Policy Brief

How Delhi is losing its Cool: **Heat and rising demand for cooling and electricity consumption**

2025

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The spotlight

Delhi stands at the forefront of the urban climate-energy nexus, where intensifying summer heat and humidity are increasing cooling demand and electricity consumption. The city's summers are no longer defined by predictable seasonal curves of temperature and demand; instead, they now unfold as a volatile interaction of heatwaves, erratic rainfall, humidity, and surging dependence on mechanical cooling.

The Centre for Science and Environment (CSE) explores this insidious link between ambient heat and humidity conditions and electricity consumption in Delhi. It investigates to show how the city's energy consumption responds to temperature changes, relative humidity, and land surface heating, and quantify how that impacts electricity consumed. It further attempts to identify the threshold of thermal comfort defined through the heat index beyond which demand begins to surge sharply as cooling devices are switched on across the city. Heat and humidity stress increase active cooling demand and that has a direct bearing on electricity consumption. Electricity consumption becomes the near real-time reflection of heat stress.

This study shows how increase in peak electricity demand is now occurring earlier, and persisting longer. But Delhi's deadly dilemma is not only the high heat during the pre-monsoon months, but also the high humidity during monsoon months causing sharp increase in heat index (combination of heat and humidity). This is when the heat index goes beyond the threshold of thermal comfort to surge sharply as cooling devices are switched on across the city. This leads to sharper surge in electricity consumption that is also straining grid reliability. Delhi has hit the second highest peak demand for electricity after 2024 summer.

Moreover, warmer nights due to inadequate dissipation of heat accumulated during the day, is causing prolonged heat exposures increasing public health risks. This needs urgent action to address growing concretization, inadequate urban greens and water bodies, lack of thermal comfort in buildings, inadequate cooling shelters, waste heat from air conditioners and vehicles, that are making our cities hotter while climate change is making temperature and humidity trends more erratic.

A moderate heat index range of 31–32°C is noticed during pre-monsoon months of March to May and then a sharp rise above 46 –50°C during June-August. This explains why cooling and electricity demand remain elevated in monsoon months despite rainfall. Moreover, during the monsoon months in 2025, the daytime and nighttime land surface temperatures (LSTs) have risen by about 2.1 °C and 3.0 °C respectively compared to 2024 while the day–night cooling difference has narrowed down thus reducing the cooling window. This is adding to the heat distress. Notably, April 2025 registered higher electricity consumption than April 2024, reflecting a much warmer start to the summer this year.

This new assessment is a continuum of CSE's earlier analyses in 2018, 2019, and 2020 that had also highlighted the impact of heat stress on electricity demand in the city. In June 2018, CSE's report *Power Pangs* had noted a then record peak of 6,934 MW. By May–June 2019, as reported in the report *A Midsummer Nightmare*, Delhi's peak load was nearly 25 per cent higher than the previous summer, with night-time demand rising faster than day-time peaks. Even during the subdued summer of July 3, 2020, *Power and the Pandemic* recorded a peak of 6,305 MW despite the city being under lockdown. The combined impact of heat and humidity were playing their role.

Data and methodology

The study is based on comparative statistical analysis of air temperature, electricity demand, land surface temperature, heat index and humidity condition observed in Delhi from 2021- 2025. The study's definition of summer is the period from March to August. It is furthered divided into pre-monsoon (March-May) and monsoon (June-August) as per IMD classification. This is based on publicly available datasets from various national and global agencies.

Time frame of the study: 1 January 2021 to 25 August 2025. The analysis presented in this report integrates multiple datasets—real-time electricity demand, weather observations, land surface temperature, and computed heat index to provide an evidence-based understanding of how Delhi's power consumption has evolved under intensifying heat stress. By correlating meteorological conditions with electricity use, it identifies the thresholds at which demand begins to escalate, quantifies the loss of natural cooling, and demonstrates how summer demand is increasingly spilling over into months once considered relatively mild.

Electricity data: Real time electricity consumption data of 5-minute granularity has been sourced from the State Load Dispatch Center, Delhi, which ensures integrated operation of Delhi's power system. This data is publicly available. Historical data has been sourced from the Annual, Power Supply and Load Generation Balance Reports of the Central Electricity Authority.

Weather data: The weather data including air temperature and relative humidity have been sourced from the CPCB's CAAQMS network. Delhi has 39 CAAQMS stations. But quality of weather data is not consistent all across, as weather monitoring is not the primary objective. After careful assessment of quality of available weather data from these stations, 24 stations that have most consistent data starting from January 2021 were selected and considered. These stations include Alipur, Anand Vihar, Ashok Vihar, Bawana, Dr Karni Singh Shooting range, Dwarka Sector 8, Jahangirpuri, JLN Stadium, MDC National Stadium, Mandir Marg, Mundka, Najafgarh, Narela, Nehru Nagar, Okhla Phase 2, Patparganj, Punjabi Bagh, Pusa DPCC, RK Puram, Rohini, Sonia Vihar, Sri Aurobindo Marg, Vivek Vihar, and Wazirpur.

These stations are geographically well distributed across in Delhi and cover rural, urban, residential, commercial, and industrial areas within Delhi. Mean of the observations form these stations has been considered representative of weather condition in Delhi. In addition, freely available MODIS Land Surface Science data from NASA Earth Observations has been used to capture seasonal variations in land surface temperature.

Heat index has been used instead of absolute air temperature as a measure of external thermal conditions. Heat index is a measure of how hot it really feels when relative humidity is factored in with the actual air temperature. Heat index has been computed using formula given the United States National Oceanic and Atmospheric Administration (NOAA) in their National Weather Service Technical Attachment (SR 90-23).

