The Diesel Generator Dilemma: Reliable Power, Unwanted Emissions

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by Kavyashree N Kalkura and Sameer Mishra.

If you face frequent power outages in your area, diesel generators (DGs) are possibly your only saviour during such times. They are known to provide reliable and uninterrupted power supply, which is especially needed in rural regions or areas with limited access to the grid. DG sets are an important tool, particularly for sectors such as telecommunications and healthcare.

But have you wondered about their emissions and how harmful they are to humans and the environment?

The Ministry of Environment, Forest, and Climate Change (MoEFCC) in their 2019 report on the National Clean Air Programme (NCAP) reported that 7%–18% of the total air pollution in non-attainment cities (cities consistently exceeding the National Ambient Air Quality Standards for 5 years in a row) in India could be attributed to DG sets. A DG set can roughly emit 2.7 kg of carbon dioxide (CO_2) per litre of diesel consumed

(Carbon Footprint). It also releases particulate matter (PM), including black carbon (BC), and pollutant gases such as carbon monoxide (CO), hydrocarbons (HCs), sulphur dioxide (SO2), and nitrogen oxides (NOx). Exposure to diesel exhaust can result in health impacts such as lung inflammation, aggravating chronic respiratory symptoms and increasing the frequency of asthma attacks. Short-term exposure can cause eye, nose, and throat irritation; coughing; light-headedness; and nausea (Aderibigbe et al., 2017). Moreover, the International Agency for Research on Cancer (IARC) has classified diesel exhaust as a Group 1 carcinogen.

A closer look at DG set emissions

The Center for Study of Science, Technology and Policy's (CSTEP's) Air Quality Monitoring Station (AQMS) captures nitric oxide (NO), nitrogen dioxide (NO_2), and SO2 emissions (and resultant changes in ozone) released by CSTEP Bengaluru office's DG set operating during grid power outages, in addition to characterising ambient air quality. Figures 1 and 2 show NO levels when the DG set ran for more than 30 minutes. The data also indicates instances when NO levels were extremely high, even reaching the maximum AQMS detection limit of 1,000 ppb. Some of the instances indicating lower levels of NO may be because of meteorological factors, such as wind blowing the emissions away from the AQMS inlet.

