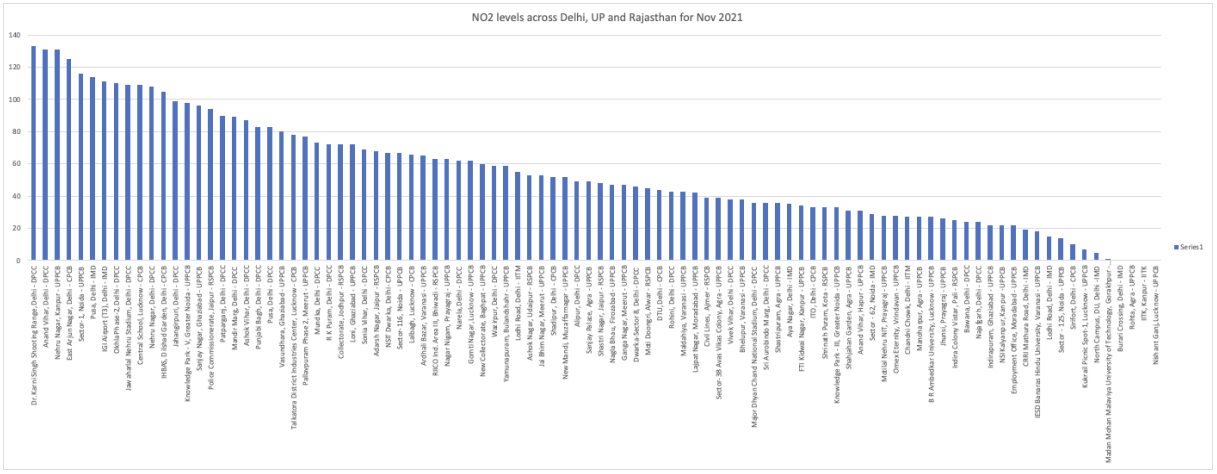
**Table 2: Daily and annual average trends across all CAAQMS monitoring sites in Delhi, Uttar Pradesh & Rajasthan**

| S No. | Monitoring Location | NO2 Daily Avg >80 ug/m3 *Avg for Nov 2021* | No. of Days NO2 >80 ug/m3 *365 days monitored Nov20-Nov21* | Annual NO2 Avg >40 ug/m3 |
|---|---|---|---|---|
| | **DELHI** | | | |
| 1 | Anand Vihar, Delhi - DPCC | **131** | 30 | **73** |
| 2 | Nehru Nagar, Delhi - DPCC | **108** | 30 | **62** |
| 3 | Okhla Phase-2, Delhi - DPCC | **110** | 30 | **53** |
| 4 | Dr. Karni Singh Shooting Range, Delhi - DPCC | **133** | 27 | **63** |
| 5 | Pusa, Delhi - IMD | **114** | 27 | **43** |
| 6 | IHBAS, Dilshad Garden, Delhi - CPCB | **105** | 26 | **52** |
| 7 | East Arjun Nagar, Delhi - CPCB | **125** | 25 | **66** |
| 8 | Mandir Marg, Delhi - DPCC | **89** | 25 | **66** |
| 9 | Jahangirpuri, Delhi - DPCC | **99** | 24 | **48** |
| 10 | Jawaharlal Nehru Stadium, Delhi - DPCC | **109** | 22 | **64** |
| 11 | IGI Airport (T3), Delhi - IMD | **111** | 20 | **56** |

