Anatomy of October smog episode in Delhi and National Capital region

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On 2 November, 2023, PM2.5 concentration in Delhi crossed 313µg/m3 that is equivalent to “severe+” level as per the Air Quality Index concentration range. This first spike of this winter season was a sudden escalation and a staggering increase of 68 per cent within 24 hours.

This has emerged from the latest analysis of the Urban Lab at Centre for Science and Environment (CSE)..

This winter season has started with a much higher pollution level compared to the previous November. The combination of adverse meteorological conditions, onset of crop residue burning, and high local pollution has tilted the scale dangerously increasing public health risk.

Even though the overall long term pollution curve is stable and downward it is still significantly above the national ambient air quality standards. This demands the most stringent and sustained action on vehicles, industry, energy systems, and waste management across the region.

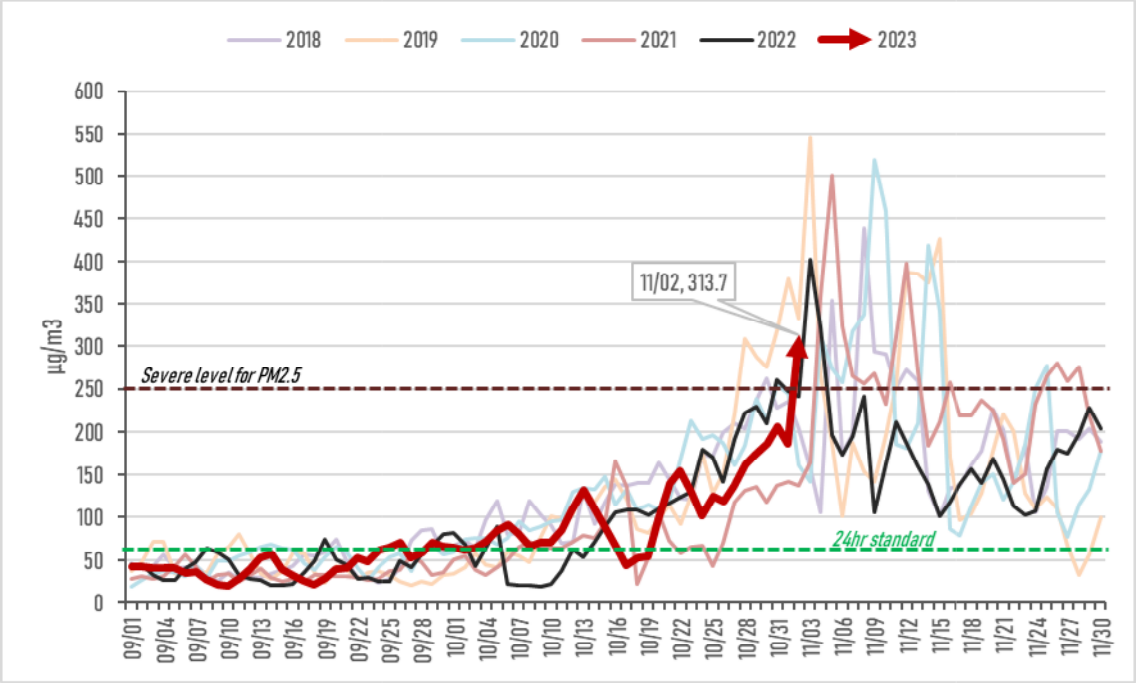
This kind of rapid buildup is not uncommon during this part of the season and is generally associated with smoke-fall from the farm stubble fire and meteorological factors assisting transportation of smoke to Delhi-NCR and topping the high local pollution. It is dramatic to see such a rapid buildup within a short time span.

Key Highlights

Massive increase within a short time frame: The most notable trend this year is the sudden and rapid build up of smog episode in this early phase of winter. On 2 November, PM2.5 levels in Delhi crossed 300µg/m3 or “severe+” level for the first time this season. It was a very sudden escalation as the level rose a staggering 68 per cent within 24 hours.

