ANATOMY OF A VICIOUS CYCLE

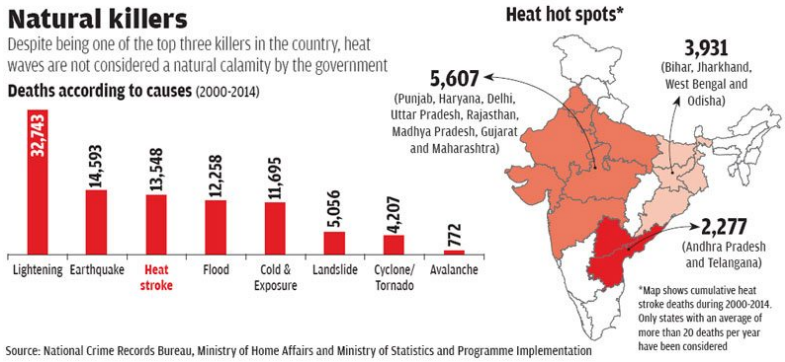
By **panchali ganguli** - June 26, 2019

The hotter it gets, the more power we use to run our ACs. And this, in turn, puts all our climate change mitigation and energy security actions in the red

What is the solution? India must design its buildings and cities for thermal comfort and work to minimise the use of mechanical cooling systems, says CSE's new study – A Midsummer Nightmare.

Study is based on eight-year trend analysis of electricity consumption in Delhi.
Finds that power demand does not increase noticeably when the heat index is within 25-32oC.
Demand starts peaking after this point is breached due to high and inefficient use of air conditioning.
Average electricity consumption in Delhi during the peak heat wave days of June 7-12, 2019

increased by 25 per cent compared to the season's average.This trend is expected to worsen nationally as the heat index and climatic stress are continuously increasing.



Study says in Delhi 25-30 per cent of annual energy consumption is because of thermal stress. During peak summers, it is as much as 50 per cent.
If urgent steps are not taken to design buildings for thermal comfort and reduce dependence on mechanical cooling, the energy budget can spiral out of control with huge economic and environmental costs.
The National Cooling Action Plan also says that thermal comfort standardsare needed for all buildings– including those in the affordable housing sector.

As severe summer-time heat waves become the norm in India, the use of air-conditioners (ACs) and resultant energy consumption have started hitting the roof. If every household in India ran an AC for seven months a year, the total electricity required would be 120 per cent higher than the total electricity produced in the country during 2017-18. In this scenario, all the plans India has on energy security and climate change mitigation are bound to fall by the wayside – unless the country takes urgent steps towards designing buildings that ensure thermal comfort and reduce the use of ACs and other mechanical cooling devices. This is the argument offered by Centre for Science and Environment's (CSE) new report on thermal cooling, released .

CSE has studied the trends – over eight years — in electricity consumption in Delhi.Its analysis shows that power demand barely changes when the heat index (a measure of temperature and humidity) is within 25-32oC – it spirals out of control the moment this range is breached. Says CSE executive director (research and advocacy) Anumita Roychowdhury: "If the growing discomfort due to increasing heat is not addressed with wide-ranging architectural design solutions, mixed use of cooling approaches (including less energy-intensive devices like fans) and improved energy efficiency of mechanical cooling methods, India's energy security and climate

change mitigation efforts will be deeply undermined."

The CSE report points out that this situation can nullify the goals of India's Cooling Action Plan (ICAP) released this year. India is already facing an energy crisis where urban penetration of air conditioning is 7-9 per cent, and domestic demand for electricity is 24.32 per cent of the total electricity consumption in 2016-17 (as per the India Energy Statistics Report 2018).

Says Rajneesh Sareen, programme director, Sustainable Habitat team in CSE: "Demand for space cooling in buildings is expected to explode and upset the energy budget of India. Cooling energy consumption in buildings is likely to double in the next decade and become nearly four times in the next two decades compared to the 2017-18 baseline."

Avikal Somvanshi, the report's author and programme manager with the Sustainable Habitat team, points out that the Bureau of Energy Efficiency (BEE)has forecasted that the total connected load in India due to air conditioning alone will be about 200 GW by 2030 — the power ministry estimates that the total domestic connected load for all utilities in the country in 2015 was 216 GW. "Thus, by 2030, air conditioning will single-handedly lock in electricity equal to the total domestic connected load of today," says Somvanshi. "This is astounding and raises serious sustainability and equity concerns."

