OPINION: Beyond ACs and fans - The alternative space cooling route!

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The Sixth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC) projects intense heatwaves in India, with longer durations and at an increasing frequency. This doesn't bode well for the country which has a predominantly tropical climate and cooling is constantly required to maintain comfortable indoor spaces. Only 8% of Indian households currently have room air conditioners (RACs). This demand is set to grow 11-fold by 2037, estimates the India Cooling Action Plan (ICAP).

By 2050, space cooling could drive almost 30% of India's electricity demand growth and 45% of its peak electricity load. The building sector would account for the majority share of this demand for cooling, expected to rise from 169 Terawatt-hour (TWh) of electricity in 2017 to 970 TWh in 2037, finds the India Energy Security Scenario 2047 tool. Furthermore, the carbon-intensive electricity grid and the use of high global warming potential (GWP) refrigerants are causes of environmental concern. India is working towards reducing the energy and emissions associated with space cooling without compromising on providing thermal comfort to its citizens.

Passive cooling

The present focus of space cooling research in India is on passive cooling and energy efficiency. Passive cooling includes limiting heat gain (through building geometry, facades, shading, glazing, etc.), increasing natural ventilation, use of materials with better heat insulation properties, and sustainable manufacturing process (e.g., autoclaved aerated concrete and hollow bricks). Energy efficiency measures include building management systems using Internet of Things (IoT) and tracking performance standards through a star rating system for cooling equipment, among others.

The International Energy Agency predicts that by increasing the efficiency of space cooling equipment, India could reduce 46% of its projected annual electricity demand in 2050. The above approaches have the potential to reduce cooling energy demand by 30%–50%, but are incomplete solutions towards optimum reduction in energy and emissions. They need to be complemented with alternative space cooling solutions that reassess the space cooling paradigm in the Indian building sector.

Emerging technologies

Several path-breaking technologies already exist, albeit with a low deployment in India and limited practical expertise. Two technologies, in particular, are promising in their application in the building sector:

Ground source heat pump (GSHP): A few meters below the Earth's surface, the ground has a stable annual temperature. GSHP systems utilise the ground as a heat sink to remove heat from indoor spaces through a vapour compression cycle, similar to air conditioners. They might bring about a 25%–50% reduction in electricity consumption. This solution is highly modular and is suitable across various climatic conditions, with a dual functionality of providing both heating and cooling. With a higher upfront cost and payback period of about three years, the technology is 100% refrigerant-free, with a product life of more than 30 years. The building that houses the Ministry of Environment, Forestry and Climate Change (MoEFCC) in New Delhi has a vertical GSHP system at 80m depth, leading to significant energy savings.

District cooling system (DCS): District cooling refers to a highly integrated system consisting of a central plant that cools multiple buildings through a pipe network with chilled water as the medium. DCS has a higher efficiency (30%–50% energy savings) and allows for easier integration of future technologies such as IoT, thermal energy storage, and waste heat recovery, enabling further savings. With DCS, cooling is provided as a service, with no consumer purchase needed. DCS is suitable for large-scale spaces with a highly intensive cooling demand, such as IT parks, commercial buildings, and apartment complexes. It has an expected lifetime savings of 20%–25% despite high capital costs. An example of DCS is Singapore's Marina Bay project, which provides cooling to two dozen buildings, with consumers benefitting from a 40% energy savings.

Both technologies have their own set of challenges for widespread adoption in India. GHSP system requires a detailed feasibility study, adequate land, and high investment. DCS needs to be integrated into the construction phase and requires coordinated planning with the local development authorities.

To promote these technologies, it is vital to create a robust policy framework and necessary guidelines. Some suggestions include:

- Creating performance and labelling standards for primary components of DCS, GSHP systems by the Bureau of Energy Efficiency.
- Including DCS in the urban development bylaws for construction of large dense

greenfield projects.
- Setting up financial schemes for local technology service providers for manufacturing, creating dedicated B2B platforms, and cultivating R&D collaboration with research institutions.
- Providing capital subsidies for consumers looking to adopt DCS and GHSP systems. In 2016, the Ministry of New and Renewable Energy (MNRE) issued a draft policy with financial subsidies for GSHP projects above 100TR. This scheme can be expanded for smaller projects focusing on the residential sector.
- Initiating awareness programmes through stakeholder engagement with government agencies, industry, NGOs, and research institutions.

Despite the challenges, the potential benefits of these technologies merit a greater study of their applicability to India’s building sector. More so, as temperatures are set to soar in the coming years.

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