During previous five years, the overall trend shows that PM2.5 levels start to rise steadily from the start of October. This year, the PM2.5 levels started to rise from middle of September onwards. Illustratively, this increase was at a slower rate and by the end of October, the levels were 20-30 per cent lower than the average levels for the corresponding Octobers of the previous five winters – since 2018-19. (see Graph 1: Trend in daily PM2.5 level in Delhi during Sept-Nov)

Graph 1: Trend in daily PM2.5 level in Delhi during Sept-Nov

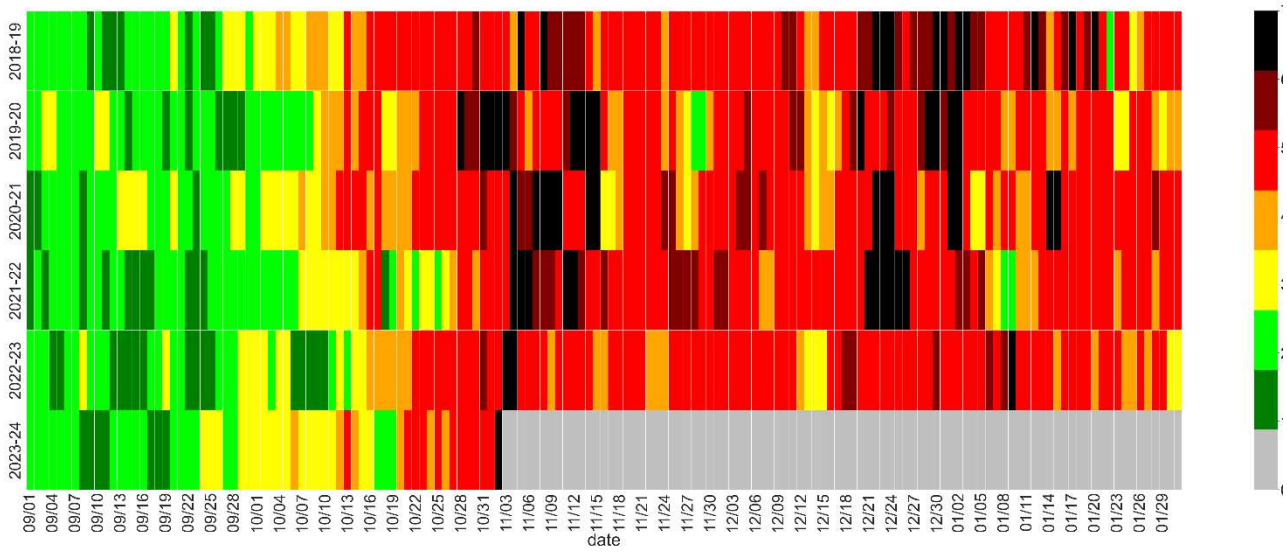


Note: 37 station average includes all the Delhi stations except Lodhi Road IITM, Chandni Chowk IITM and East Arjun Nagar. 24-hour averages are calculated from midnight to midnight. Data up till 2 Nov 2023. PM2.5 AQI subcategories´: Good (1-50 AQI) = less than 30µg/m3; Satisfactory (51-100 AQI) = 30-60µg/m3; Moderate (101-200 AQI) = 60-90µg/m3; Poor (201-300 AQI) = 90-120µg/m3; Very poor (301-400 AQI) = 120-250µg/m3; Severe (401-500 AQI)= over 250 µg/m3;
Source: CSE analysis of CPCB realtime data

Early beginning of bad air quality days this year due to lower rainfall during September and October: In contrast to the previous winter of 2022-23, the smog episode has started earlier this year. The last day with "good" PM2.5 AQI before the onset of winter was observed on 19 Sept 2023.

It remains to be seen how many more smog episodes with varying duration may occur this winter. It may be noted that there was one smog episode last winter (2022-2023). As is the global practice, at least three continuous days of severe AQI is considered as one smog episode. In previous winters such episodes have been recorded lasting 6-10 days. During the winter of 2022-23, one such smog episode was recorded from 6-9 January 2023. Also last year both Diwali and late December did not experience a smog episode like the earlier winters. The winters between 2018 and 2021 on an average had experienced three smog episodes. (see Graph 2: Daily heatmap of PM2.5 concentration classified as per the AQI categories in Delhi during winter seasons).