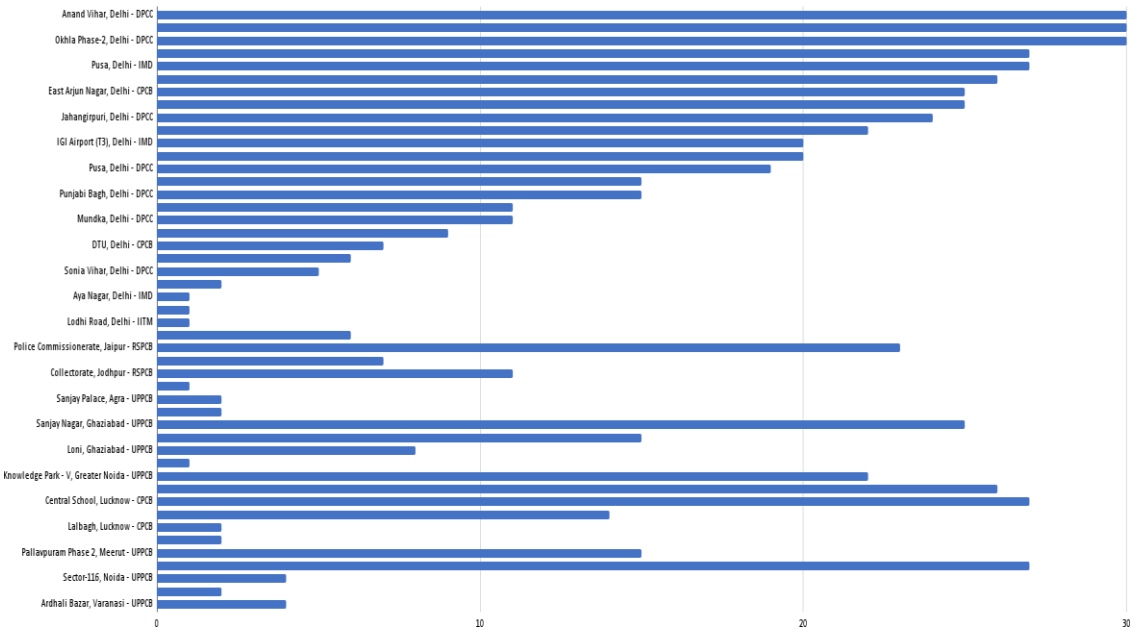
| | | | | |
|---|---|---|---|---|
| 12 | Patparganj, Delhi - DPCC | 90 | 20 | 32 |
| 13 | Pusa, Delhi - DPCC | 83 | 19 | 47 |
| 14 | Ashok Vihar, Delhi - DPCC | 87 | 15 | 45 |
| 15 | Punjabi Bagh, Delhi - DPCC | 83 | 15 | 52 |
| 16 | R K Puram, Delhi - DPCC | 72 | 11 | 38 |
| 17 | Mundka, Delhi - DPCC | 73 | 11 | 38 |
| 18 | NSIT Dwarka, Delhi - CPCB | 67 | 9 | 31 |
| 19 | DTU, Delhi - CPCB | 44 | 7 | 61 |
| 20 | Narela, Delhi - DPCC | 62 | 6 | 37 |
| 21 | Sonia Vihar, Delhi - DPCC | 69 | 5 | 39 |
| 22 | Shadipur, Delhi - CPCB | 52 | 2 | 49 |
| 23 | Aya Nagar, Delhi - IMD | 35 | 1 | 17 |
| 24 | Wazirpur, Delhi - DPCC | 59 | 1 | 41 |
| 25 | Lodhi Road, Delhi - IITM | 55 | 1 | 44 |
| | **RAJASTHAN** | | | |
| 26 | RIICO Ind. Area III, Bhiwadi - RSPCB | 63 | 6 | 41 |
| 27 | Police Commissionerate, Jaipur - RSPCB | 94 | 23 | 53 |
| 28 | Adarsh Nagar, Jaipur - RSPCB | 68 | 7 | 36 |
| 28 | Collectorate, Jodhpur - RSPCB | 72 | 11 | 29 |
| 30 | Ashok Nagar, Udaipur - RSPCB | 53 | 1 | 31 |
| | **UTTAR PRADESH** | | | |
| 31 | Sanjay Palace, Agra - UPPCB | 49 | 2 | 22 |
| 32 | Yamunapuram, Bulandshahr - UPPCB | 59 | 2 | 24 |
| 33 | Sanjay Nagar, Ghaziabad - UPPCB | 96 | 25 | 61 |
| 34 | Vasundhara, Ghaziabad - UPPCB | 80 | 15 | 37 |
| 35 | Loni, Ghaziabad - UPPCB | 72 | 8 | 35 |
| 36 | Indirapuram, Ghaziabad - UPPCB | 22 | 1 | 37 |
| 37 | Knowledge Park - V, Greater Noida - UPPCB | 98 | 22 | 62 |
| 38 | Nehru Nagar, Kanpur - UPPCB | 131 | 26 | 68 |
| 39 | Central School, Lucknow - CPCB | 109 | 27 | 48 |
| 40 | Talkatora District Industries Center, Lucknow - CPCB | 78 | 14 | 44 |
| 41 | Lalbagh, Lucknow - CPCB | 66 | 2 | 45 |