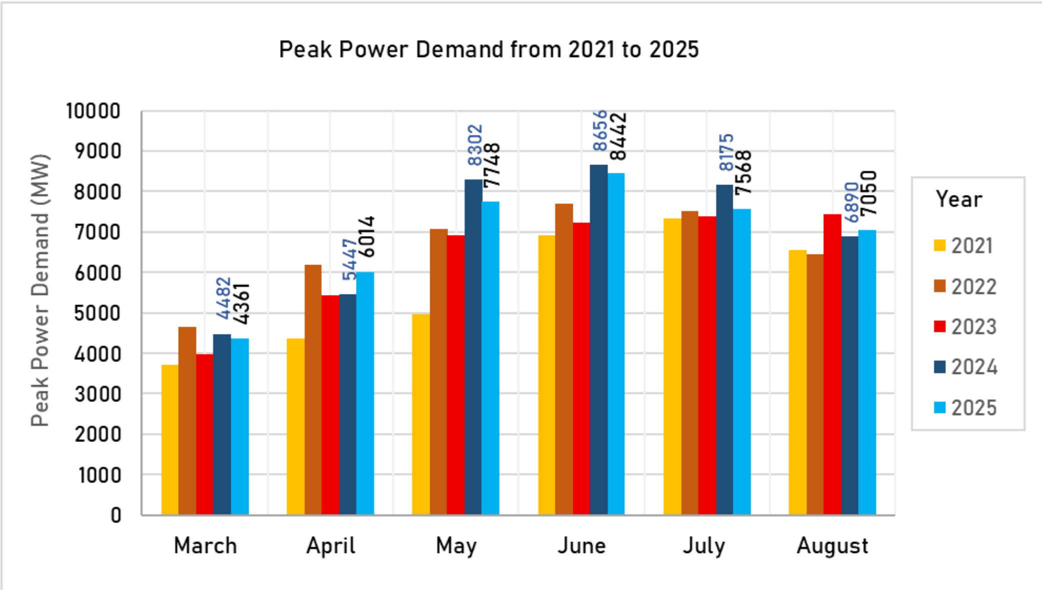
Key Findings

Heat stress increases electricity demand during summer

Summer temperature regime, relative humidity, heat waves, and growing heat stress lead to significant increase in cooling demand that impacts electricity demand. During the summer of 2025, power needs jumped by nearly 40 per cent between March and April alone. Peak demand alone rose by 567 MW (+10.4 per cent), reflecting higher cooling requirements during the warmer than usual start to summer (s*ee Graph 1: Trend in Peak power demand from 2021- 2025).* Energy consumption follows a similar pattern, climbing from about 2,200–2,300 MU in March to well over 4,500 MU in June.

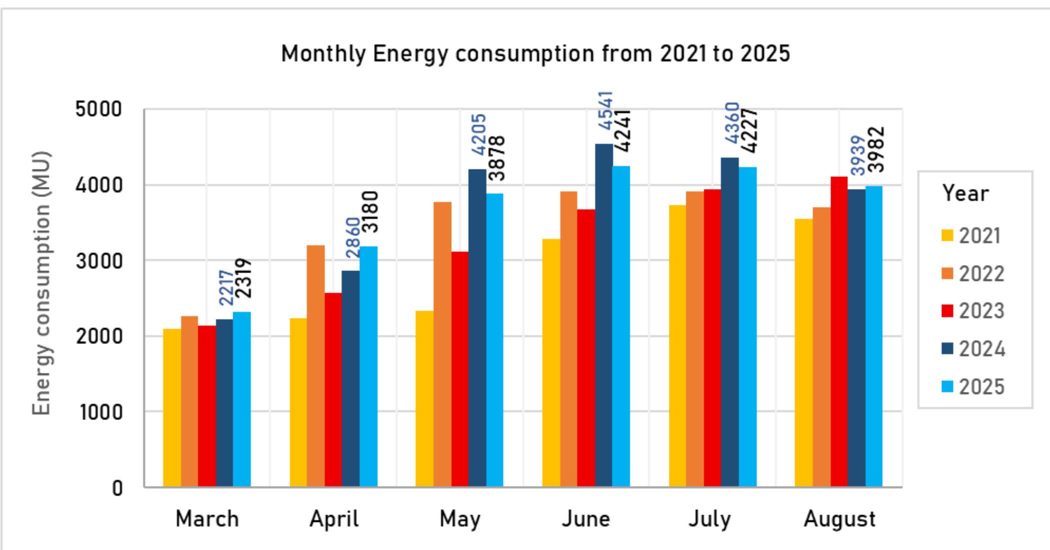
March 2025 recorded a moderate growth of 4.6 per cent in overall energy use compared to March 2024, yet peak power dipped slightly. In August 2025, peak demand rose to 7,050 MW (recorded on 8 August), about 2 per cent higher than the previous year. *(see Graph 2: Trend in energy consumption from 2021- 2025).*

Graph 1: Trend in Peak power demand from 2021- 2025



Source: Load Generation Balance Reports of the Central Electricity Authority

Graph 2: Trend in energy consumption from 2021- 2025



Source: Load Generation Balance Reports of the Central Electricity Authority

The trend in 2025 summer is quite consistent with what has been noted in previous years:

2022 summer: May recorded a stunning 62 per cent surge in energy demand over the previous year, the sharpest jump in five years. The load curve no longer dropped sharply with the arrival of the monsoon. July, once a month of relief, is increasingly carrying forward the stress. In 2022, demand slipped as rains cooled the city. Even August, once considered the tail-end of the high-demand season showed unexpected turns. In 2022, demand eased as monsoon showers took hold.