Graph 2: Daily heatmap of PM2.5 concentration classified as per the AQI categories in Delhi during winter seasons (2018-19 to 2023-2024)

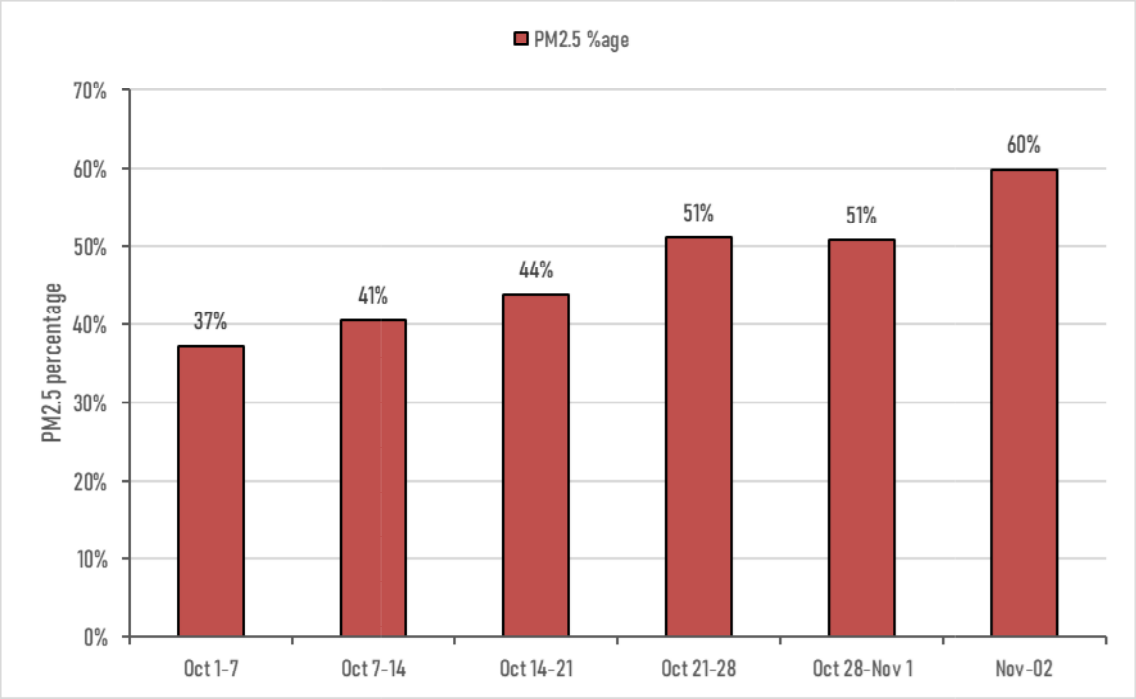


Note: 37 station average includes all the Delhi stations except Lodhi Road IITM, Chandni Chowk IITM and East Arjun Nagar. 24-hour averages are calculated from midnight to midnight. Cell colour is based on the official colour-scheme of AQI sub-categories. Data up till 2 Nov 2023.
Source: CSE analysis of CPCB realtime data

High influence of combustion sources – percentage share of PM2.5 in PM10 is very high: The share of PM2.5 in PM10 is an important indicator of the impact of combustion sources. While coarser PM10 comes largely from dust sources, the tinier PM2.5 come more from vehicles, industry and open burning. This year the percentage share of PM2.5 in PM10 has crossed 50 per cent which indicates higher impact of combustion sources.

On 2 Nov 2023 the ratio for PM2.5 stood at 60 per cent, highest this season indicating the higher influence of combustion sources. (Graph 3: Trend in daily percentage of PM2.5 among Pm10 in Delhi).

