



A CSE SURVEY REPORT

RULES WITHOUT REACH

How the brick-making industry has fared on CAQM compliances in Delhi-NCR





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CAQM compliances in
Delhi-NCR**

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Citation Nivit Kumar Yadav, Subhrajit Goswami and Shobhit Srivastava, 2026, *Rules without Reach: A CSE Survey Report*, Centre for Science and Environment, New Delhi

Published by
Centre for Science and Environment

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Introduction

Delhi-NCR has, for long, grappled with severe air pollution, and industrial emissions have contributed to the problem significantly. Among local industries, the brick-making sector – which traditionally relies on high-emission fuels like coal and wood – has often been identified as a key emitter. A highly unorganised sector in nature, this industry also has had a history of flouting environmental as well as mining rules and norms.

As per a 2016-17 study for Delhi-NCR conducted by the Automotive Research Association of India (ARAI) and The Energy and Resources Institute (TERI)¹, brick kilns accounted for an average 8 per cent of the total PM_{2.5} emissions by all industries in the region during the winter season (the average contribution of the industrial sector overall was 30 per cent). The Central Pollution Control Board (CPCB) says the sector's contribution to Delhi-NCR's total PM₁₀ has ranged at 5 per cent in winters and 7 per cent in the summer season.²

The Commission for Air Quality Management (CAQM) in National Capital Region and Adjoining Areas has issued multiple directives focusing on industrial pollution control, with the emphasis on switching of fuels, stringent emission standards and stricter enforcement. Some of its key regulatory orders include:

- Direction No 62 (dated March 17, 2022) mandated industries to shift from fossil fuels to PNG or biomass with stringent particulate matter (PM) limits (80 mg/Nm³ initially, with the target at 50 mg/Nm³).
- Direction No 63 (dated May 18, 2022) allowed new industries to use biomass as an alternative.
- Direction No 64 (dated June 2, 2022) permitted metallurgical coke and low-sulfur fuels for specific processes like foundries, contingent on emission controls.
- Direction No 72 (dated March 17, 2023) enforces biomass co-firing (5-10 per cent) in captive power plants, aligning with broader efforts to curb stubble burning.
- Standard Fuel List (Letter dated June 3, 2022) institutionalised cleaner fuels (CNG, PNG, biofuels) while phasing out coal and diesel by October 2022-January 2023.

There are also a number of CAQM directives that have a specific bearing for the brick-making sector (*see next section in this chapter*).

Brick kilns were selected as the subject of this study primarily due to their significant impact as a highly polluting sector. Beyond this pressing environmental concern, they also offered a practical advantage for fieldwork: the lack of physical boundaries around most kilns allowed surveyors to freely conduct visual inspections and evaluate compliance on the ground.

Specific directives for the brick-making industry

Ensuring the brick-making industry's transition is critical for reducing black carbon and PM_{2.5} emissions in the region, particularly during winter when kiln activity peaks. The CAQM's phased mandates – fuel switching, emission controls and biomass co-firing – are aimed at aligning this sector with the National Capital Region's (NCR's) broader air quality targets, though challenges in enforcement and technology adoption persist.

While future directives may focus on financial incentives for clean kiln technologies (like Zig-Zag designs) to accelerate compliance, some of the existing regulations under the CAQM's framework are as follows:

- Order (dated November 16, 2022) prohibits the use of wood logs, mandating a shift to approved biomass (such as crop residues or sawdust) or cleaner fuels like PNG. This directive required immediate cessation of non-compliant practices and amendments to Consent to Operate (CTO) permits to reflect fuel changes.
- Emission standards for brick kilns are tighter now, with particulate matter limits mirroring those for biomass boilers (Direction No 62, dated March 17, 2022).
- Direction No 64 (dated June 2, 2022), which is for brick kilns in non-conforming areas (Order dated March 16, 2023), tasks state pollution control boards with regularising their operations through CTOs or enforcing closures, highlighting the tension between informal sector livelihoods and environmental compliance.

The Supreme Court of India, through a series of orders issued between April 2022 and April 2024, has restricted brick kiln operations in the NCR to a four-month period annually – from March 1 to June 30. This rule applies only to kilns that meet strict environmental standards, including the mandatory adoption of Zig-Zag technology, valid regulatory consent and a declared production capacity. Notably, the Court has permitted the continued use of approved fuels like coal, firewood and agricultural residues during these months, while prohibiting more polluting alternatives such as pet coke, tires and plastics.

The Supreme Court has also directed that brick kilns must comply with the CPCB's 'Guidelines for Brick Kilns' and use only clean fuels. These guidelines list coal as a "permissible" clean fuel; but in the NCR region, the directions issued by the CAQM take precedence – these mandate that only clean fuels *excluding coal* shall be used in brick kilns operating in NCR.

These measures align with the Union Ministry of Environment, Forest and Climate Change's (MoEF&CC) 2022 notification, which requires all new kilns to use cleaner technologies (Zig-Zag, vertical shaft, or PNG) and mandates existing kilns to transition to these methods within set deadlines.

2. Objectives and Methodology of the Study

The objectives

The study aims to understand how the brick kiln sector has responded to the CAQM guidelines, including the one on ban on coal. Through two rounds of surveys conducted in 2025 and 2026, it also seeks to assess changes in compliance levels over time and highlight the various issues and challenges faced by the sector in complying with these guidelines.

One of the things that the study attempts to do is to gauge the support and hand-holding the sector requires from the government to enable it to comply with environmental norms and guidelines and maintain a sustainable environmental ecosystem.

The methodology

CSE team conducted field surveys of brick kiln units for two consecutive years across Delhi-NCR during 2025 and 2026. The first round, conducted in 2025, covered 128 brick kilns across identified clusters in Uttar Pradesh and Haryana. The second round, conducted in 2026, covered 152 brick kilns, revisiting the previously surveyed clusters while expanding the coverage to additional units and locations. During both rounds, the team attempted to meet brick kiln owners and operators to understand their concerns and operational challenges, as well as their reactions to the CAQM mandates and whether they received any assistance from the government to abide by these mandates. Unfortunately, the team was completely stonewalled in its efforts: brick kiln owners refused to share any information.

As a result of this, the team was forced to adapt a different strategy – it approached the kilns as a potential buyer of high-quality bricks. In this manner, CSE surveyors were able to observe the fuel feeding operations to assess the use of coal in the process and the infrastructure available for monitoring and controlling fugitive dust emissions.