| | | | | |
|---|---|---|---|---|
| 42 | Gomti Nagar, Lucknow - UPPCB | 89 | 2 | 33 |
| 43 | Pallavpuram Phase 2, Meerut - UPPCB | 77 | 15 | 102 |
| 44 | Sector-1, Noida - UPPCB | 116 | 27 | 64 |
| 45 | Sector-116, Noida - UPPCB | 67 | 4 | 42 |
| 46 | Nagar Nigam, Prayagraj - UPPCB | 63 | 2 | 29 |
| 47 | Ardhali Bazar, Varanasi - UPPCB | 65 | 4 | 56 |

**Analysis for NO2 trends from monitoring stations across Uttar Pradesh, Rajasthan & Delhi**




*Graph: NO2 levels across all the CPCB monitoring locations in Delhi, UP and Rajasthan*




*Graph: Locations with highest number of days breaching the CPCB set daily limit for NO2.*

**Delhi**

An analysis of the monthly average NO2 levels for all 40 monitoring sites in Delhi maintained by the Continuous Ambient Air Quality Monitoring System (CAAQMS) establishes that 25 locations out of a total of 40, in the national capital had NO2 greater than 80 ug/m3 in November 2021 for days ranging from 1 to 30 days. Meanwhile 18 locations breached the annual average limit of 40 ug/m3, the data was calculated from 01-12-2020 to 30-11-2021 (365 days). 15 locations had levels greater than 80 ug/m3 average for the month of November 2021, 9 of which were above 100. *(Refer to the above graph and table for specifics on locations)*

Anand Vihar, also listed among Delhi's 13 most polluted hotspots by CPCB, clocked 131 ug/m3 average for November 2021. Clearly local sources like the Inter-State Bus Terminus (ISBT), the Ghazipur landfill site and the NH24 highway in the area are transporting emissions from heavy vehicles and other sources to this monitoring site. The ambient PM2.5 at Anand Vihar was recorded at 250 ug/m3, its possible that near-surface exposure levels will be much higher for the population in that area, in comparison to ambient exposure levels. Dr Karni Singh Shooting Range at 133 ug/m3 NO2 monthly average levels is situated in a large expanse of green and flanked by residential colonies, however heavy construction equipment and nearby activity in Tughlakabad Industrial Area can be factors at play. Out of Delhi's 13 pollution hotspots, seven had annual average limits greater than 40 ug/m3 – Jahangirpuri (48), Anand Vihar (73), Ashok Vihar (45), Wazirpur (41), Punjabi Bagh (52), Okhla Phase II (53) and RK Puram (72).

More locations which recorded November averages for NO2 levels in triple digits in the national capital are East Arjun Nagar (125), IGI Airport (111), Dilshad Garden (105), Jawaharlal Nehru University (109), Nehru Nagar (108) and Pusa Road where the monitoring site maintained by the Delhi Pollution Control Committee (DPCC) records 83, while the India Meteorological Department's (IMD) monitor records 114. These levels are also juxtaposed with parts of the city with much lower NO2 levels, like CRRI Mathura Road (19), North Campus (5), Siri Fort (10) and Lodhi's IMD monitor (15), while the Indian Institute of Tropical Meteorology (IITM) monitor at Lodhi Road records 55. Clearly micro-strategies need to be developed to address these hyperlocal sources in vicinities to address NO2 emissions.

The wastewater treatment plant in Sonia Vihar could be responsible for a large share of its 69 ug/m3 NO2, while the industrial activity in areas like Mundka (73), Narela (62), Okhla Phase 2 (110) can be the contributing factor for high NO2 levels. Areas like Ashok Vihar (87), Maya Puri (52), Wazirpur (59), Punjabi Bagh (83) near the arterial roads of Delhi are affected by heavy vehicular emissions, while major traffic junctions like Mandir Marg (89), Patparganj (90), RK Puram (72), NSIT Dwarka (67), Nehru Nagar (108) also face the brunt of hyperlocal sources like vehicular emissions.