Graph 3: Trend in daily percentage of PM2.5 in PM10 concentration in Delhi



Note: 37 station average includes all the Delhi stations except Lodhi Road IITM, Chandni Chowk IITM and East Arjun Nagar. 24-hour averages are calculated from midnight to midnight. PM2.5 percentage is calculated from the hour PM10 average. Data up till 2 Nov 2023.
Source: CSE analysis of CPCB realtime data

The farm stubble fire count has increased now. But it is still much lower than the seasonal peak of the previous year: The estimate of contribution of crop residue burning to Dehi's air quality carried out SAFAR shows that the percentage contribution of farm stubble fire to Delhi's PM2.5 concentration had crossed 25 per cent on 2 November. This is expected to rise in coming days. The fire instances in Punjab and Haryana are yet to peak. (Graph 4: Trend in daily fire count and its percentage contribution to Delhi PM2.5).

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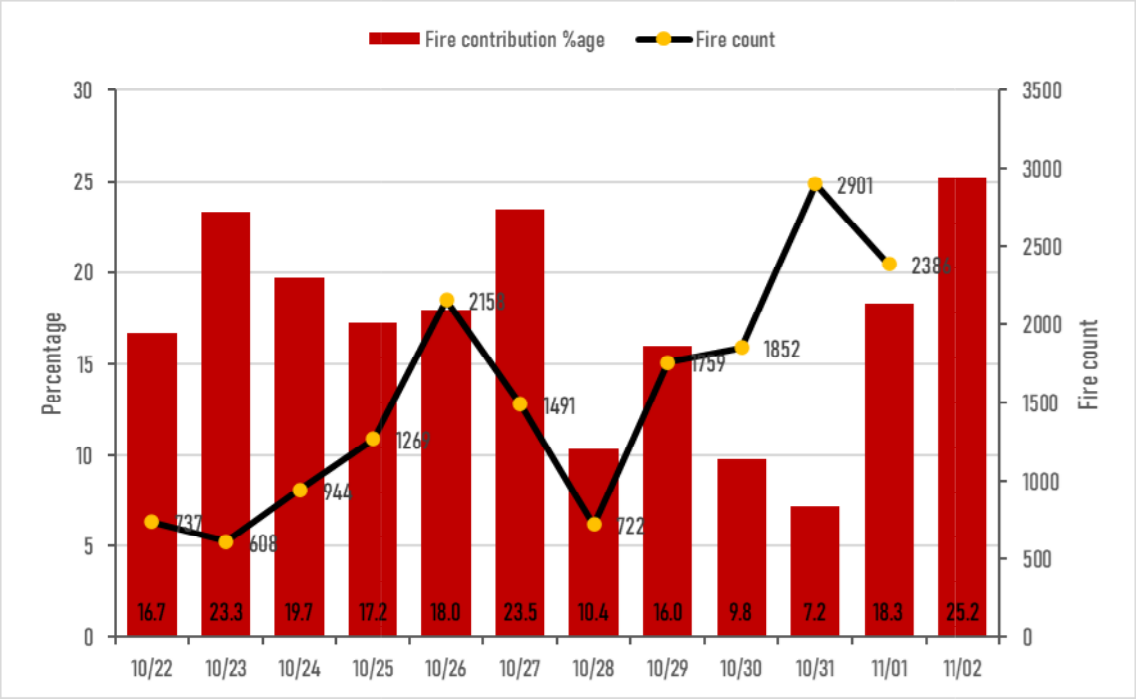
Graph 4: Trend in daily fire count and its percentage contribution to Delhi PM2.5