The study methodology adapted by CSE can be summarised as follows:

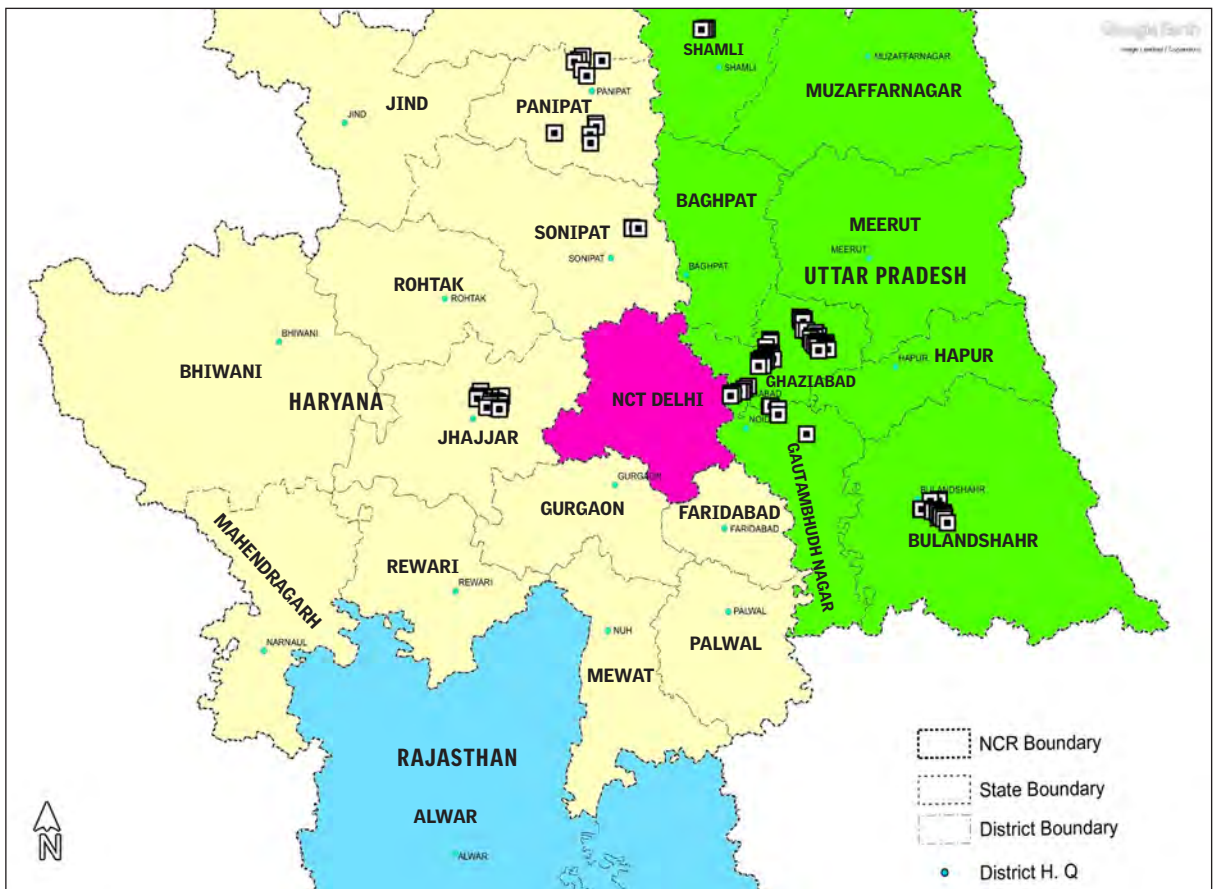
- The different/specific districts in Delhi-NCR, across Uttar Pradesh and Haryana, were identified.

- A cluster mapping of kilns was done in each of these identified districts using satellite data.
- Walk-through surveys and discussions with available representatives of the industry were conducted.
- All the surveyed units were assessed based on the following parameters: conversion status (FCBTK or Zig Zag), type of fuel used, infrastructure for monitoring, and availability of green cover.
- The team also attempted to conduct short surveys with available brick kiln owners to understand the assistance provided by the CAQM/CPCB/SPCBs to help the units in their efforts to comply with the directions and guidelines. However, the majority of the owners were very resistant to sharing the information.
- Areas covered during the study: Shamli, Baghpat, Ghaziabad, Modinagar and Bulandshahr in Uttar Pradesh and Jhajjar, Panipat and Sonipat in Haryana.

3. The Survey

The CSE team conducted two rounds of surveys across identified brick kiln clusters spread across Delhi-NCR. **The first round, undertaken in 2025, covered 128 brick kilns, while the second round, undertaken in 2026, covered 152 brick kilns (including the earlier 128).** The 2026 survey revisited the clusters covered during the first round and expanded the coverage to additional brick kilns and locations to better understand changes in compliance status and operational practices across the sector.

Map showing the NCR districts covered under the CSE survey. The background map is from the National Capital Region Planning Board



BAGHPAT

The survey covered brick kilns across Baghpat, Dhikana, Luhari, Baraut Rural, Rajpur, Khampur and Tyodhi. A total of 22 kilns were surveyed in 2025, while 35 kilns were surveyed in 2026.

- **Technology conversion:** All the surveyed kilns in 2025 and 2026 were observed to have been converted to Zig-Zag technology.
- **Fuel use:** In 2025, about 91 per cent of the surveyed kilns (20 out of 22) were observed to be using coal as fuel. In 2026, coal use was observed in about 83 per cent of the surveyed kilns (29 out of 35). Loose biomass was found to be in use across all surveyed kilns during both survey rounds. In the 2025 survey, CSE found 20 kilns using coal; in 2026, this number increased to 29 after the addition of nine more coal-using kilns. But the share of surveyed kilns using coal changed from 91 per cent to 83 per cent.
- **Monitoring:** All the surveyed units in both years were found to have the required monitoring infrastructure, including portholes, ladders and platforms. In 2025, four out of 22 kilns had monitoring platforms that could be considered safe for conducting monitoring. In 2026, 10 out of 35 kilns were found to have safe monitoring platforms. The number of kilns with safe monitoring platforms changed from four to 10 between the two survey rounds.
- **Green cover:** In 2025, only one kiln was observed to have sparse plantation, while no green cover was observed in the remaining units. In 2026, three kilns were observed to have sparse plantation, while no green cover was available in the remaining 32.
- **Roads:** Road infrastructure was found to be absent at many places during both survey rounds, resulting in generation of road dust due to vehicle movement in and around the kiln clusters.