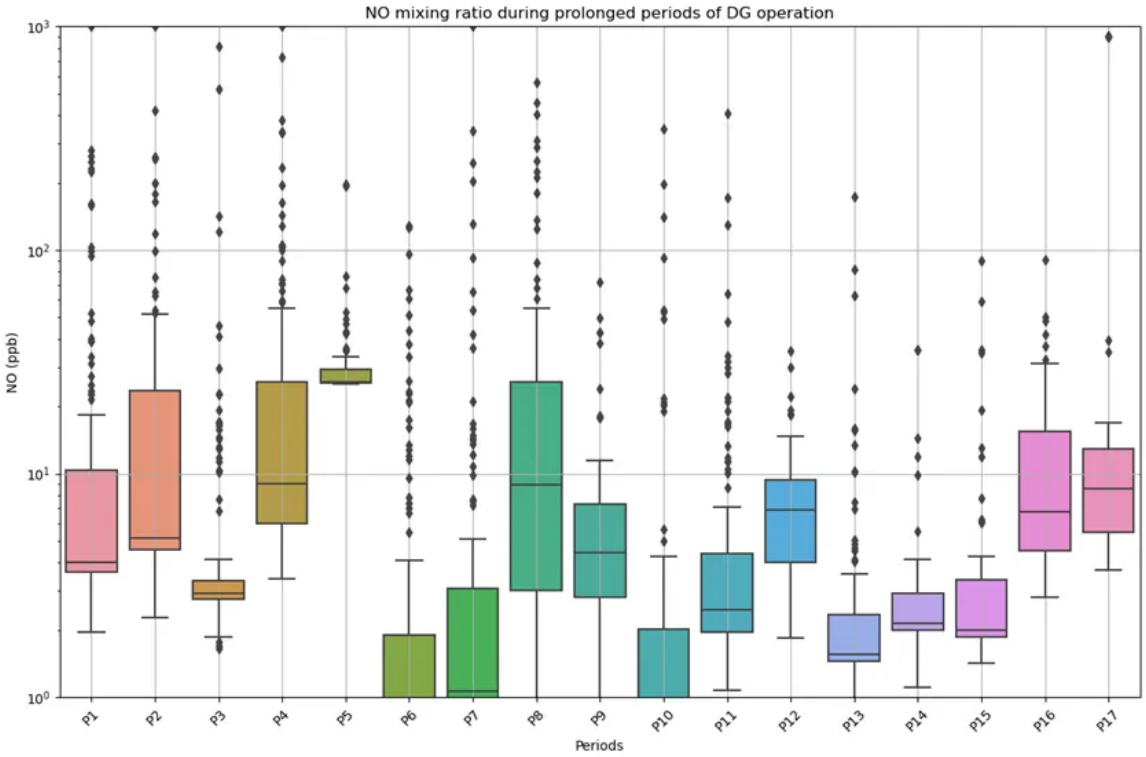

Figure 1. Ambient NO levels (1-min averages) when the DG set ran for over 30 min

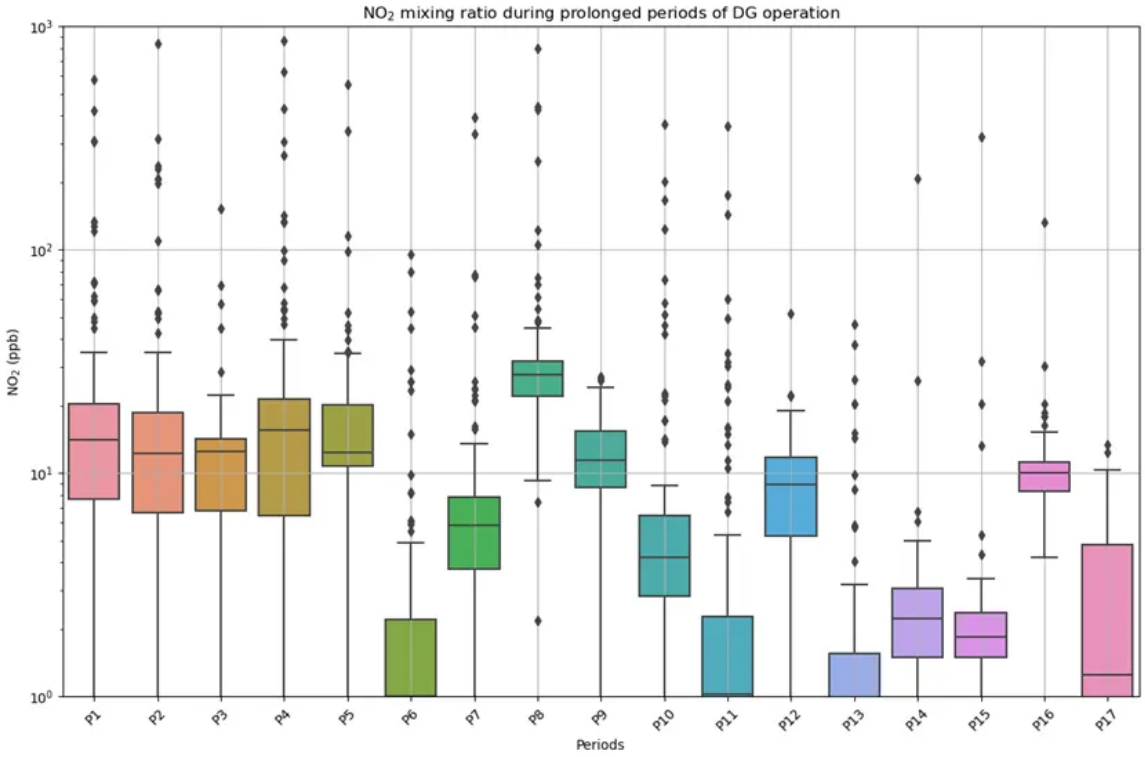

Figure 2. Ambient NO2 levels (1-min averages) when the DG set ran for more than 30 min

DG sets also emit SO2, which oxidises to form sulphate aerosols that contribute to ambient air pollution. Figure 3 shows two episodes of sporadic increases in NO, NO_2, and SO_2 levels. When NO emissions are released from the DG set, a dip in ground-level ozone is observed because of the fast reaction between NO and ozone to produce NO2.