2023 summer: In 2023, it crept up again, crossing 7,400 MW, as lingering heat and humidity delayed the relief that the city usually expects by then. May 2023 saw demand fall by 17 per cent, highlighting how quickly electricity use can swing with changes in temperature, rainfall, and economic activity. The July peak had bounced back strongly, even overtaking June, as humidity kept air conditioners running. The pattern grew sharper in 2024, with July demand climbing close to June levels, reflecting the late arrival of rains that prolonged the heat.

2024 summer: May typically exerted the greatest stress on the system. In 2024, peak demand touched 8,302 MW, nearly double March's level. But in 2025, early spells of rain lower the month's intensity, keeping demand about 7 per cent lower than the year before. The real pressure, however, has shifted into June. In 2024, the city saw its highest-ever peak of 8,656 MW. Even with wetter conditions in 2025, the June peak still crossed 8,400 MW, showing that early summer cooling needs are now deeply entrenched. In August 2024, peak demand touched 6,890 MW.

Worsening impact of relative humidity on heat stress and power demand: Pre-monsoon vs Monsoon effect

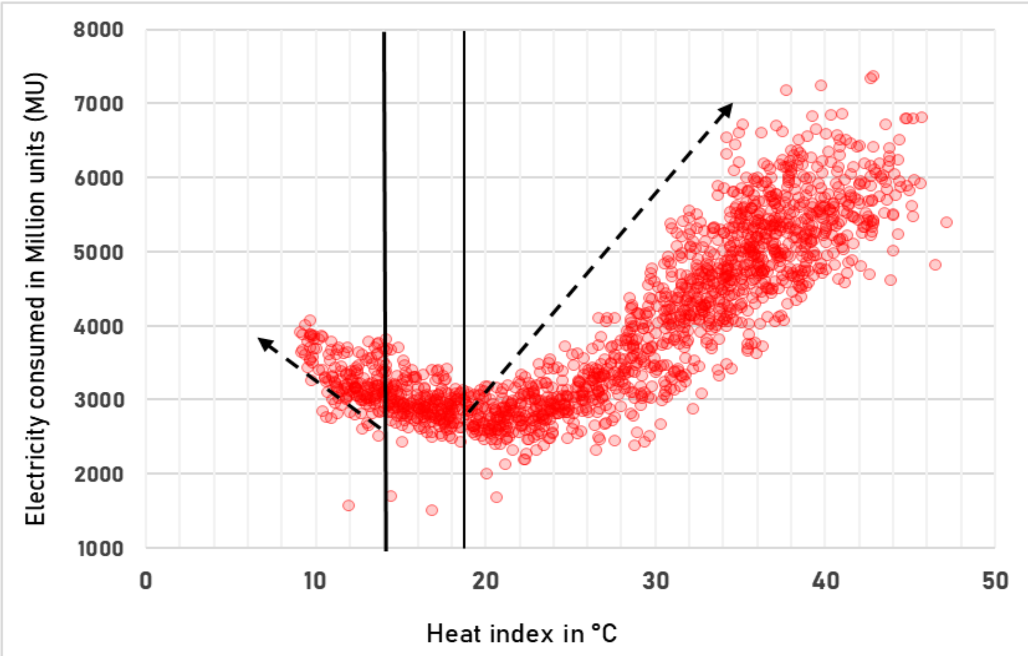
While rising ambient temperature is expected to increase demand for cooling and electricity consumption, this summer has also demonstrated that relative humidity worsens heat stress and worsens the trend. This is reflected in the heat index that determines how it feels like to the human body when relative humidity is combined with the air temperature. It is the "feels-like" temperature which is an important consideration for the human body's comfort. An analysis of heat index from the last five years (2021-2025) shows the impact of these conditions on the city's power consumption.

During the monsoon, however, high humidity drastically elevates the heat index even when air temperatures are lower. In July and August, Delhi often records heat index values above 46 –50°C, creating conditions that are stifling and oppressive. The city's demand patterns confirm this: electricity consumption remains high well into the monsoon, reflecting how humidity-driven discomfort continues to drive demand. Statistical analysis shows that about 67 per cent of daily peak electricity demand in Delhi can be explained by variations in heat index, while the rest depends on socio-economic and behavioral factors.

This clearly brings out that the power consumption remains steady, as long as the daily heat index remains in the 31–32°C range. During the pre-monsoon period, when humidity levels are moderate, electricity demand begins to climb steeply once the heat index crosses 31–32°C. This represents the broad tolerance threshold beyond which residents turn to cooling devices. This is what is largely noticed during the pre-monsoon months (March–May), when Delhi's heat index generally stays below 40°C. Even though the cooling demand increases during this range, it is not to the extent that is noticed once the heat index crosses the 31–32°C sweet spot.