Ghaziabad

The survey covered brick kilns in and around Ghaziabad, Mathurapur, Shahpur Nij Morta, Kalchhina, Nagala Musa, Saunda, Modinagar, Kakra, Mahmudabad, Bhikanpur, Makraida and Bahadurpur. A total of 31 kilns were surveyed in 2025, while 39 were surveyed in 2026.

- **Technology conversion:** All the surveyed kilns in 2025 and 2026 were observed to have been converted to Zig-Zag technology.
- **Fuel use:** In 2025, about 87 per cent of the surveyed kilns (27 out of 31) were observed to be using coal as fuel. All surveyed kilns were utilising loose biomass, while six kilns were also found to be using wood and processed municipal solid waste. In 2026, coal use was observed in 30 out of 39 surveyed kilns, representing about 77 per cent of the surveyed units. The number of surveyed

kilns using coal changed from 27 in 2025 to 30 in 2026, while the share of surveyed kilns using coal changed from 87 per cent to 77 per cent.

- **Fuel-use pattern:** During the 2025 survey, kilns located along roadside stretches such as Tilla Mod and Farukh Nagar Road were largely using biomass as fuel, while kilns located in interior areas such as Kalchhina were observed to be using coal along with other fuels. Similar fuel-use patterns were observed during the 2026 survey, with coal continuing to be observed across a number of interior clusters.
- **Monitoring:** All the surveyed units in both years were found to have the required monitoring infrastructure, including portholes, ladders and platforms. In 2025, seven out of 31 surveyed kilns had monitoring platforms that could be considered safe for conducting monitoring exercises. In 2026, 13 out of 39 surveyed kilns were found to have safe monitoring platforms.
- **Green cover:** In 2025, five kilns were observed to have sparse plantation, while the remaining units had no significant green cover. In 2026, seven kilns were observed to have sparse plantation.

Bulandshahr

The survey covered brick kilns in and around Bulandshahr, Pali Badshapur, Naya Gaon, Mirzapur, Dhatoori and Mukimpur. A total of 18 kilns were surveyed in both 2025 and 2026.

- **Technology conversion:** All the surveyed kilns in 2025 and 2026 were observed to have been converted to Zig-Zag technology.
- **Fuel use:** In 2025, about 56 per cent of the surveyed kilns (10 out of 18) were observed to be using coal as fuel. All surveyed kilns were utilising loose biomass, while one kiln was also found to be using wood. In 2026, coal use was observed in 11 out of 18 surveyed kilns, representing about 61 per cent of the surveyed units. Loose biomass continued to be used across all surveyed kilns, while the use of wood was observed in one kiln. The number of surveyed kilns using coal changed from 10 in 2025 to 11 in 2026, while the share of surveyed kilns using coal changed from 56 per cent to 61 per cent.
- **Monitoring:** All the surveyed units in both years were found to have the required monitoring infrastructure, including portholes, ladders and platforms. In 2025, 10 out of 18 surveyed kilns had monitoring platforms that could be considered safe for conducting monitoring. In 2026, 11 out of 18 surveyed kilns were found to have safe monitoring platforms.
- **Green cover:** In 2025, one kiln was observed to have sufficient plantation, four had sparse plantation and 13 had no green cover. In 2026, two kilns were observed to have sufficient plantation, five had sparse plantation and 11 had no

green cover. The number of kilns with sufficient plantation changed from one to two, while the number of kilns with sparse plantation changed from four to five between the two survey rounds.

- **Siting:** During the 2025 survey, brick kilns were observed to be operating close to a school in Pali Badshapur. Similar siting concerns continued to be observed during the 2026 survey in parts of the district.

Shamli

Eight kilns were surveyed across Shamli and Darghapur; a follow-up survey was not conducted in Shamli in 2026. Therefore, the findings presented in this section are based on observations made during the 2025 survey.

- **Technology conversion:** All the brick kilns have been converted to Zig Zag technology.
- **Fuel use:** Seven kilns were observed to be consuming coal as fuel. All eight kilns were also using loose biomass, while one was also found to be utilising wood. The CSE team observed that the kilns using coal and located along the roadside had deliberately stacked manufactured bricks in between the road and the kiln (as there is no boundary wall) to hide the coal stored on the kiln's premises.
- **Monitoring:** All the surveyed units were found to be having the required monitoring infrastructure. However, only three have taken care of the safety aspect while building monitoring platforms at the stacks.
- **Green cover:** Only three of the eight kilns had sparse plantation.

Jhajjar

The survey covered brick kilns across Jhajjar, Mehrana, Agarpur, Tatarpur and Bhadani. A total of 31 kilns were surveyed in 2025, while 40 were surveyed in 2026.

- **Technology conversion:** All the surveyed kilns in both 2025 and 2026 were observed to have been converted to Zig Zag technology.
- **Fuel use:** In 2025, about 87 per cent of the surveyed kilns (27 out of 31) were observed to be using coal as fuel. All surveyed kilns were utilising loose biomass, while two kilns were also found to be using wood. In 2026, coal use was observed in 33 out of 40 surveyed kilns, representing about 83 per cent of the surveyed units. Loose biomass continued to be used across all surveyed kilns, while wood use was observed in two. The number of surveyed kilns using coal changed from 27 in 2025 to 33 in 2026, while the share of surveyed kilns using coal changed from 87 per cent to 83 per cent.
- **Coal handling and site conditions:** During the 2025 survey, coal was observed to be in extensive use across the Jhajjar cluster, including open unloading of

coal in Tatarpur. The survey also noted the absence of road infrastructure and limited identification signage across several kiln clusters. Similar observations were made during the 2026 survey, with coal storage and handling practices continuing to be visible at a number of surveyed locations.

- **Monitoring:** All the surveyed units in both years were found to have the required monitoring infrastructure, including portholes, ladders and platforms. In 2025, 19 out of 31 surveyed kilns had monitoring platforms that could be considered safe for conducting monitoring. In 2026, 24 out of 40 surveyed kilns were found to have safe monitoring platforms. The number of kilns with safe monitoring platforms changed from 19 to 24 between the two survey rounds.
- **Green cover:** In 2025, four kilns were observed to have sparse plantation, while the remaining 27 units had no green cover. In 2026, six kilns were observed to have sparse plantation, while the remaining 34 units had no green cover. The number of kilns with sparse plantation changed from four to six between the two survey rounds.

Panipat

The survey covered brick kilns in and around Panipat, Jondhan Khurd, Palri, Diwana and Manana. A total of 15 kilns were surveyed in 2025, while 17 were surveyed in 2026.