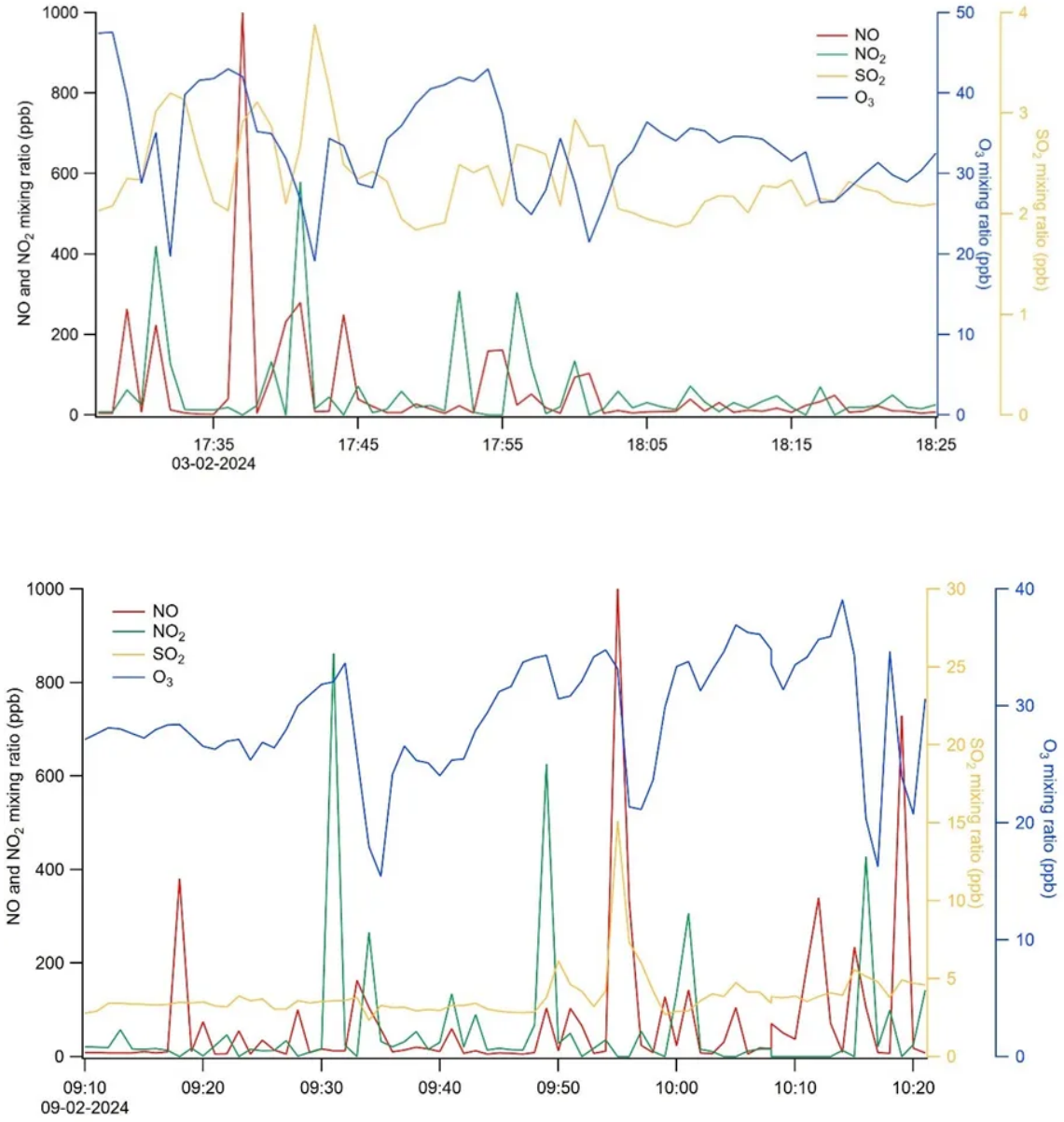

Figure 3. Two episodes of high NO, NO_2, and SO_2 levels

Black carbon, a major component of soot emitted from diesel combustion, is harmful to both health and the environment. While organic carbon and sulphates (almost entirely *scattering aerosols,* which are particles that reflect incoming solar radiation) have a cooling effect on the Earth's atmosphere, black carbon absorbs solar radiation and

warms the atmosphere (read our policy brief on the Case for Action on Black Carbon).

Policy measures to curb DG set emissions

Our previous study (2022) found that the Bruhat Bengaluru Mahanagara Palike (BBMP) operated around 8,700 DG sets in Bengaluru, which emitted 1,601 tonnes of PM2.5, 2,186 tonnes of PM10, 30,919 tonnes of NOx, and 2,039 tonnes of SO2 in 2019. Contributing about 51% of SO_2 and 37% of NOx emissions, DG sets were found to be major contributors to gaseous pollution in Bengaluru. In 2023, the Karnataka State Pollution Control Board released guidelines mandating the use of retrofit emission control devices (RECDs) or dual fuel systems for 61–800 kW DG sets over 5-years old. An addendum to this guideline, released in 2024, required larger DG sets to adopt compliant air pollution control devices by 31 March 2024.

Emissions from DG sets may meet the norms when new, but they can worsen over time. To address this, the Central Pollution Control Board (CPCB) issued specific regulations for commissioned DG sets with capacities above and below 800 kW. The NCAP Report highlighted that the most cost-effective option to curb DG set emissions is to retrofit DG sets with emission control equipment, which can capture up to 70% of harmful emissions. Following this report, the National Green Tribunal (NGT) mandated the use of RECDs and dual fuel kits in 2019 and directed CPCB to create norms and standards for them. In 2022, CPCB released the documentation on the standards and procedures for testing the emission compliance of RECDs for DG sets (with capacity up to 800 kW), which was later updated in 2023.