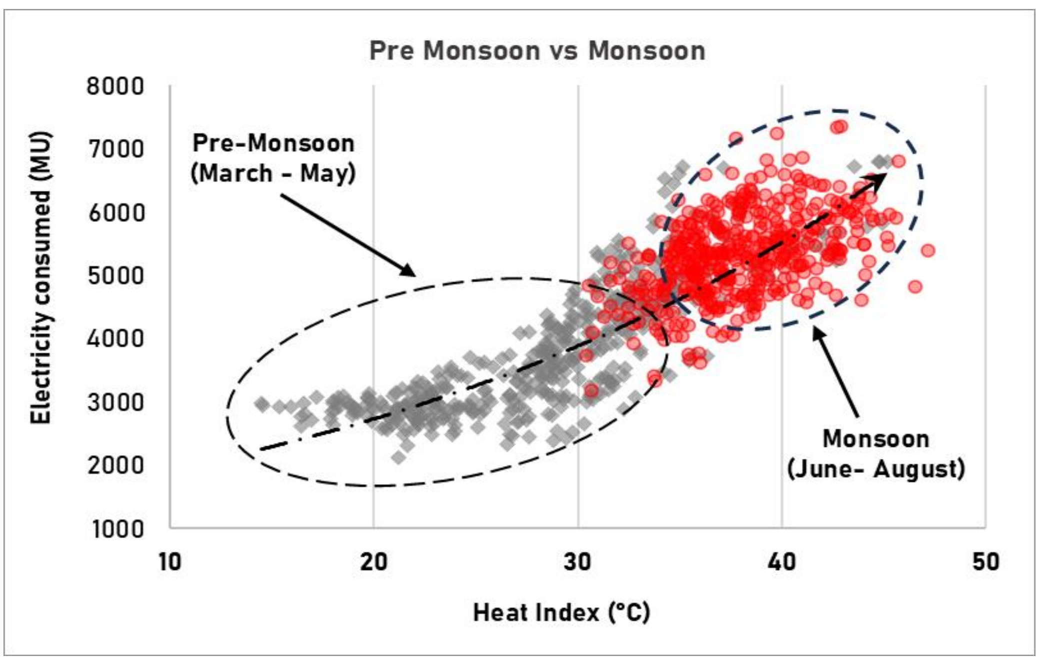
With the arrival of the monsoon (June–August), high relative humidity pushes the heat index up to 46–50°C, even when actual air temperatures are lower. This makes the weather feel much more oppressive and drives a sharper surge in electricity consumption as cooling systems work harder and longer. This explains why demand remains elevated in monsoon months despite rainfall and cloud cover the combined effect of heat and humidity keeps the city energy-hungry. The relationship between weather and electricity consumption forms an asymmetric U-shaped curve *(see Graph 3: Correlation between daily average heat index and average daily power demand (2021–2025) and Graph 4: Delhi's electricity demand in response to thermal discomfort (Pre-Monsoon vs Monsoon)).*

Graph 3: Correlation between daily average heat index and average daily power demand (2021–2025)



Note: Heat index has been calculated using the U.S. National Oceanic and Atmospheric Administration formula. Data is from Jan 1, 2021 to Aug 25, 2025. Data till 25 Aug, 2025.
Source: CSE analysis of real-time power demand data from State Load Dispatch Centre, Delhi and weather data from CPCB.

Graph 4: Delhi's electricity demand in response to thermal discomfort (Pre-Monsoon vs Monsoon)



Note: Heat index has been calculated using the U.S. National Oceanic and Atmospheric Administration formula. Data is from Mar – August for period 2021- 2025. Data till 25 Aug, 2025.
Source: CSE analysis of real-time power demand data from State Load Dispatch Centre, Delhi and weather data from CPCB.

August has been the peak demand month

The analysis of August peak demand shows how the city's electricity stress is no longer confined to May–June alone, but is now spilling deeper into the monsoon months. In August 2025, the average peak demand was about 2 per cent higher compared to August 2024, despite wetter conditions this year. Nearly half of the days in August 2025 (16 out of 31) recorded higher peak demand than the same days in 2024.

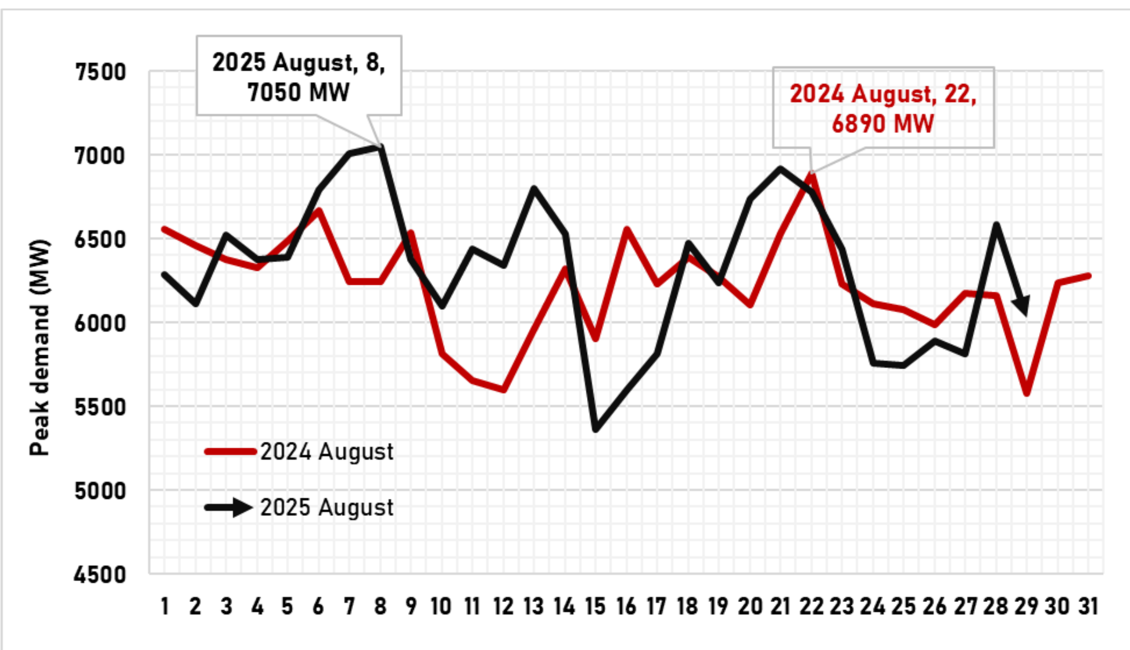
The pattern of the demand curve also shows a clear shift. In 2024, it moved within a relatively narrower band, with one clear high point on 22 August (6,890 MW). In contrast, 2025 shows a much more pronounced and sustained upward movement, peaking early on 8 August (7,050 MW) and maintaining higher values across multiple days *(see Graph 5: Peak electricity demand in August (2024 vs 2025)).*