- **Technology conversion:** All the surveyed kilns in both 2025 and 2026 were observed to have been converted to Zig Zag technology.
- **Fuel use:** In 2025, about 47 per cent of the surveyed kilns (seven out of 15) were observed to be using coal as fuel. All surveyed kilns were utilising loose biomass and none were found to be using wood. In 2026, coal use was observed in eight out of 17 surveyed kilns, representing about 47 per cent of the surveyed units. Loose biomass continued to be used across all surveyed kilns, while no kiln was observed to be using wood. The number of surveyed kilns using coal changed from seven in 2025 to eight in 2026, while the share of surveyed kilns using coal remained at about 47 per cent.
- **Fuel storage and visibility:** During the 2025 survey, large stacks of bricks around the kilns made it difficult to identify stored coal from the roadside. Similar conditions were observed during the 2026 survey, with coal storage not readily visible at several surveyed locations.
- **Monitoring:** All the surveyed units in both years were found to have the required monitoring infrastructure, including portholes, ladders and platforms. In 2025, two out of 15 surveyed kilns had monitoring platforms that could be considered safe for conducting monitoring. In 2026, three out of 17 surveyed kilns were found to have safe monitoring platforms. The number of kilns with safe monitoring platforms changed from two to three between the two survey rounds.

- **Green cover:** In 2025, four kilns were observed to have sparse plantation, while the remaining 11 units had no green cover. In 2026, five kilns were observed to have sparse plantation, while the remaining 12 units had no green cover. The number of kilns with sparse plantation changed from four to five between the two survey rounds.
- **Roads and siting:** During the 2025 survey, approach roads in some locations were observed to be made of cement blocks and one kiln was found to be operating in the vicinity of a school. Similar road conditions and siting observations were recorded during the 2026 survey.

Sonipat

The survey covered brick kilns in the Murthal Khas area. A total of three kilns were surveyed in both 2025 and 2026.

- **Technology conversion:** All the surveyed kilns in 2025 and 2026 were observed to have been converted to Zig Zag technology.
- **Fuel use:** In 2025, one out of the three surveyed kilns was observed to be using coal as fuel. All surveyed kilns were utilising loose biomass and none were found to be using wood. In 2026, coal use was observed in one out of the three surveyed kilns. Loose biomass continued to be used across all surveyed kilns, while no kiln was observed to be using wood. The number of surveyed kilns using coal remained unchanged between the two survey rounds.
- **Site conditions:** During the 2025 survey, large stacks of bricks around the kilns made it difficult to identify stored coal from outside the premises. The survey team also noted that none of the surveyed kilns had proper signboards displaying their details. Similar observations were recorded during the 2026 survey.
- **Monitoring:** All the surveyed units in both years were found to have the required monitoring infrastructure, including portholes, ladders and platforms. In 2025, one out of the three surveyed kilns had a monitoring platform that could be considered safe for conducting monitoring. In 2026, one out of the three surveyed kilns was found to have a safe monitoring platform. The number of kilns with safe monitoring platforms remained unchanged between the two survey rounds.
- **Green cover:** In 2025, one kiln was observed to have sparse plantation, while the remaining two units had no green cover. In 2026, one kiln was observed to have sparse plantation, while the remaining two units had no green cover. The availability of green cover remained unchanged between the two survey rounds.

4. The Observations

Based on the survey conducted by the CSE team, the major observations/findings are as follows:

1. **Technology conversion:** All the 128 brick kilns surveyed in 2025 and all the 152 brick kilns surveyed in 2026 have shifted to Zig Zag technology from the conventional FCBTK technology. However, the quality of conversion was found to be poor: the team saw kilns with broken or unplastered walls or walls with poor quality of plastering, which ultimately leads to heat loss into the surroundings from within the system. It also results in increased fuel consumption and decreased efficiency. Approximately 50 per cent of the total heat supplied to a brick kiln is lost through its surfaces, including the walls, roof, floor, *miyan* (central flue duct) and wicket gates due to poor structural design. This efficiency loss is heavily exacerbated by structural defects; a massive temperature differential exists across the kiln wall, and because air travels through the path of least resistance, cold air leaks directly into the system through any opening. The survey revealed that cracks and leaks were present in around 70 per cent of the evaluated kilns, a critical flaw that completely neutralises the intended energy efficiency benefits and environmental advantages of technology conversion.



Mud plastering being carried out on the outer wall of a brick kiln



Mud-plastered outer wall of a brick kiln with adjacent fuel storage area



Unplastered outer wall of a brick kiln with adjacent fuel storage area



Cracks observed on the outer wall of the brick kiln



Structural cracks on the exterior wall of the brick kiln

2. **Design changes:** During the survey, the CSE team observed that many of the kilns had increased the width of their trenches to increase their capacity – for example, in Uttar Pradesh, the consent to brick kilns is usually given for 20,000-25,000 bricks per day. As per sector experts, the normal trench width for such capacity should be in the range of 20-25 feet. However, the survey revealed many brick kilns had trench widths more than the prescribed norms. In some cases, this was around 40-50 feet, double of what the consent is given for. It was understood that this is done due to the restriction of four months of operations that has been levied on brick kilns. To maximise production during the operational four months, kiln owners have taken recourse to increasing the trench width without informing the pollution control board. This results in violation of the Consent to Operate (CTO) issued to brick kilns by SPCBs. Moreover, since this design modification has been done without any technical inputs from experts, it results in increased coal/fuel consumption and eventually means that while the production has doubled, so has the consumption of fuel (coal, biomass etc).

3. **Fuel use:** In spite of the ban on coal usage in NCR, coal seems to be in extensive use in brick kilns. However, none of the kilns surveyed were using only coal as fuel. In 2025, about 77 per cent of the surveyed kilns (98 out of 128) were observed to be using coal, while almost all the kilns were utilising



Coal stored within the brick kiln premises in bags and stacked for use



Coal/petcoke grinding within the brick kiln premises



Coal stored behind the outer wall in the backside of the brick kiln

loose biomass as fuel. In 2026, coal use was observed in about 72 per cent of the surveyed kilns (109 out of 152), while loose biomass continued to be used across almost all surveyed units. The majority of the surveyed kilns in both years were using a blend of coal and biomass rather than any one type of fuel.

Brick kiln units located along the roadsides – because their operations are visible – use biomass pellets, bagasse etc. However, as the surveyors went deeper inside villages and away from the roads, they found units using coal.