**Uttar Pradesh**

NCR Cities - Ghaziabad, Noida, Greater Noida - November monthly average in satellite towns of Uttar Pradesh (UP) surrounding the national capital show Ghaziabad at 70 ug/m3, Noida (57) and Greater Noida (65). Heavy vehicular movement, industrial activity, heavy construction and peripheral highways are all contributing factors. However, once we drill down deeper into each city, the two monitoring sites in Greater Noida point towards the source of the problem. Knowledge Park-III accounts for 33 ug/m3, while Knowledge Park-V is at 98 ug/m3 monthly average, 62 ug/m3 annual

average and 22 days when levels remained greater than 80 ug/m3. Clearly pointing towards the need for local administrative interventions at the latter location.

Out of 4 locations in Ghaziabad, Indirapuram is within safe limits (22) and Loni records 72, while Sanjay Nagar (96) and Vasundhara (80) breach the daily average. Sanjay Nagar also crossed the annual average with 61 (40 ug/m3 is annual limit) and experienced 25 days where daily limits were breached (80 ug/m3). The Uttar Pradesh Pollution Control Board (UPPCB) identified construction waste and unpaved roads as major sources of pollution in Ghaziabad. Industrial and vehicular emissions and open-air garbage burning are also major contributing factors.

Meanwhile Noida's 4 monitors point towards Sector-1 as a clear culprit at 116 ug/m3 November average and Sector-116 at 67 ug/m3. However, the PM2.5 levels of all 4 locations in Noida are not vastly different; Sector-125 (227), Sector-62 (216), Sector-1 (218) and Sector-116 (245). Both these locations also breached the annual limits – Sector-1 (64) experienced 27 days where levels were greater than the daily average and Sector-116 (42 ug/m3) with 4 days of breached NO2 levels.

An analysis by Legal Initiative for Forests and Environment (LIFE) of the city action plans submitted by Ghaziabad and Noida claimed that plans for both large metropolitan areas are nearly identical. Same actions have been given for the two cities, which means that their specific pollution profiles have not been taken into account at all. Both plans lack specific targets for pollution reduction.

Lucknow - Out of seven monitoring stations in Lucknow, the Nishat Ganj station does not provide any readings, while Kukrail Picnic Spot station situated in the wooded outskirts of the city records 7 ug/m3 avg NO2 for Nov 2021. Traffic heavy locations like Lalbagh and Gomti Nagar recorded 66 and 89 ug/m3 respectively, while Talkatora Industries Centre recorded 78 and Central School a whopping 109 for November 2021. These vast differences in data from monitoring sites resulted in Lucknow's average NO2 levels for November at 58 ug/m3, but clearly hyperlocal monitoring data can help develop targeted air quality management plans which can help the local population in affected areas. Meanwhile the PM2.5 levels in November 2021 in the city are; BR Ambedkar University (103), Central School (116), Gomti Nagar (97), Kukrail (99), Lalbagh (104), Nishat Ganj (null) and Talkatora District Industries Centre (186). 4 locations had NO2 levels greater than 80 ug/m3 – Central School (27 days), Talkatora (14), Lalbagh and Gomti Nagar 2 days each. Central School, Lalbagh and Talkatora Industries Centre stations also breached the annual average NO2 limit of 40 ug/m3.

Kanpur - The biggest outlier in the state of Uttar Pradesh is the Nehru Nagar site in Kanpur recording a monthly average NO2 levels of 131 ug/m3. The monitor at IIT Kanpur does not provide NO2 data, Kidwai Nagar remains within CPCB's safety limits (34) and NSI Kalyanpur at 22. Hence, the city's total monthly averages to 62, but clearly there is a need for improved data monitoring at all sites and local source management at sites like Nehru Nagar situated in the bustling and congested heart of the industrial city. The annual average for Nehru Nagar at 68 crossed the safety limit of 40 ugm3 and experienced 26 days of NO2 levels greater than CPCB's safety limit of 80. WHO's prescribed daily average is 25 ug/m3 and annual 10 ug/m3. Meanwhile the PM2.5 levels at all four locations in the city are; Kidwai Nagar (118), IIT Kanpur (169), Nehru Nagar (173) and Kalyanpur (119).

