ANNEXURE 1 of URDPFI Guidelines, 2014

Addendum to Urban and Regional Development Plan formulation and Implementation Guidelines, 2014

1. Introduction

Cities should consider promoting urban forestry. Building water bodies and fountains in dense areas, and improving green transport and energy systems is important. Unnecessary concretization should be avoided and maximum permeability in construction should be encouraged.

Increase in construction of concrete buildings adversely impacts the urban environment mainly by the production of waste heat from refrigeration and air- conditioned systems. Industrial processes and motorized vehicular traffic have also been recognized as additional causes of the Urban Heat Island (UHI) effect. The urban heat island adversely affects the residents, with spill over effects for environmental aspects.

Cooling is particularly important in cities facing rising temperatures, worsened by the urban heat island effect—concrete and tarmac absorbing the sun's power, radiating it out as heat and keeping the city warm long after the sun has gone down. Waste heat from engines and other energy-consuming equipment in transportation, industry and space cooling make cities even hotter.

Often, slum and unauthorized colonies neighbourhoods are more affected as residents have less access to air conditioners and breezy green spaces, putting vulnerable people at greater risk of heat-related health complications.

The standard solution to cooling in cities is to add more air conditioning, but this brings its own set of problems. Energy-hungry cooling further drives global warming. In addition to increasing urbanization and wealth – climate change will also play a decisive role in the surge of the number of ACs in India, which are projected to reach 40% of households by 2038. The number of Cooling Degree Days in India is also projected to increase by 25% and 40% under moderate and high warming scenarios. If air conditioners were provided to all those who need them, not just those who can afford them, there will be 14 billion cooling appliances in use by 2050. There will be considerable increase in Green House Gases (GHG) emissions.

Cities need to take steps so that they can keep cool in a sustainable manner through a system of well-articulated green spaces, and by greening building facades and roofs and promoting passive building design; cities can modernize traditional construction and help reduce urban temperatures. The Indian city of Ahmedabad has taken many steps in this direction. The city implemented its Heat Action Plan after an extremely hot and deadly pre- monsoon season in 2010. The plan not only sets up an early-warning system for the vulnerable but it also included water supplies to the public, plants and trees and a "cool roof" initiative to reflect heat. Some

7,000 low-income households have had their roofs painted white, a simple measure that dramatically reduces inside temperatures by reflecting sunlight.

Cool roof is a simple and cost-effective solution for minimising heat gain in the buildings. Cool roofs save energy, increase thermal comfort and reduce cooling demand. Cool roofs reflect sunlight and absorb less heat. Depending on the setting, cool roofs can help keep indoor temperatures lower by 2 to 5°C (3.6 - 9°F) as compared to traditional roofs. Ahmedabad Municipal Corporation has made use of this technique for reducing heat gain in several lower income households. The AMC is also developing a citywide Cool Roof Program.

Three main strategies can help achieve these objectives:

2. Strategy 1: Mandatory cool roofs for all municipal, commercial and government buildings.

There is need for spearheading the Cool Roofs Program in the cities and towns. It is important for all government office buildings, new and existing, to adopt cool roofs. The key driver for this building sector is to showcase leadership in adoption of the cool roof technique with the benefits of thermal comfort, energy savings, and reduction of urban heat island affect. The commercial sector includes all offices, retail complexes/shops, malls, hotel, industrial buildings etc. The key driver for adoption of cool roofs for these types of buildings is the cooling load reduction and resulting energy savings. Thus, a pay-back period of cool roofing material installations is important for these types of buildings, which would have an impact on the overall energy bill of the building.

3. Strategy 2: Voluntary cool roofing for residential buildings.

The residential segment includes all multi-level apartment complexes as well as individual houses. The key driver for this segment of the population staying in these buildings in addition to the thermal comfort would be the cooling load reduction and resulting energy savings. Thus, a pay-back period of cool roofing material installations is important for these types of buildings.

4. Strategy 3: Cool roofing for low income housing under HAPs and through CSR initiatives

In low-income communities, cool roofs keep temperatures lower and increase thermal comfort. In the long run, cool roofs for vulnerable communities also introduce the concept of cool roofs for existing buildings and potentially new buildings in the future, thus locking in energy savings and reducing the demand for cooling conditions indoors. The driver for this segment of the population for cool roofs is increased thermal comfort and lower indoor temperatures. Also, since for a large proportion of these households, their homes are also their place of work, increased thermal comfort due to cool roofs, would also lead to enhanced productivity.

The city-wide program with the above three main strategies also define the regulatory outreach and awareness, and financial mechanisms, along with the implementation plan for the program.

5. Cool Roofing Material

The choice of an appropriate cool roof material in a particular context depends on a range of factors such as existing roof material, life and maintenance, availability, cost, time needed for installation and availability of skilled labour. In order to help cater to a range of contexts, cool roofs techniques can be broadly divided into four categories. Building owners can choose from these techniques as appropriate for implementing cool roofs.