Some of the brick kiln owners informed the CSE team that it is easier for them to replace 20-30 per cent of coal with biomass.

4. **Supply and delivery of fuel:** Kiln owners are not procuring coal in one go – they have made arrangements with coal suppliers to supply coal on a daily basis; the deliveries usually take place in the evening or the night. However, during the survey in the Jhajjar cluster, it was observed that coal was being supplied to brick kilns in the daytime as well.



Coal/petcoke being unloaded from a truck within the brick kiln premises

5. **Carbon black:** The survey team witnessed black bags at many of the brick kilns – kiln staff and laborers informed that this was carbon black, which is used as fuel mainly during the night. The team was told that the stock of carbon black is received mainly during night hours.
6. **Storage:** Coal and the bags of carbon black are usually stored at the back side of kilns to avoid detection. Covering the coal and carbon black with tarpaulin sheets is also in practice.
7. **Using paddy straw as fuel:** On June 3, 2025, the CAQM issued directions for Air Quality Management in NCR and Adjoining Areas. In view of the compelling need to control air pollution from uncontrolled/open burning of paddy straw, the Commission has directed the state governments of Punjab and Haryana to mandate the use of paddy straw-based biomass pellets/briquettes in all brick kilns located in the districts beyond NCR, as one of the means towards elimination of the practice of open paddy stubble burning, aiming for 50 per cent co-firing of paddy straw-based pellets/briquettes with a target of at least 20 per cent from November 1, 2025; 30 per cent from November 1, 2026; 40 per cent from November 1, 2027; and 50 per cent from November 1, 2028. While the survey observed widespread adoption of loose biomass as a primary fuel, pellets were also observed being used in a few instances in Panipat. Though the availability of pellets is not an issue in the Panipat clusters, the problem with pellets is that they absorb moisture when mixed with loose biomass; owing to their weight, they sink to the bottom and burn incompletely.



Biomass fuel stored within the brick kiln premises



Unloading of biomass fuel within the brick kiln premises

Biomass pellets stored in front of a brick kiln in Panipat

8. **Monitoring:** Port-hole, ladder and platform for monitoring were available in all the surveyed units during both survey rounds. In 2025, 46 out of the 128 surveyed kilns (about 36 per cent) were observed to have a safe ladder and platform for monitoring purposes. In 2026, 61 out of the 152 surveyed kilns (about 40 per cent) were observed to have a safe ladder and platform for monitoring purposes.



Damaged port hole and access ladder requiring maintenance

Port hole and access ladder maintained in usable condition

-
9. **Green cover:** In 2025, no green cover was observed in 105 out of the 128 surveyed kilns (about 82 per cent). Sparse plantation was observed in 22 kilns (about 17 per cent), while only one kiln had sufficient green cover on its premises. In 2026, no green cover was observed in 118 out of the 152 surveyed kilns (about 78 per cent). Sparse plantation was observed in 32 kilns (about 21 per cent), while two kilns were observed to have sufficient green cover on their premises.



Well-developed green belt along the outer boundary of a brick kiln in Ghaziabad

10. **Product quality:** There is no testing of briquette quality done at the brick kilns, which is why briquette suppliers have been negligent about the quality of their products. Brick kiln entrepreneurs have informed the surveyors that soil had been mixed in the briquettes that had been supplied.
11. **Other observations:** Environmental and safety issues have been observed across various regions in the NCR. Notably, brick kilns were found operating in close proximity to schools in the Panipat and Bulandshahr districts. Furthermore, significant fugitive dust emissions were recorded during the transportation of green bricks due to poor road conditions, as explicitly documented in the Baghpat district and prevalent throughout the interiors of all districts.



Brick kiln operating beside a school



Poor internal road conditions contributing to fugitive dust generation

5. Challenges in Transitioning from Coal to Biomass Fuel

The CSE surveys show that the brick manufacturing industry in Delhi-NCR faces significant challenges, especially in transitioning from coal to biomass as the primary fuel source for kilns. Following the 2017 mandate to convert traditional Fixed Chimney Bull's Trench Kilns (FCBTK) to high-draught Zig Zag kilns, manufacturers have collectively invested approximately Rs 1,400 crore to convert 2,783 brick kilns (as informed to CAQM by the Brick Kiln Owners Association).^{3REF} This capital investment occurred without any external financial support, and has come as a significant economic burden for the industry.

The sector's plight worsened when operations were completely halted from 2019 to 2021 due to National Green Tribunal (NGT) orders, followed by restricted operations for only four months a year, which severely impacted the payback period for these investments.

While the environmental benefits of conversion to Zig Zag technology are notable, the abrupt transition from coal to biomass presents multiple technological and logistical challenges. The submission by the Brick Kiln Owners Association to CAQM says Zig Zag technology alone has reduced PM10 emissions by 4 per cent, suggesting that the industry's environmental impact has already been significantly mitigated. With complete conversion to Zig Zag technology, brick kilns' contribution to PM10 is projected to drop down to a mere 1 per cent in winter and 3 per cent in summer, rendering their environmental impact relatively minimal compared to other pollution sources.^{4REF}

The Association and sectoral representatives have also highlighted the fact that the proposed phase-out of coal (rather than a gradual phase-down) presents huge operational difficulties. The Brick Kiln Owners Association has highlighted that the CPCB's notification dated February 22, 2022 explicitly mentions coal as the main fuel for high-draught technology with prescribed emission standards of 250 mg/Nm³. An immediate shift to biomass would require not only technological modifications, but also assurances of consistent biomass supply.

The surveys also highlighted another concern. Approximately 1.0-1.50 million tonne (MT) of coal is being currently used up for brick firing in the region.

Switching to biomass would require almost double this quantity – about 3-3.5 MT of processed biomass (briquettes or pellets) during a 120-day operational period. This massive demand far exceeds the current processing capacity, which can presently serve only 10-15 brick fields. To meet the regional demand, an estimated 250 agro-waste processing plants will be needed.

The Association claims that from a technical perspective, loose agro-waste is unsuitable as a direct replacement for coal – only processed forms such as briquettes or pellets can serve as viable substitutes. The calorific values of various biomass sources differ significantly from coal, necessitating adjustments to firing processes or larger quantities of biomass. Coal, typically, offers 4,000-6,000 kcal/kg, while most crop residues provide only 3,000-4,000 kcal/kg.

Current practices in the NCR already incorporate approximately 20-40 per cent agro-waste in loose form alongside coal, indicating some progress toward mixed-fuel approaches. However, the inconsistent quality and supply of this loose biomass often lead to the use of illegal fuels to maintain production. A successful transition would require not only technological adaptation but also significant skill enhancement among operators to manage the different combustion characteristics of biomass fuels.