The 2025 curve is less stable and more elevated, reflecting how humidity-driven discomfort during monsoon has extended the duration and intensity of high electricity use. August is increasingly behaving like a peak summer month, with rising demand loads that stretch the grid beyond its traditional summer stress period.

The city's peak power demand closely mirrors daily weather patterns. The study found that daily peak demand has a strong correlation (0.82) with the heat index. In other words, when the weather feels hotter and more humid, power demand rises almost in lockstep.

A statistical analysis (R-squared of 0.67) further shows that 67 per cent of the variation in Delhi's daily peak electricity demand can be explained by how hot and humid it feels outside. The remaining share (about one-third) is influenced by other factors such as economic activity, time of day, or household appliance use.

Graph 5: Peak electricity demand in August (2024 vs 2025)



Source: CSE analysis of real-time power demand data from State Load Dispatch Centre, Delhi.

Warmer nights - Land Surface Temperature and the weakening of Night-time cooling in City

This analysis once again confirms that the nights are getting warmer and losing its natural cooling efficiency. The much-needed night-time relief is steadily reducing, especially during the pre-monsoon and monsoon seasons. Despite abundant rainfall this year, cities continue to struggle to cool down at night.

During the pre-monsoon months of March to May, the city once experienced a significant drop of nearly 15°C from day to night, based on the average between 2001 and 2010. In 2025. However, this decline has reduced sharply to just 8.6°C, making a 42 per cent loss in cooling. Night-time land surface temperatures in this period now average 22.8°C, notably higher than the long-term baseline of 20.4°C *(see Graph 6: Trend in pre-monsoon land surface temperature (2021-2025)).*

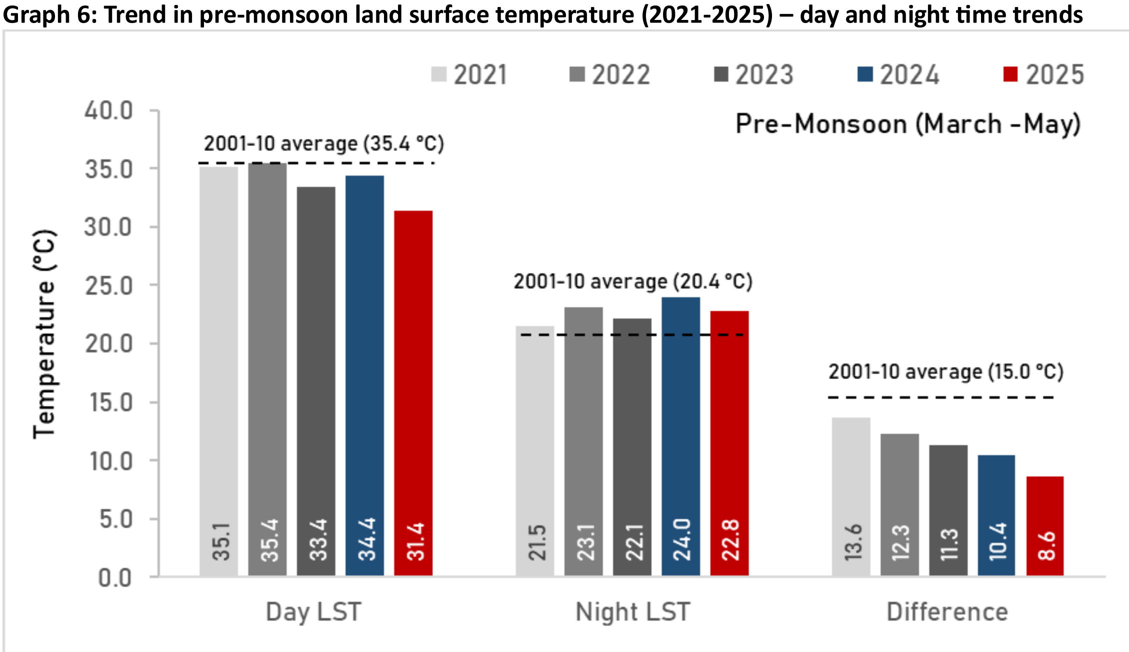
Notably, the 2025 demand peak occurred at night (11:09 PM), a departure from the usual afternoon surges seen in most years. Cooling demand at night is shifting the peak pattern.

During the monsoon season, between June and August, the average night-time cooling of 9.6°C that was observed in the earlier decade, has dropped to only 5.6 °C in 2025, again, a 42 per cent decline. Night-time temperatures during this period have touched 30.6°C, which is nearly 6°C warmer than the baseline average of 2001–2010.