Varanasi - Out of four monitoring sites in Prime Minister Narendra Modi's Parliamentary constituency, Varanasi, one is located in the green campus of Banaras Hindu University (BHU) recording 18 NO2 and 96 PM2.5. The heavily crowded and busy traffic area of Ardhali Bazaar recorded monthly average NO2 levels at 65 ug/m3, Maldahiya (40) and Bhelupur (38). Ardhali Bazaar's annual NO2 average was almost 1.5 times of the CPCB limit at 56 ug/m3. Varanasi as one of the Smart Cities is undergoing massive infrastructure project development, the power shortages are compensated for by diesel gensets like most tier 3 towns in India and unlike the 15 years limit for scrapping old vehicles in Delhi, Uttar Pradesh's transport scrappage policy allows for 20 year old vehicles to ply on the roads. With limited resources for monitoring and compliance, vehicles older than 20 years may also be plying on the city roads and interior lanes, adding to transport emissions in the city.

Meerut - With three CAAQMS sites in the city, Meerut recorded a monthly average of 59 ug/m3. Pallavpuram Phase-2 recorded the highest NO2 at 77, followed by Jai Bhim Nagar at 53 and Ganga Nagar at 47. The city's average NO2 level is more than double of WHO's daily average of 25 ug/m3. The annual NO2 average in Pallavpuram touched 102, almost 2.5 times of CPCB standards and 10 times of WHO's annual limits of 10 ug/m3. With increasing two wheeler and four wheeler ownership in cities, urban planning has not been able to absorb these developments keeping environment impacts in mind. In recent years, with the expansion of the city of Meerut to Mohiuddinpur on Delhi Road, Daurala on Roorkee Road, Gokalpur on Garh Road and Ganganagar on Mawana Road, along with other establishments such as residential colonies, industries, connecting roads and motorway junctions have only increased. Against this background, the state government commissioned the Meerut Development Authority (MDA) to draw up the Meerut Master Plan 2021. The work will be carried out in three phases. The PM2.5 levels breached CPCB limits by more than 5 times in the month of November; Pallavpuram Phase-2 (213), Jai Bhim Nagar (202) and Ganga Nagar (197).

The 'Comprehensive Environmental Pollution Index' (CEPI) carried out by Ministry of Environment & Forests (MoEFCC) in association with CPCB and IIT Delhi in 2009 identified nine critically polluted Areas (CPA) in Uttar Pradesh -- Mathura, Kanpur, Moradabad, Varanasi-Mirzapur, Bulandshahar-Khurja, Firozabad, Gajraula area, Agra, Ghaziabad and 4 severely Polluted Areas which were Noida, Meerut, Aligarh and Singrauli (UP & MP). The NO2 analysis for some of the cities in Uttar Pradesh reveal that many of these cities have consistently been pollution hotspots and need long term pollution management strategies. NO2 monthly average in November in Industrial cities like Bulandshahr was 59 ug/m3, Baghpat (60), Firozabad (47) and Muzaffarnagar (52). All these cities have only one CAAQMS monitoring station therefore hyperlocal monitoring and analysis of local sources' impacts can not be derived accurately. Out of these cities, Bulandshahr was the only one with 2 days in the year when NO2 levels crossed 80 ug/m3.

Gorakhpur - The only station to record 1 ug/m3 NO2 levels in the entire state of Uttar Pradesh was UP Chief Minister, Yogi Adityanath's constituency, Gorakhpur. While the CM has been lauding the 'Gorakhpur Model' for tackling air pollution, the CAAQMS monitor was installed only in June 2021 as there is no prior air quality monitoring data available. The PM2.5 level in the city for November is 139 ug/m3, the highest recorded this year. However the NO2 levels since June have been a static 1 ug/m3, raising doubts on the monitoring of the precursor gas.