The industry's experience in Rajasthan, where agro-waste from mustard plants has been used, provides valuable insights, but may not be directly applicable across the entire NCR due to regional variations in biomass availability and kiln configurations. This underscores the need for region-specific approaches rather than universal mandates.

6. Good Practices: What a Modern Brick Kiln should Look Like

While the brick kiln sector collectively stands out as a major polluter, there are individual kiln owners who have taken the initiative to transform their units by adopting sustainable and efficient practices. The CSE survey team came across one such unit in Jhajjar in Haryana.

Deswal Brick Kiln Co (DBC)

DBC has successfully transitioned from a traditional Fixed Chimney Bull's Trench Kiln (FCBTK) to a modern Zig Zag kiln, showcasing how infrastructural improvements and innovative operations can significantly enhance energy efficiency and environmental performance.



Brick kiln with proper shed providing better working environment for workers

The kiln features a well-insulated structure with thick cement-plastered outer walls, a clay-plastered inner lining, and sand insulation that reduces heat loss. Structural adjustments – such as reducing the number of wicket gates and side flue ducts – help to limit leakage and improve fuel efficiency. The floor is layered with aluminium foil and fired bricks, while a shed over the kiln further retains heat and reduces fugitive dust emissions.

A key shift in DBC's operations is its move from coal to 100 per cent biomass briquettes, which have a lower calorific value (3,200-4,000 kcal/kg) but which burn more cleanly, significantly reducing particulate matter, black carbon and sulfur oxide emissions. The fuel is stored in a covered shed with natural light and proper ventilation to maintain dryness and reduce emissions. Fuel feeding is optimised using a funnel system across 114 fire-holes, ensuring uniform and complete combustion, with a feed cycle every two hours.

These practices are reinforced by continuous monitoring of combustion gases, where the CO to CO₂ ratio is below 0.015, which indicates near-complete combustion – a key indicator of energy efficiency. An Induced Draught (ID) fan, powered by a Variable Frequency Drive (VFD), regulates air flow and saves energy, while emissions and pressure are monitored using a magnehelic gauge and flue gas analyzers.

The incorporation of renewable energy has further transformed the kiln's sustainability profile. A 50-kWp solar panel system, along with battery back-up, powers the ID fan, lighting and water pumps; this has reduced the electricity bills from Rs 45,000 to Rs 11,000 per month and had eliminated the need for diesel generators.

DBC also leads in water conservation: it has installed a 40-kld sedimentation system to recycle wastewater from domestic use, which is reused in brick making and dust suppression. Sludge and ash collected from the system are mixed back into the green bricks, ensuring zero waste discharge.

Dust emissions are controlled through regular water sprinkling and the development of a three-layered green belt comprising trees, shrubs and ground cover, which act as a buffer against dust, reduce ambient temperatures, and enhance the overall site environment. All walking surfaces and brick stacking zones are cemented, improving safety and reducing particulate emissions. The use of pallets and forklifts during brick loading reduces breakage and fugitive dust, improving operational efficiency.

DBC also follows strong compliance and documentation practices, with all statutory details – including kiln registration, GST number and geographic coordinates – clearly displayed at its entry. A dedicated monitoring room tracks key process parameters such as fuel feeding, temperature and airflow, ensuring consistency and enabling prompt corrective actions. All kiln equipment is well-insulated to prevent heat loss, and secure boundary walls with a gated entry ensure a clean, organised and safe workplace.

The unit does face a serious challenge. With its operations restricted to just four months, the economics of brick-making has become unviable for it, as it has for all other kilns. Despite that, its best practices have yielded tangible benefits. DBC has reduced particulate matter emissions from 796 kg/day in 2022 to just 4-10 kg/day by 2024; brought its specific energy consumption down to below 0.8 MJ/kg; and increased the share of high-quality Class I bricks from 80 per cent to over 90 per cent. Most significantly, these improvements are economically viable: the return on investment for key changes such as infrastructure upgrades and solar installation is achieved within one or two operational cycles.

DBC's example proves that a sustainable, low-emission and economically sound model for brick manufacturing is not only possible but replicable. If such best practices are widely adopted and supported through policies and incentives, the Indian brick manufacturing sector can transition towards a cleaner, more efficient and environmentally responsible future.

7. Conclusions and Recommendations

The CSE survey team's aim was to understand the key issues and challenges dogging the sector and the kind of policy ecosystem required to enable the sector to operate in a sustainable manner. Besides the on-ground surveys conducted on 128 kilns in 2025 and on 152 kilns in 2026, the team also communicated virtually with 60 kiln owners to know more about the support provided to them by regulatory authorities to help them comply with the CAQM guidelines.

Conclusions

Based on the responses received during the survey (*see Table 1*), the following conclusions can be derived:

No intimation about the coal ban from official agencies: Awareness about the coal ban, the survey team felt, was critical for the brick-making sector to start rethinking its operations. The surveyors tried to find out through which medium brick kiln owners came to know about the ban. None of the kiln owners in the survey received any intimation from CAQM or concerned pollution control boards regarding the coal ban: 40 per cent of the respondents came to know about the ban through media, while the remaining 60 per cent were informed through their union meetings.

No awareness-building and technical sessions conducted on alternate options for coal: All the respondents informed that no technical sessions were arranged by the CAQM or any regulatory body to explain to brick kiln owners how the industry can shift away from coal, and what are the alternative fuels available to replace coal.

Gas-based kilns non-existent in the survey location: All the respondents agreed that there are no gas-based kilns in Delhi-NCR. As far as CSE knows, there is only one live example of a gas-based brick kiln in the country – this is a tunnel-type brick kiln operated by M/s Wienerberger near Bengaluru in Karnataka. Worth about Rs 100 crore, this facility cannot be compared to normal Zig Zag brick kilns.

Low availability of gas infrastructure near brick kilns: Only 25 per cent of the respondents mentioned that gas infrastructure was available at a distance of 0.5-1 km in some areas; 75 per cent did not have any access to a gas pipeline.

No awareness-building sessions conducted on use and feeding of biomass fuel: All the respondents said no technical sessions were organised for them by CAQM on the usage and feeding of biomass fuel. Few of the respondents mentioned that only the Central Building Research Institute (CBRI) at Roorkee conducted one national training on the subject.