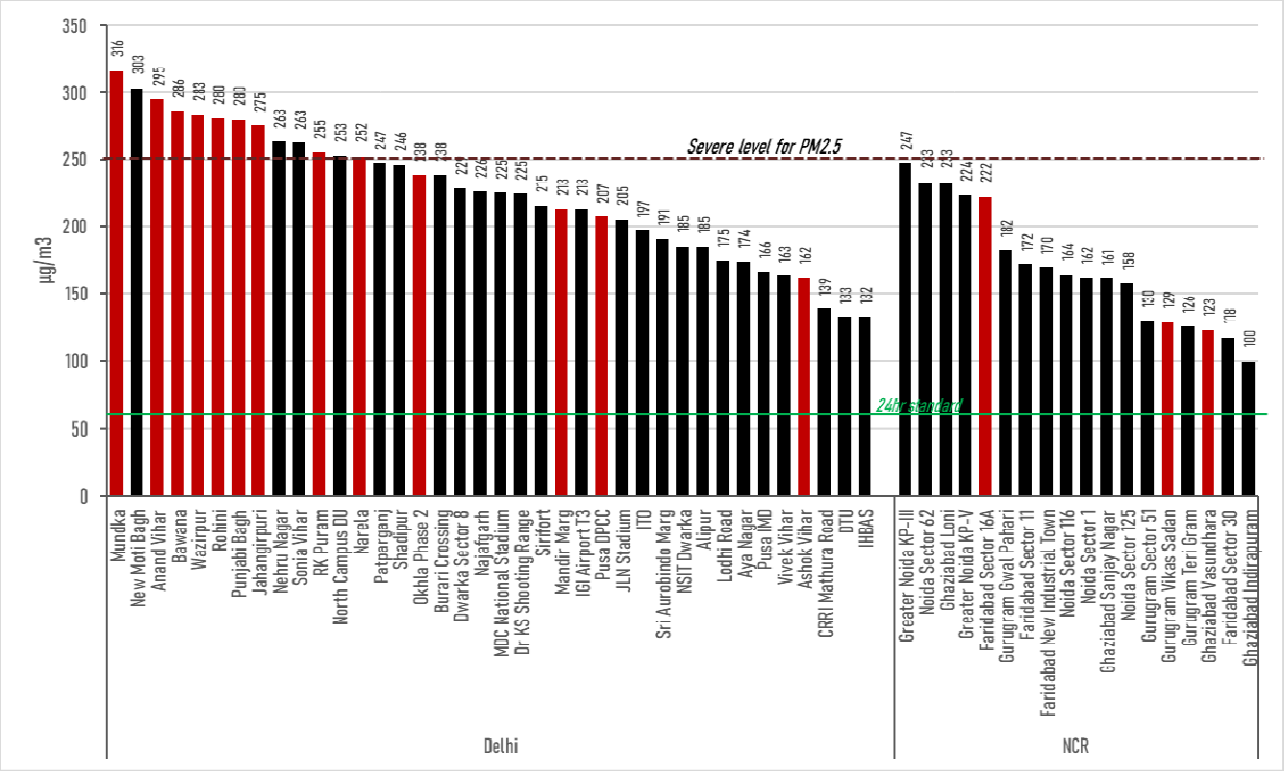


Source: CSE analysis of SAFAR data

Pollution hotspots remain most polluted despite the implementation of hotspot action plans: About 13 pollution hotspots that were identified in 2018-10 continue to remain a challenge while newer hotspots also are emerging. Newer hotspots have also proliferated.

Among all hotspots, Mundka and New Moti Bagh are the most polluted locations in Delhi with average PM2.5 levels exceeding 300 µg/m3. Most of the official hotspots of Delhi are exceeding the severe level of pollution. At the same time, any non-hotspots are showing higher pollution levels. New Moti Bagh, Nehru Nagar, Sonia Vihar and DU North Campus are the worst polluted new hotspots in Delhi. Greater Noida, Noida Sector 62, Loni and Faridabad are the most polluted locations in NCR. (see Graph 5: PM2.5 level among Delhi-NCR stations during 30 Oct-2 Nov 2023).