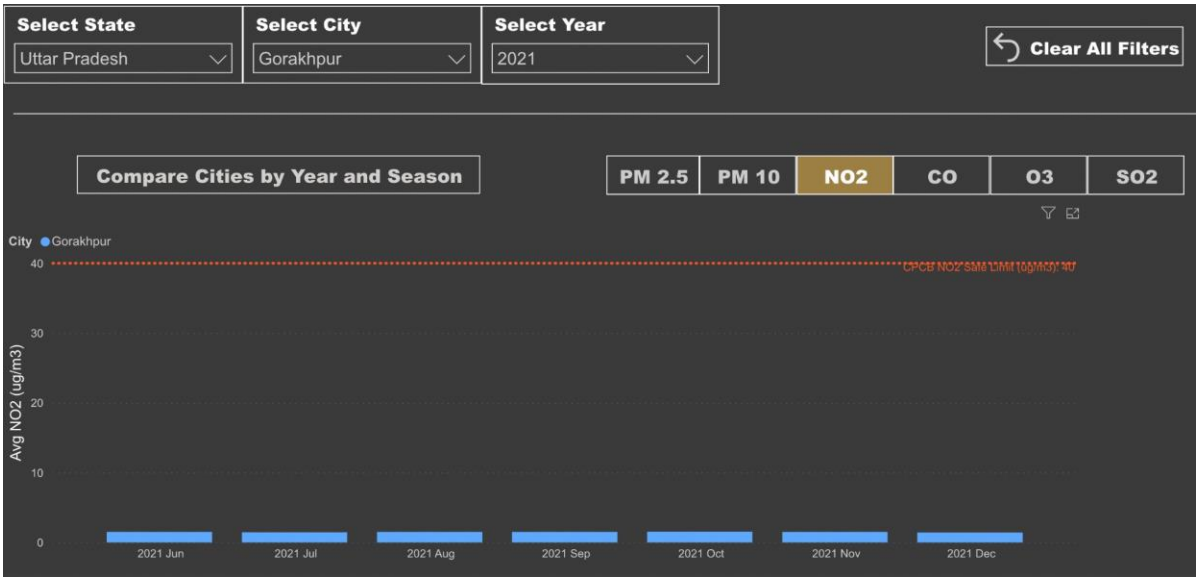



*Image: Screenshot of the CAAQMS monitoring graph for NO2 in Gorakhpur for 2021. Source: NCAP Tracker*

**Rajasthan**

The desert state of Rajasthan has 8 non-attainment cities -- Jaipur, Jodhpur, Udaipur, Ajmer, Alwar, Bhiwadi, Kota and Pali -- and 10 CAAQMS monitoring stations. Five of these locations experienced days where NO2 levels crossed daily averages – RIICO Industrial Area, Bhiwadi (6 days), Police Commissionerate Jaipur (23 days), Adarsh Nagar Jaipur (7 days), Collectorate Jodhpur (11 days) and Ashok Nagar Udaipur (1 day). Only the capital city, Jaipur has 3 monitoring sites while all other cities have one CAAQMS monitor each. November 2021 monthly average NO2 level for Rajasthan is 54 ug/m3. According to Global Burden of Disease 2017, Rajasthan recorded the highest number of child mortality due to air pollution, 126 per lakh.

Jaipur - Police Commissionerate in Jaipur crossed the annual average with 53 ug/m3, almost five times of WHO's annual limit of 10. Open waste burning, diesel vehicles and traffic jams are major contributors of NO2 in the city. The PM2.5 levels at these three locations were -- Police Commissionerate (99), Adarsh Nagar (111) and Shastri Nagar (95). A source apportionment study for Jaipur conducted by IIT Kanpur claimed that NO2 levels in winter are higher than those in summer at all sites and the levels meet the national air quality standard of 80 ug/m3. The highest NO2 levels were observed at Ajmeri Gate, a commercial site exposed to emissions from vehicles, road dust, garbage burning and restaurants. In addition, high levels of NO2 are expected to undergo chemical transformation to form fine secondary particles in the form of nitrates, adding to high levels of existing PM10 and PM2.5.

Bhiwadi, which is part of Delhi-NCR and home to a range of large, medium and small-scale industries from steel mills and furnaces to automobile and electronics manufacturing, is among the most polluted in the state with high PM 2.5, PM 10 and NO2 concentration throughout the three years (2019- June 2021). According to an assessment by Centre for Science and Environment (CSE) and the Rajasthan Pollution Control Board in 2020, the Bhiwadi Industrial Area contributes around 65% to the industrial pollution load of the region (Jaipur-Alwar-Bhiwadi airshed). The NO2 for the month of Nov in Bhiwadi was 63 ug/m3, annual average NO2 was 41 and 6 days where levels were greater than 80

ug/m3. Bhiwadi's PM2.5 average for November was 195. Meanwhile Alwar's NO2 is 45 and PM2.5 is 68 ug/m3, its monitor is located in Moti Doongri.