Questions about the quality of bricks made using biomass: All the respondents were of the opinion that coal is must to manufacture good quality bricks, as the calorific value and heat content of biomass is not sufficient to bake bricks. As per feedback from brick kiln owners, good bricks can be manufactured by blending at least 20-30 per cent of coal with 70-80 per cent biomass. One of the respondents also mentioned that technology using waste as fuel can be developed as there is no pollution when waste is burned at 800-1,000°C – this can also address the issue of waste management.

No financial incentives or schemes for supporting the shift to cleaner fuels: There is no financial support from the government for the sector for switching over to cleaner technologies and fuels. Brick kiln owners have invested in technology transformation on their own.

Challenges with loose biomass: Due to the limited space available in brick kilns, storage of loose biomass is a major issue. More manpower is required for handling the biomass; there are concerns of fire safety as well – dry and loose biomass can get ignited very easily. Since it becomes airborne quite easily, biomass needs to be stored under covers or in confined spaces – which need additional investments.

Low utilisation of pellets and briquettes: Low availability and quality and high cost are the reasons behind this, say more than 80 per cent of the respondents. The cost of pellets/briquettes can be 1.5-2 times more than loose biomass. The process also leads to more pollution due to the involvement of freight. There are no standards for quality for briquettes and pellets – at times, the products tend to have a larger percentage of soil (as high as 70 per cent) in their composition. If these briquettes and pellets get wet due to unseasonal rains, they become useless due to the increased moisture content in them, thus resulting in production loss for the units.

Table 1: Responses received during the CSE survey

Survey question	Yes	No
How did you come to know about the coal ban in Delhi-NCR? Was there any official communication received from CAQM/SPCB regarding this? (CAQM/Media/Communication from SPCB/Community Whatsapp)	0	100% <i>Respondents came to know either through the media, their union meetings or through whatsapp messages. No official communication was received from either CAQM or PCBs.</i>
Were any technical sessions arranged to explain the options available after the coal ban?	0	100%
Are there any gas-based kilns in NCR?	0	100%
Are there any gas-based kilns in other parts of the country?	0	100%
Is gas infrastructure available near kilns in your area?	25% Gas pipeline is available within 0.5-1 km range in areas like Charthawal (Muzaffarnagar) and Ananda (Pilkhuwa)	75%
Was any technical session on using biomass as a fuel organised by CAQM?	0	100% <i>No session was organised by CAQM. CBRI-Roorkee conducted a national-level training on this.</i>
Was any technical session on feeding biomass in kiln (in loose/pellet/briquette form) conducted?	0	100% <i>No session was organised by CAQM. CBRI-Roorkee conducted a training.</i>
Is it possible to produce good quality bricks using biomass as fuel?	0	100% <i>Respondents said that a blend of 20-30 per cent coal with 70-80 per cent biomass can result in good quality bricks.</i>
Has any scheme/financial instrument been announced to support the shift to cleaner fuels?	0	100% <i>No financial support received from the government.</i>
Are there any challenges with loose biomass storage?	92% Brick kilns have limited space – storage is a concern. More labour is required to manage loose biomass, which is prone to catching fire (due to workers throwing bidis carelessly after smoking) or getting airborne if not stored in a confined space, which again needs investment.	8%
Are you using pellets and briquettes?	16%	84% Availability and cost are the two major reasons for not using briquettes or pellets. Costs are almost 1.5-2 times more compared to loose biomass. Quality of available briquettes/ pellets is also an issue for those using them – there are no standards for their quality.

Overall, the survey and study concludes that the CAQM's ban on coal has come as a sudden and abrupt move for the sector. With no strategy prepared for enabling a seamless transition and no technical support offered to the sector to cope with the ban, the measure's efficacy may suffer.

This study also establishes the fact that there is no monitoring mechanism to check the implementation of the coal ban in the brick-making sector in Delhi-NCR. Neither has an assessment been done of the technical and financial challenges faced by brick kilns in switching over from coal to biomass as fuel. Involving specialised institutions like the CBRI, Roorkee or the Punjab State Council for Science and Technology could have resulted in better implementation of the directions and effortless transition.

The findings from two consecutive rounds of surveys paint a concerning picture of regulatory compliance in the brick kiln sector across Delhi-NCR. This is particularly significant because Delhi-NCR remains one of the most polluted regions in the country and has been the focus of continuous policy attention, judicial scrutiny and regulatory intervention for several years. Despite clear directions issued by the Commission for Air Quality Management (CAQM), including the prohibition on the use of coal in brick kilns across the NCR region, CSE's surveys found coal to be in widespread use across the surveyed districts. The surveys indicate that these directions continue to be openly disregarded, including in areas located in close proximity to Delhi. The persistence of coal use across both survey rounds suggests that regulatory requirements have not translated into effective implementation on the ground.



Sign board mentioning good quality coal made brick available

The findings also point to limited awareness of regulatory provisions among kiln operators and weak enforcement of existing directions. Taken together, the evidence from the surveys highlights a significant disconnect between regulatory mandates and field-level compliance, with little indication of a meaningful shift in practices during the survey period.

Recommendations

Provide technical assistance for shifting from coal to cleaner fuels: The shift to cleaner fuels involves modifications in existing systems, which would require specialised technical knowledge and expertise. There is a need for regulatory authorities to identify sector experts who could assist them in developing SOPs on technical modifications required while shifting to cleaner fuels, fuel-feeding mechanism etc.

Ensure that required product quality is met through cleaner fuel production: While it is important to switch over to cleaner fuels, this should be done without interfering with the product quality. Pilot interventions can be taken up by sectoral associations with the help of brick kiln owners to maintain the quality of the final product even while using biomass, briquettes etc.

Encourage public procurement and offer other incentives for bricks manufactured with cleaner fuels: Even as brick kilns are switching over from coal to cleaner fuels, it is imperative for the government to encourage public procurement and offer other incentive mechanisms to ensure that the bricks manufactured using cleaner fuels have sufficient market demand.

Put in place strategies to cease the supply of coal to kilns in NCR by targeting suppliers: There is a need to develop a monitoring mechanism to ensure that coal is not supplied to NCR. Identification of major coal suppliers in the region is important to curb coal consumption.

CAQM should work with technical institutions towards proper implementation of its mandates and directions and provide hand-holding support to the sector: Regulatory bodies need to work with technical institutes like the CBRI, Roorkee and the Punjab State Council for Science and Technology (PSCST) to hand-hold the sector to enable smooth transition. The PSCST, for instance, has already been involved in providing technical guidance and feasibility reports for technology conversion in brick kilns; it also conducts ground-level surveys to assess the quality of the conversion, and if satisfied, issues a Completion Certificate to the kiln.