The daytime and nighttime LSTs have risen in 2025 compared to 2024 by about 2.1 °C and 3.0 °C respectively. At the same time, the day–night cooling difference has narrowed by another 0.9 °C, pointing to a dual challenge of hotter days as well as warmer nights, with an increasingly reduced cooling window (*see Graph 7: Trend in monsoon land surface temperature (2021-2025)).*

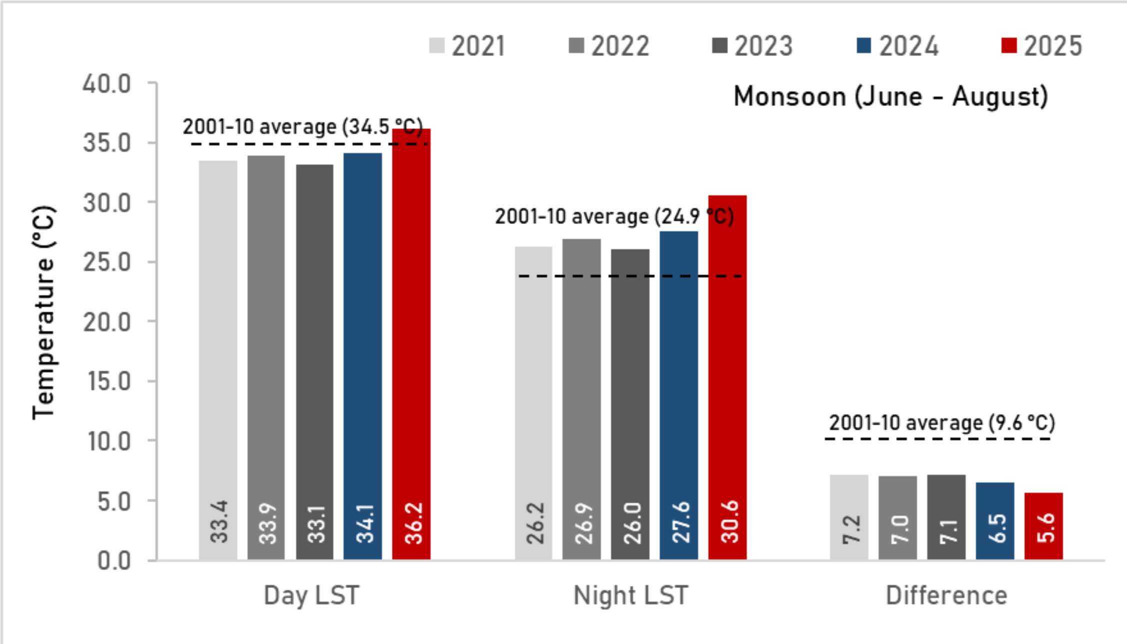
This weakening of nocturnal cooling has severe implications. Scientific studies have shown that rising night-time temperatures are among the most dangerous aspects of climate change because they prevent the human body from recovering from daytime heat stress [i],[ii]. In Delhi, this is reflected not only in health risks: dehydration, exhaustion, heat strokes but also in energy use.

Graph 6: Trend in pre-monsoon land surface temperature (2021-2025) – day and night time trends



Note: Pre-monsoon refers to the months of March, April and May. * Data from 2021-2025.
Source: CSE analysis of monthly MODIS Land Science data from NASA Earth Observations.

Graph 7: Trend in monsoon land surface temperature (2021-2025): Day and night time trends



Note: Monsoon refers to the months of June, July and August. Data from 2021-2025. Data till *20 Aug 2025.
Source: CSE analysis of monthly MODIS Land Science data from NASA Earth Observations.

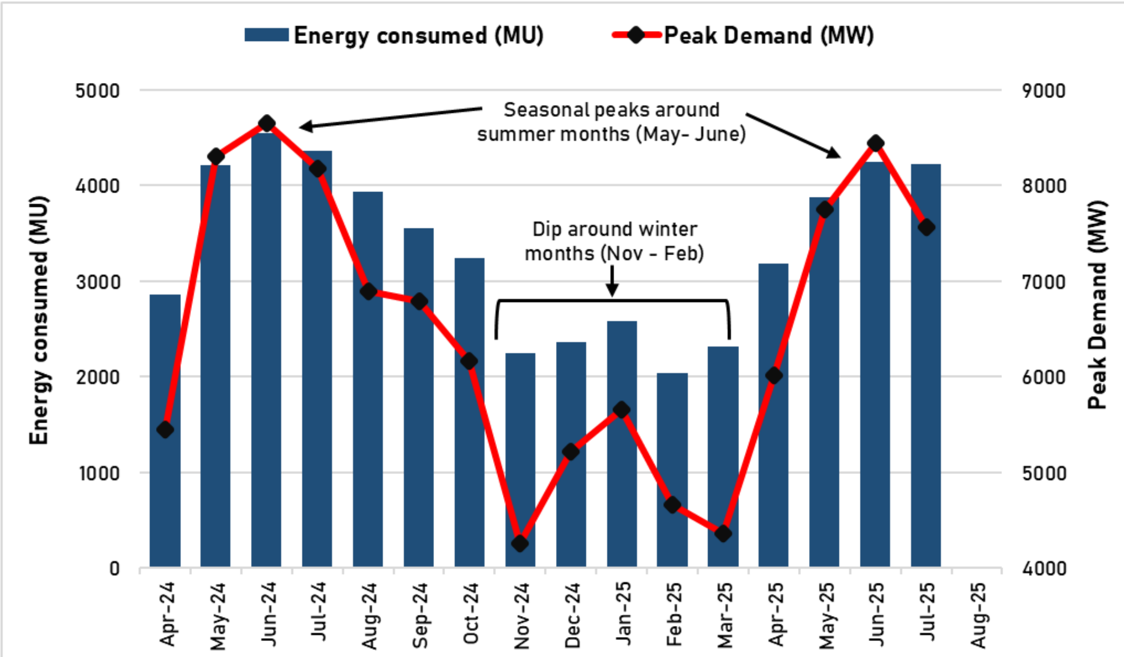
Summer vs winter: Electricity demand shows extreme seasonal swings, with April 2025 setting an early summer surge:

Delhi's electricity consumption continues to reflect a highly seasonal trend, with sharp peaks during the scorching summer months and significant dips through the winter season. Between April 2024 and July 2025, the city's peak demand touched an all-time high of 8,656 MW in June 2024, with energy consumption peaking at 4,546 MU in the same month.