Graph 5: PM2.5 level among Delhi-NCR stations during 30 Oct-2 Nov 2023



Note: Mayapuri and Sahibabad don't have a CAAQM station, therefore nearest station to them (Pusa DPCC and Vasundhara respectively) is used to represent their air quality. Gurugram and Faridabad are represented by their oldest station- Vikas Sadan and Sector 16A respectively. Data for 30 Oct-2 Nov 2023. PM2.5 AQI subcategories´: Good (1-50 AQI) = less than 30µg/m3; Satisfactory (51-100 AQI) = 30-60µg/m3; Moderate (101-200 AQI) = 60-90µg/m3; Poor (201-300 AQI) = 90-120µg/m3; Very poor (301-400 AQI) = 120-250µg/m3; Severe (401-500 AQI)= over 250 µg/m3;
Source: CSE analysis of CPCB realtime data

Delhi in grip of multi-pollutant crisis – while particulate pollution is severe, nitrogen dioxide (NO2) levels are also rising: The levels of NO2 – that come largely from vehicles, are also rising in the region. This indicates high impact of vehicular pollution.

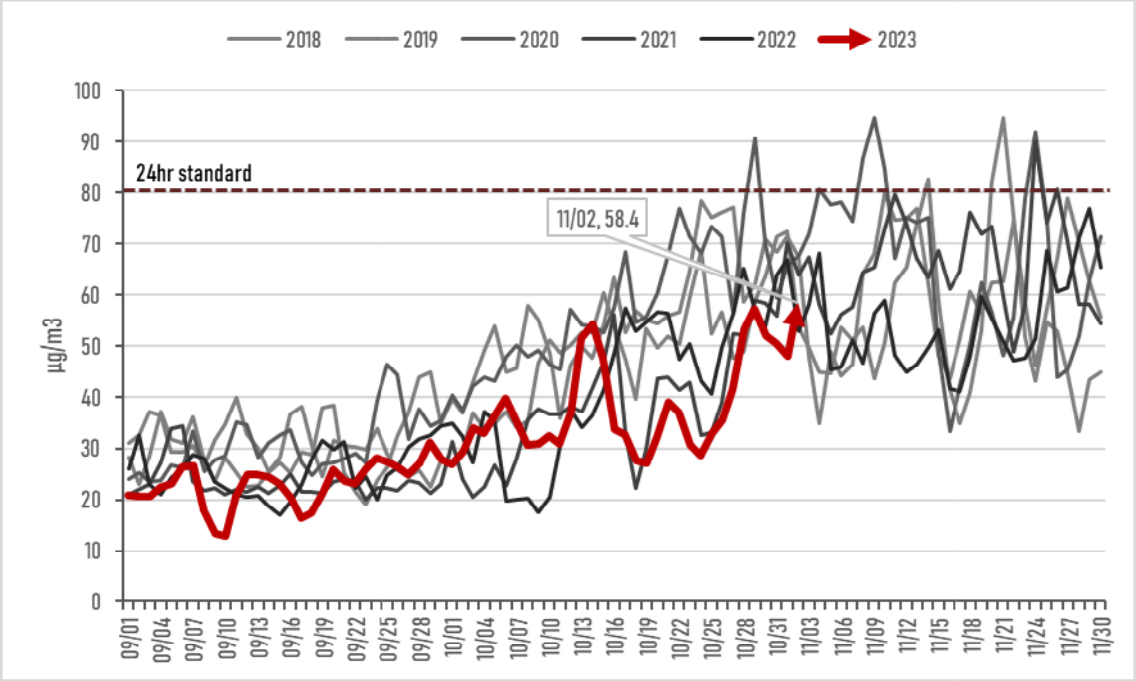
Citywide average NO2 is up by 60 per cent compared to first week of October last year. Certain high traffic locations have reporting levels as high as 3-4 times the 24hr standard.

ITO is most polluted NO2 locations in Delhi with average of 219 µg/m3. Nehru Nagar and Sirifort are the next most polluted NO2 locations in Delhi.

PM2.5 and NO2 hotspots can vary across the city: The official PM2.5 hotspots of Delhi are relatively less polluted with NO2. Noida Sector 125 and Sector 1 and Gaziabad's Sanjay Nagar and Indirapuram are the most polluted NO2 locations in NCR (see Graph 6: Trend in daily NO2 level in Delhi during Sept-Nov .

(Graph 6: Trend in daily NO2 level in Delhi during Sept-Nov and Graph 7: PM2.5 level among Delhi-NCR stations during 30 Oct-2 Nov 2023).