Assess the adequacy of the design of kilns: State pollution control boards should conduct regular inspections of brick kilns to assess any variations in design of kilns with respect to the CTO issued to the unit. The boards can engage with technical institutions like the CBRI to conduct ground-level verification.

Introduce better policies and standards around improving the quality and supply of biomass as a fuel: While there are regulations that direct brick kilns on using biomass, it is important that policies should be drafted in a way to ensure stable supply of quality biomass fuel to the sector. The quality of pellets and briquettes needs to be standardised as well for upscaling their use in the kilns as well as in other industrial sectors.

Encourage use of C&D waste as raw material in brick manufacturing: Construction and demolition (C&D) waste is available in abundance. The CSIR-Central Building Research Institute (CBRI) has developed technologies for incorporating C&D waste, such as recycled aggregates, into brick manufacturing. This approach offers a sustainable way to manage C&D waste while reducing the demand for virgin raw materials at the same time.

Brick kilns that have adequate infrastructure should be allowed to operate throughout the year except in winter season: There are a number of brick kilns in Delhi-NCR which have invested cleaner technologies and systems and have developed adequate infrastructure for sustainable operations. These kilns should be considered for exemption from the restriction of four months of operations that has been mandated for the sector. They should be allowed to operate throughout the year except during winter. This will ensure viability of the cost incurred in transformation of the kiln. Also, it will encourage the kiln owners to develop better infrastructure and adopt sustainable practices in their units.

ANNEXURE

District-wise survey information

Parameter	Ghaziabad		Shamli	Baghpat		Bulandshahr	
	2025	2026	2025	2025	2026	2025	2026
Areas	Mathurapur, Shahpur Nij Morta, Kalchhina, Nagala Musa, Saunda, Modinagar, Kakra, Mahmudabad, Bhikanpur, Makraida, Bahadurpur	Ghaziabad, Mathurapur, Shahpur Nij Morta, Kalchhina, Nagala Musa, Saunda, Modinagar, Kakra, Mahmudabad, Bhikanpur, Makraida, Bahadurpur	Shamli, Darghapur	Baghpat, Dhikana, Luhari, Baraut Rural, Rajpur Khampur, Tyodhi	Baghpat, Baraut Rural, Biharipur, Dhikana, Ladwari, Luhari, Norozpur Goorja, Rajpur Khampur, Santoshpur, Saroorpur Kalan, Sisana, Tatiri, Tyodhi	Pali Badshapur, Naya Gaon, Mirzapur, Dhatoori, Mukimpur	
No. of kilns surveyed	31	39	8	22	35	18	18
Converted to zig-zag or not	Yes (31)	Yes (39)	Yes (8)	Yes (22)	Yes (35)	Yes (18)	Yes (18)
Coal use	Yes (27)	Yes (30)	Yes (7)	Yes (20)	Yes (29)	Yes (10)	Yes (11)
% of surveyed units using coal	87%	77%	88%	91%	83%	56%	61%
Loose biomass use	Yes (31)	Yes (39)	Yes (8)	Yes (22)	Yes (35)	Yes (18)	Yes (18)
Use of other fuels	Yes (6)	Yes (9)	Yes (1)	No (0)	No (0)	Yes (1)	Yes (1)
Which other fuels are in use	Wood (5), Waste (1)	Wood, Waste	Wood (1)	-	-	Wood (1)	Wood (1)
Are port holes, ladders and platforms available?	Yes (31)	Yes (39)	Yes (8)	Yes (22)	Yes (35)	Yes (18)	Yes (18)
Is the platform safe for conducting monitoring?	Yes (7), No (24)	Yes (13), No (26)	Yes (3), No (5)	Yes (4), No (18)	Yes (10), No (25)	Yes (10), No (8)	Yes (11), No (7)
Green cover?	Sparse (5), No (26)	Sparse (7), No (32)	Sparse (3), No (5)	Sparse (1), No (21)	Sparse (3), No (32)	Sparse (4), Yes (1), No (13)	Sparse (5), Yes (2), No (11)

Parameter	Jhajjar		Panipat		Sonipat	
	2025	2026	2025	2026	2025	2026
Areas	Mehrana, Agarpur, Jhajjar, Tatarpur, Bhadani	Agarpur, Bahadurgarh, Bhadani, Daboda Khurd, Jhajjar, Mehrana, Mehrana-n, Tatarpur	Jondhan Khurd, Palri, Diwana, Manana		Murthal Khas	
No. of kilns surveyed	31	40	15	17	3	3
Converted to zig-zag or not	Yes (31)	Yes (40)	Yes (15)	Yes (17)	Yes (3)	Yes (3)
Coal use	Yes (27), No (4)	Yes (33), No (7)	Yes (6)	Yes (8)	Yes (1)	Yes (1)
% of surveyed units using coal	87%	83%	40%	47%	33.33%	33.33%
Loose biomass use	Yes (31)	Yes (40)	Yes (15)	Yes (17)	Yes (3)	Yes (3)
Use of other fuels	Yes (2)	Yes (2)	No (0)	No (0)	No (0)	No (0)
Which other fuels are in use	Wood (2)	Wood (2)	-	-	-	-
Are port holes, ladders and platforms available?	Yes (31)	Yes (40)	Yes (15)	Yes (17)	Yes (3)	Yes (3)
Is the platform safe for conducting monitoring?	Yes (19), No (12)	Yes (24), No (16)	Yes (2), No (13)	Yes (3), No (14)	Yes (1), No (2)	Yes (1), No (2)
Green cover?	Sparse (4), No (27)	Sparse (6), No (34)	Sparse (4), No (11)	Sparse (5), No (12)	Sparse (1), No (2)	Sparse (1), No (2)

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The brick-making industry in Delhi-NCR remains a significant source of pollution despite regulatory mandates promoting cleaner technologies and fuels. While most surveyed kilns have shifted to Zig-Zag technology, many conversions are structurally deficient, resulting in heat loss and reduced efficiency. Despite restrictions, coal use remains widespread, often through blending with biomass, revealing gaps between regulatory requirements and on-ground practices.

The survey also highlights inadequate green cover, poor road infrastructure contributing to dust emissions, and structural modifications aimed at extending kiln operations. Industry stakeholders cite technical and logistical challenges in achieving full compliance. The findings underscore the need for stronger implementation, technical support and sustained engagement to enable a cleaner transition in this largely unorganised sector.



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