In contrast, the winter period of November 2024 to February 2025 saw demand fall to nearly half of those summer highs. The peak demand fell to just 4,259 MW in November 2024, marking a 51 per cent decline compared to June 2024. Similarly, energy consumption dropped to 2,041 MU in February 2025, almost 55 per cent lower than the June 2024 peak *(see Graph 8: Delhi's monthly electricity consumption and peak power demand (2024-25)).* Delhi's grid comes under maximum stress during May, June, and July.

Notably, April 2025 registered higher electricity consumption than April 2024, reflecting a much warmer start to the summer this year. In fact, April 2025 demand alone had already reached nearly 69 per cent of the June 2024 summer peak, showing how sharply heat conditions advanced this year. This upward trajectory continued into June 2025, when demand climbed back close to record highs, touching 8,442 MW.

Graph 8: Delhi's monthly electricity consumption and peak power demand (2024-25)



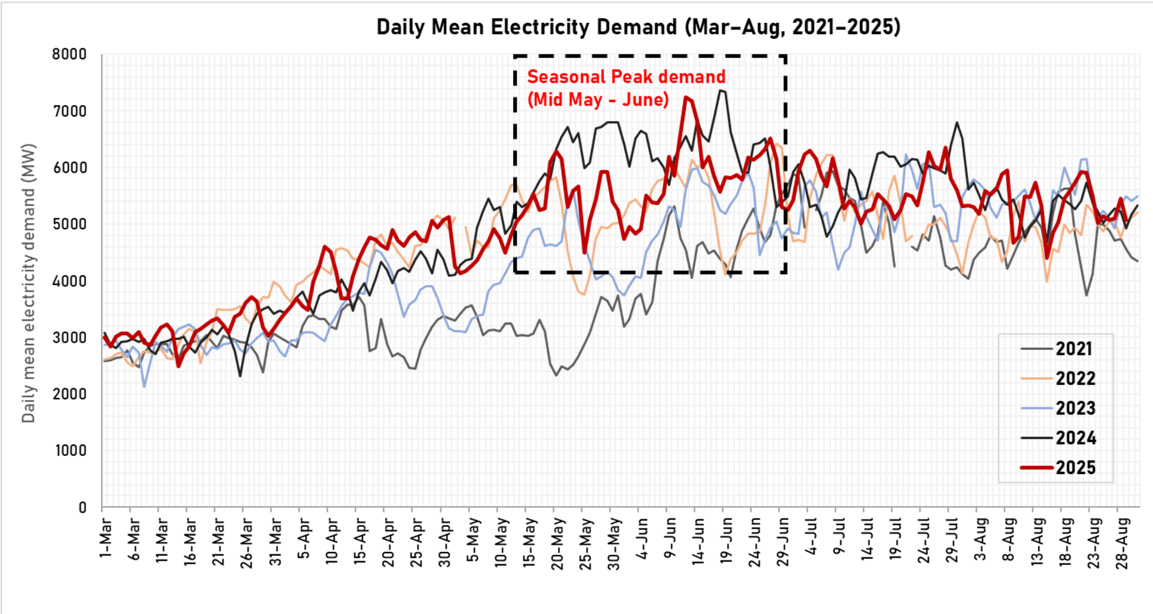
Source: Load Generation Balance Reports of the Central Electricity Authority and Real-time Monitoring data from State Load Dispatch Centre, Delhi

Erratic weather trends impact summer temperature regime

The broader trend over the years shows electricity demand rising year after year that is not only impacted by the weather but also the overall economic growth and changing lifestyle. The peak values have frequently crossed 6,000–7,000 MW during 2024 and 2005 summer compared to the previous period of 2021–2023. The demand in April 2025 was higher than April 2024, signaling a hot start to the summer *(see Graph 9: Daily mean electricity demand from March to August across five years (2021–2025)).*

While 2025 summer has recorded consistently high demand levels, the May–June peak remained slightly below that of 2024. This is explained by the weather pattern. The El Nino-driven summer of 2024 brought hotter, drier conditions, intensifying cooling needs, whereas 2025 saw more rainfall across most months leading to marginal decline in temperature.

Graph 9: Daily mean electricity demand from March to August across five years (2021–2025)



Source: CSE analysis of Real-time Monitoring data from State Load Dispatch Centre, Delhi. *Data till 28 Aug, 2025