The MoEFCC in 2022 also set new emission limits for NOx, CO, PM, and HC for DG sets with up to 800 kW capacity. DG sets that cannot meet these emission limits are required to be retrofitted or phased out. Some

governments even offer subsidies for purchasing RECDs or new DG sets. For example, the Government of Jammu and Kashmir provides 100% subsidy for the purchase and installation of DG sets in industries that are retrofitted with RECD equipment as prescribed by the NGT for DG sets of capacity 125 KVA and above. Based on the recommendations from the NCAP report, switching to gas-based generators or retrofitting existing DG sets to partially utilise gas will potentially reduce emissions by 70%. Regular maintenance and emission checks should also be carried out frequently. The CPCB IV+ guidelines, introduced in July 2022 and implemented in July 2023, introduced stricter emission limits, the use of improved particulate filters, and enhanced monitoring requirements for DG sets.

What more can be done?

To further reduce the environmental impact of DG sets, several measures such as performing regular maintenance, installing emission control devices, and exploring renewable alternatives (substituting DG with solar for load sharing) can be adopted by offices, commercial spaces, and residential zones. A shift to greener options, such as batteries and hydrogen fuel cells, is also crucial for lowering carbon emissions. For example, Google has successfully switched to 100% renewable energy in their office spaces, and Microsoft plans to do so by 2025.

A cleaner and more sustainable future can be achieved by reducing the use of DG sets and switching to cleaner alternatives.

Kavyashree N Kalkura is an Analyst in the Atmospheric Composition Observations group and Sameer Mishra is a Senior Analyst in the Atmospheric Composition Modelling group in the Air Quality sector at the Center for Study of Science, Technology and Policy (CSTEP), a research-based think tank.

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