Jodhpur & Udaipur - Jodhpur's monitor installed at Collectorate recorded monthly average NO2 levels at 72, almost triple of WHO's daily average limits (25 ug/m3) and PM2.5 at 108. The Blue City experienced 11 days where NO2 crossed daily average of 80/m3. Meanwhile Udaipur's NO2 breached to 53 according to the CAAQMS monitor at Ashok Nagar. Jodhpur and Udaipur ranked among the 100 most polluted cities in the world according to the WHO ranking in 2018, indicating industrial and vehicular exhaust emissions with limited monitoring mechanisms.

## QUOTES

**Prof S N Tripathi, Civil Engineering Department, IIT Kanpur & Steering Committee Member, National Clean Air Programme, MoEFCC**
*"NOx is showing an increasing trend in different cities of the country and particularly for Delhi NCR. Daily exceeding values for any particular period of time, and overall average levels in NCR indicate that NOx values are far greater than annual safety limits prescribed by CPCB, leading to both short term and long term exposure to people. This can have serious health implications. Therefore, these need to be urgently looked into and corrective and mitigative measures need to be taken so that NOx values can be brought within control in Delhi NCR and other parts of the country."*

**Dr Arun Sharma, Director, National Institute for Implementation Research for Non-Communicable Diseases (an ICMR body)**
*"NO2 as a gas has not so serious effects on the health of the people but it's secondary effects through increase in PM2.5 concentrations and augmentation of Ozone formation are a matter of concern. In 18 cities across the states of Rajasthan, Uttar Pradesh and NCT of Delhi, the average NO2 concentration were higher than the CPCB prescribed limit of 40 mcg/L3 in the month of November 2021. The only way that the NO2 levels can be controlled are by reduction at source as fixation of NO2 in the air along with SO2 is cause for acid rain.*

*The process of metabolizing the NO2 in the human body is also not favourable, as nitrogen fixation leads to increased urea formation. High levels of urea have adverse effects on the human nervous system. A look at the accompanying table shows that maximum concentration is seen either in densely populated urban areas or in towns with heavy concentration of industries, where habitation in poorly ventilated low income housing is predominant. Thus a large segment of the population with relatively less access to quality health care are likely to be affected, hence reduction at source remains key intervention to minimize the impact of high NO2 concentration on human health."*

**Ronak Sutaria, Founder & CEO, Respirer Living Sciences**
*"While 'non attainment' cities in India are governed based on their PM2.5 and PM10 levels, it is equally important to track NO2 levels at a hyperlocal level in urban cities in India. Given that sources of NO2 emissions tend to be vehicles as well as from industries, it is important to know the hotspots of NO2 pollution as these over time contribute to a significant increase in the more toxic and carcinogenic PM2.5 pollution.*

*The NO2 data presented here analyzed from the over 300 continuous CPCB monitors across India give a useful insight into which neighbourhoods are more toxic than others. Affordable NO2 monitoring technologies are now available to increase this NO2 monitoring at an acceptable accuracy for every urban neighbourhood of India."*

**Aarti Khosla, Director, Climate Trends**

*"This data gives a clear idea of what goes into making PM2.5 particulate and that we must have this knowledge before taking steps to reduce pollution. Focusing on such information should allow the local and state governments, the Centre, as well as citizens, to know where to act. Having year long above average concentrations of nitrogen dioxide which is evidently in busy traffic or high density industrial areas shows where action should be.''*

**About NCAP Tracker**

NCAP Tracker is a joint project by Climate Trends and Respirer Living Sciences to create an online hub for the latest updates on India's clean air policy, the National Clean Air Programme (NCAP). It is designed to track India's progress in achieving the 2024 clean air targets set under the NCAP. The NCAP Tracker enables this by compiling and evaluating various levels of air quality data and closely tracking the effectiveness of the clean air policy. The tracker compiles and analyses information on air quality and budget allocation that is publicly available or provided by the government of India.