Graph 6: Trend in daily NO2 level in Delhi during Sept-Nov



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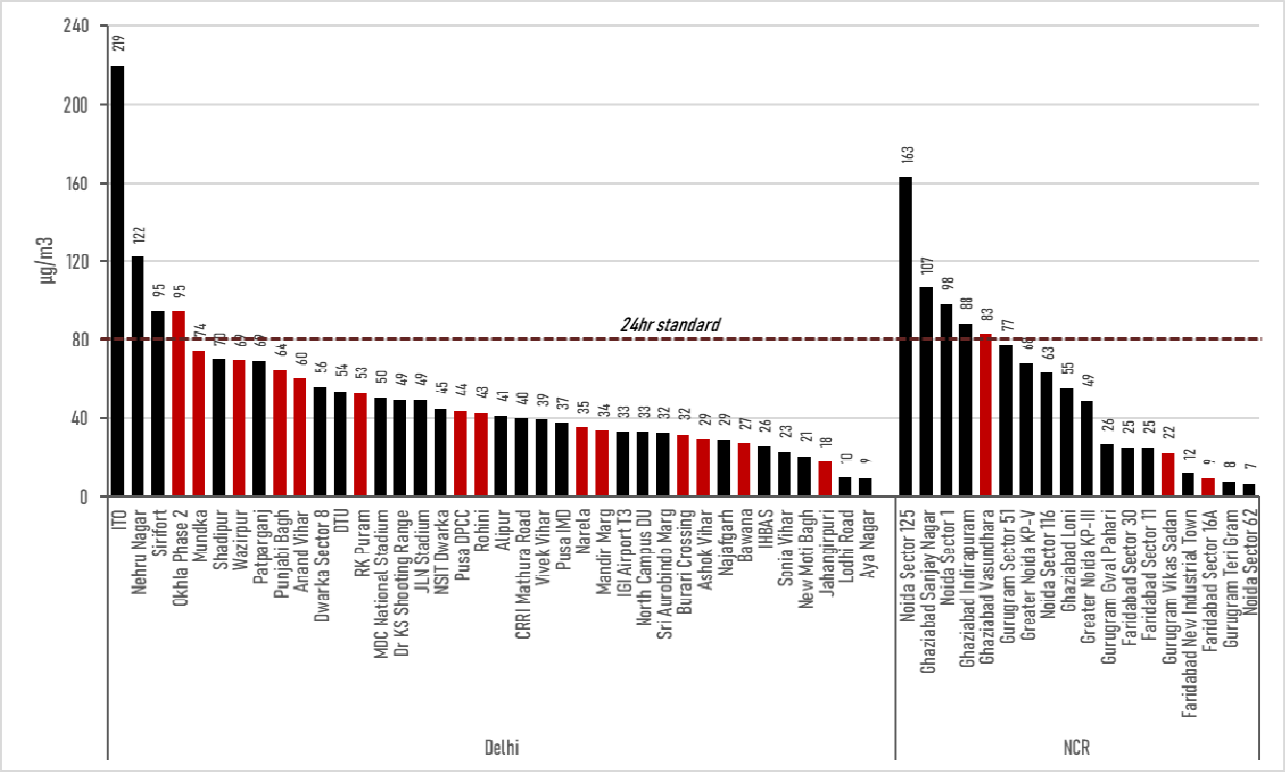
Graph 7: PM2.5 level among Delhi-NCR stations during 30 Oct-2 Nov 2023



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Source: CSE analysis based on CPCB data

Next steps: Address the key policy gaps urgently

While several measures taken over the years to clean up fuels and technology across transport and industry and control dust sources, more action is needed at a scale and speed to address the remaining policy gaps for meeting the clean air targets.

Need local and regional scale multi-sector action to cut emissions from vehicles, industry, power plants, waste burning, construction and dust sources. Need transformative changes in infrastructure and systems in each of these sectors.

Stronger control of episodic pollution like crop residue burning

Stronger hyper local action on all other pollution sources

Need stronger monitoring, enforcement and compliance strategy