The key highlights of the new study with respect to Delhi

Delhi battling energy crisis due to heat stress: This summer, the maximum temperature hit 48oC; the overall high range hovered between 45-48oC while the minimum ranged between 29-34oC. Analysis of real-time data from the State Load Dispatch Centre, Delhi for this summer — particularly the peak heatwave days of June 7-12 — shows that the peak demand for electricity was higher and more prolonged during the night than in daytime. Says Somvanshi: "This clearly shows that households are more vulnerable and lesser equipped to deal with increased heat stress and are aggressively using electricity – inefficiently — to survive these uncomfortable nights."

Sharp increase in electricity use during heat wave: The average energy demand during the heat wave in 2019 was 25 per cent higher than the average demand in the preceding week; demand dipped after the heat wave. Similar trends had been observed in 2018. The CSE report concludes that thermal stress can influence at least 25-30 per cent of electricity consumed in the city.

Long-term spike in electricity demand: The major difference this year is the rate at which the demand for electricity has risen with increase in temperatures. This year, Delhi is registering peak loads that are almost 25 per cent higher than the ones observed last year on the same date and under similar weather conditions. CSE has also noted that there is an increase of 1 per cent in peak energy demand per degree rise in temperature between 2018 and 2019 summers. These loads and trends are much steeper than the estimated increase in number of electricity consumers and are indicative of increasing usage of energy-intensive cooling devices like ACs.

Lessonsdrawn from the trends in electricity demand: The biggest lesson from long-term electricity consumption patterns in Delhi (data for 2010-18) is that electricity consumption during summer starts to rise exponentially only after the daily heat index temperature crosses the 31-32oCmark. The CSE analysis points out that for Delhi,the 25-32oCheat index is the natural climatic range – once this range is breached, the impact of high use of mechanical cooling (ACs) is starkly noticeable in the sharp upward U-turn of the electricity consumption curve .

Clarifies Sareen: "This range could be different for different cities, but this is the broad comfort condition that will have to be leveraged through building design and other modes to reduce dependence on mechanical cooling. This requires mixed mode buildings that combine strong architectural design with combination of cooling devices and reduced dependence on mechanical cooling systems."

Heat and electricity demand: A national crisis

Increasing heat during summers and monsoons: Averaged over the country, India's heat index is increasing at the rate of +0.56°C per decade and +0.32°C per decade during summer (March-May) and monsoon (June-September), respectively. Rising heat index indicates greater chances of heat-related illnesses, more prominently in the south-eastern coastal regions (Andhra Pradesh, Odisha and Tamil Nadu) during summers and over north-western India (Indo-Gangetic plains and Rajasthan) during monsoons. This influencesthe cooling demand, says the CSE report.

Urban heat making the situation worse, increasing health risk: Heat waves in Indian cities have intensified because of heat island effects, increase in air pollution, heat exhaust from traffic and air-conditioning. Currently, Delhi's urban areas experience, on an average, 2.3 more heat wave days than rural areas every summer. This difference increases to 7.1 in short-term and 13.8 in long-term projections. The India Meteorological Department (IMD) has attributed 40 per cent of all extreme weather-related deaths in 2016 to heat waves — the largest proportion of deaths due to any type of extreme weather event. A Harvard University study found that thermally stressed indoor conditions in non-AC buildings during heat waves result in deficits in cognitive functions of young adults. It established that health impacts of indoor thermal conditions during heat waves extend beyond vulnerable populations.

Most of the existing building stock is not properly designed to keep cool under heat stress: Most of the modern building stock, with its glass facades and paper-thin concrete walls,draws external heat instead of being a shield from it. These buildings use ACs to keep their interiors cool, but these ACs shootout millions of mini-heat jets into the urban air shed, increasing the temperatures outside. Says Somvanshi: "This is yet another rebound effect of AC usage. While air conditioning may help reduce mortality due to heat waves, heat reject from ACs increase street temperatures, thereby increasing heat stress on people on the street (a significant portion of informal workforce in India uses streets and sidewalks as their workspace). It also undermines thermal comfort delivery in buildings that don't have access to ACs."