Delhi hits second highest peak demand for electricity after 2024 summer

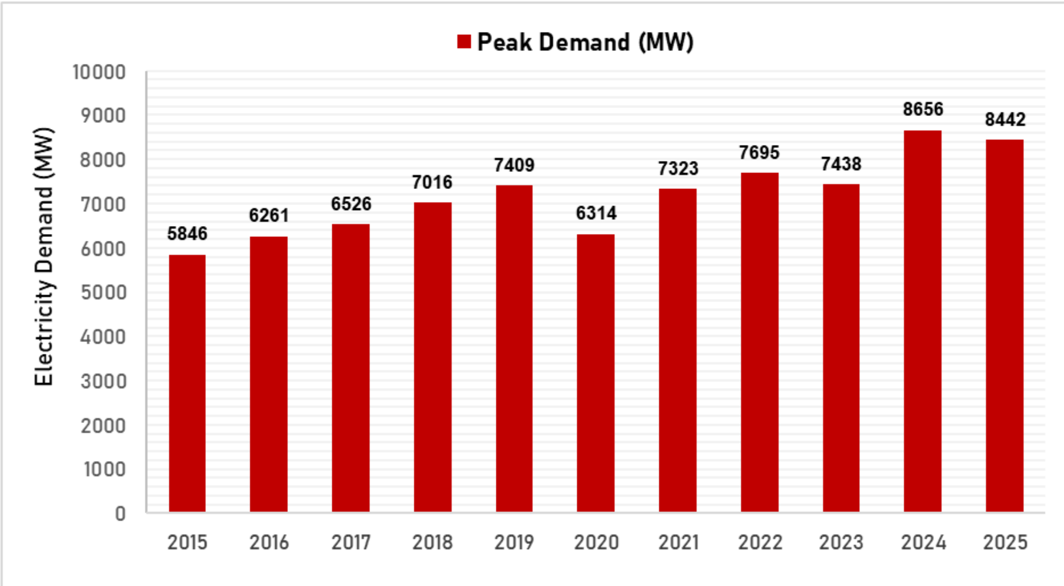
Delhi's electricity demand touched 8,442 MW on June 12, 2025, at 11:09 PM, marking the second highest peak ever recorded in the city. This was only 2.5 percent lower than the all-time high of 8,656 MW reached last summer on June 19, 2024. Between 2015 and 2025, Delhi's peak electricity demand has risen from 5,846 MW to 8,442 MW, reflecting a staggering 44 per cent increase in just a decade *(see Graph 10: Delhi's peak electricity demand from 2015 to 2025).*

Across the decade, peak demand has almost always occurred in June and July, except in 2023 when it shifted unusually to late August. The data also reveals sharp year-on-year variations driven by weather, population growth, and economic activity.

The sharpest seasonal spike came in 2024, when peak power demand shot up by 16.4 per cent, followed by another record surge in 2021 (16 per cent), showing how extreme summers push Delhi's grid to the brink. In contrast, 2020 marked a rare dip in peak load by 14.8 per cent from its previous year, as pandemic lockdowns temporarily suppressed power consumption.

The highest ever demand of 8,656 MW in June 2024 was amplified by the weather phenomenon, which triggered intense and prolonged summer heat across north India. In comparison, 2025 saw more widespread rainfall, keeping daytime temperatures in check and moderating overall electricity usage, though the grid still remains under mounting stress.

Graph 10: Delhi's peak electricity demand from 2015 to 2025



Source: Load Generation Balance Reports of the Central Electricity Authority

Delhi mirrors the national crisis

Delhi's experience reflects the national crisis. According to the International Energy Agency (IEA) study of 2023[iii] temperatures have risen steadily in India, advancing the onset of summer forward by at least one month, combined with frequent and intense heat waves. This along with growing ownership of air conditioners, peak electricity demand has grown on an average of 4 per cent annually over the last decade. Cooling demand increases sharply when the average daily temperatures cross 25 degree C [iv]. Peak electricity demand is expected to rise by around 60 per cent from 2022 levels by 2030, with cooling accounting for almost half of this increase.

Already, space cooling accounts for about 10 per cent of national electricity use, with demand rising by 21 per cent between 2019 and 2022. According to the IEA every 1 °C rise in the average daily temperature above 24 °C drives a 2 per cent increase in electricity demand in India.[v] Before 2019, only 1 in 10 households had access to an air conditioner, while 24 per cent households owned either an evaporative air cooler or air conditioner in 2021. This has increased electricity consumption by 21 per cent between 2019 and 2022. Currently, nearly 10 per cent of electricity demand comes from space cooling requirements. But heat exposed vulnerable sections cannot access adequate means for cooling and require other means to improve thermal comforts of their dwellings.

Way Forward

Growing heat stress due to climate change is a reality in Delhi and this reflects the growing challenge in other cities and regions as well. There is an urgent need for Delhi and other regions to rethink its approach to managing intensifying summer heat, heat index and the growing electricity burden with both short and long term measures. Electricity demand peaks precisely when people are most at risk from extreme heat. This requires strategies for building resilience. Electricity demand has become a sensitive marker of heat stress. It is necessary to reduce exposure to heat while managing the energy footprint of cooling.

- **The heat action plans need stringent compliance framework for implementation of the thermal comfort measures in buildings:** This requires binding and mandatory implementation of the regulations related to energy efficiency and thermal comfort requirements in buildings including Energy Conservation Building Code, and Eco-Niwas Samhita, Standards and Labelling of appliances, district cooling systems among others, and adoption of passive cooling solutions including passive architectural design, reflective surfaces, shading, natural ventilation, better insulation and adoption of energy efficient cooling technologies in buildings. Adopt cooling as a service model.

Implement thermal comfort measures in affordable housing and create cooling shelters of low-income groups and build awareness on management of heat stress for all income categories**.**

- **Expand urban green and water bodies and increase permeability by reducing concrete surfaces to reduce the urban heat island effect.**
- **The heat action plans need to acknowledge the link between the heat index and peak electricity load and integrate climate and heat-related indicators into power system planning**: This requires forecasting models based on weather data with real-time demand to help power operators to anticipate peak surges more accurately and prepare for it, improve grid stability, and ensure reliable supply of power when it is most needed. Ensure uninterrupted power supply especially for essential services. The regions will require better load balancing and easing of grid strain during high-demand hours.

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