Traditionally, the urban form of many Indian cities is that of low, closely-built, dense networks with shaded alleyways which kept people naturally cooler during summers. The introduction of ACs in this framework has destroyed the natural ventilation of entire neighbourhoods, rendering them almost unlivable.

Energy cost of cooling: Energy cost of just running a super-efficient AC would be at least 30 kWh a day for a household owning one AC unit. This would translate into a monthly electricity bill of about Rs 5,000 at Delhi domestic power tariff rates (lowest in the country) — assuming the household does not use electricity for anything else. Says Roychowdhury: "The ICAP has estimated that 60 per cent of the current space cooling energy consumption is by only 10 per cent of the population. It is very clear that a majority of Indians won't be able to afford an AC even if it was given for free and charged the lowest electricity rates. Yet the survival of this AC-less majority is being threatened by the 'waste heat' being dumped on them by ACs of the rich. Given the limited supply of energy, should a society be spending it on fighting sweat stains or providing healthcare? About 90 per cent of Primary Healthcare Centres (PHCs) in India report long power cuts between 9.00 am and 4.00 pm, a period during which PHCs function at their peak capacity!"

Make comfort affordable for all: CSE researchers say that this is more important now as India is constructing affordable and low-cost housing at a massive scale, largely on the mixed-mode pattern. Regulations will have to ensure requisite design and material innovation takes place to keep these buildings comfortable for all. Low-cost yet effective solutions will be needed to deliver on the overall comfort condition in affordable housing.
The ICAP has recommended thermal comfort strategies for affordable housing projects under the Pradhan Mantri Awas Yojana for the economically weaker section. "This is important for the affordable and low-income housing sector, where the current focus is only on speed and ease of construction, disregarding comfort requirements of the poor," says Sareen.

The way forward

Moving towards a 'thermal comfort for all' approach and making a thermal comfort standard as the central focus of building regulations and practice — as the India Cooling Action Plan has asked for — will require a diverse and broad-based approach. While steps are needed to frame and operationalise thermal comfort standards for buildings, this approach has to go much beyond buildings to include heat mitigation plans for cities on the whole. Says Roychowdhury: "Establishing this interconnectedness is important to reduce the overall thermal load in a climate-constrained world."

At the same time, while design and technology will be combined to reduce the thermal load on buildings and operational hours of active cooling, steps must also be taken for demand-side management. Every piece of this jigsaw will have to be in its perfect place to create an environmentally sustainable and socially equitable solution.

The CSE report says: "Heat waves are here to stay, and according to climate change science they will only get worse in future. We have no option but to learn to adapt and this will require a rationalised expectation for thermal comfort, better building design and city planning, and veering away from climate-change aggravating cooling technologies. It is easy to blame everything on the weather but significant portion of this distress can be attributed to the way we are transforming our cities and buildings. Weather does aggravate energy consumption, but cheap and subsidised electricity, mindless overcooling, poor building design and wrong urban planning pushes the system to waste energy — often in a way that increases the heat problem."

Develop urban heat action and mitigation plans to reduce urban heat island in the same spirit as clean air action plans.
As recommended by ICAP,adopt Adaptive Thermal Comfort Model-based mixed-mode building design and operation, to reduce prolonged use of ACs.
Adopt passive design and envelope improvements through shading and ventilation in all new construction to inherently reduce the need for active space cooling.
In existing buildings, introduce measures to enhance thermal comfort and reduce operational need for active cooling systems. This should include addition of sunshades to any exposed glass in the facade, cool roofs and capping of thermostat of building heating, ventilation and air conditioning (HVAC).
Improve star labelling of existing technology to better inform people of the energy costs — the current labels are misleading and pushthe market towards 3-star technologies instead of 5-star ones.
Initiate demand-side management and demand-response programmes for behavioural change such as peer-to-peer energy performance comparison, use of demand response-enabled cooling technologies, real-time power consumption displays in all room ACs and building automation and management systems.
Makedisclosure of energy and cooling demand and electricity consumption mandatory for all buildings. This information should be made publically available for all buildings with a connected load equal to or more than 100 kW.

(Pratyusha Mukherjee is a BBC News Correspondent based at Kolkata)