- ***Coated cool roofs:*** these roofs involve the coating of a material or paint with high reflectivity on top of a conventional roof material to increase the roof surface's solar reflectance index. These are liquid applied coatings made of simple materials such as lime wash or an acrylic polymer or plastic technology and are usually white in colour.
- ***Membrane cool roofs:*** these roofs involve using pre-fabricated materials such as membranes or sheeting to cover an existing roof in order to increase the roof surface's Solar Reflection Index (SRI). These types of roofs can be polyvinyl chloride (PVC) or bitumen- based.
- ***Tiled cool roofs:*** these roofs involve the application of high albedo, china mosaic tiles or shingles on top of an existing roof or to a new roof.
- ***Special cool roof materials such as Mod Roof:*** these roofs, made of coconut husk and paper waste, have been installed in households around Gujarat and Delhi and can serve as an alternative to reinforced cement concrete roofs.
- ***Green roofs:*** green roofs make use of vegetation to help the roof absorb less solar energy by providing a thermal mass layer to reduce flow of heat into a building. Vegetation is especially useful in reflecting infrared radiation. Green roofs are also considered cool roofs, but due to higher costs and need for water, they are likely not a cost-effective solution for heat reduction in low-income communities in India.

The cost implications vary by the type of material used for cool roofing. However, most of these materials have been applied locally in India and are available through local vendors.
Source: Ahmedabad Heat Action Plan-2018

Green infrastructure includes parks, street trees, community gardens, green roofs and vertical gardens. In tropical and subtropical climate zones, green infrastructure is a cost-effective cooling strategy.

One of the best ways to tackle the problem of the urban heat island is simple – plant more trees. Evapotranspiration might sound made up, but it's a real process that helps cool our cities down. Trees soak up radiation from the sun before it hits the ground, and the heat evaporates the water from the tree's leaves. That cools the surrounding area.

It is assumed that a 10% increase in tree canopy cover can lower afternoon ambient temperatures by as much as 1-1.5C, as the chart below shows. Similarly, in parks with adequate irrigation ambient temperatures can be 1-1.5°C lower than nearby un- vegetated or built-up areas.

The authorities can increase street tree canopy cover by planting more shade trees on footpaths, lanes and street medians. Where there is little space for parks and street trees, green roofs and walls may be viable options.

6. Water-sensitive Urban Design

The use of water as a way to cool cities has been known for thousands of years. Water-based landscapes such as rivers, lakes, wetlands and bios wales can reduce urban ambient temperatures by 1-2°C. This is a result of water heat retention and evaporative cooling.

In addition to natural water bodies, various other water-based technologies are now available for both decorative and climatic reasons. Examples include passive water systems, like ponds, pools and fountains, and active or hybrid systems, such as evaporative wind towers and sprinklers. Active and passive systems can decrease ambient temperatures by 3-8°C,

Water-based systems are usually combined with green infrastructure to enhance urban cooling, improve air quality, aid in flood management and provide attractive public spaces.

7. Cool materials

Building materials are major contributors to the urban heat island effect. The use of cool materials on roofs, streets and pavements is an important cooling strategy. A cool surface material has low heat conductivity, low heat capacity, high solar reflectance and high permeability.

Evidence suggests that using cool materials for roofs and facades can reduce indoor temperature by 2-5°C, improve indoor comfort and cut energy use.

Cool materials commonly applied to buildings include white paints, elastomeric, acrylic or polyurethane coating, ethylene propylene diene terpolymer membrane, chlorinated polyethylene, polyvinyl chloride, thermoplastic polyolefin, and chlorosulfonated polyethylene.

Lighter aggregates and binders in asphalt and concrete, permeable pavers made from foam concrete, permeable asphalt and resin concrete are standard cool pavement materials.

8. Shading

Shading can decrease radiant temperature and greatly improve outdoor thermal comfort. Providing shading on streets, building entries and public venues using greenery, artificial structures or a combination of both can block solar radiation and increase outdoor thermal comfort. Examples of artificial structures include temporary shades, sunshades and shades using solar panels.

9. Combined cooling strategies

Performance analysis of various projects in Australia suggests the cooling potential of the combined use of the different strategies discussed above is much higher than the sum of the contributions of each individual technology, as the charts below show. The average maximum temperature reduction with just one technology is close to 1.5°C. When two or more technologies are used together the reduction exceeds 2.5°C.

Climate-responsive building design and adaptive design techniques in existing buildings can minimize occupants' demand for cooling energy by reducing indoor and outdoor temperatures

Urban Local Bodies and Urban Development Authorities can prepare for and respond to heat events through emergency response plans. However, emergency responses alone cannot address other challenges of urban heat, including human vulnerability, energy disruptions and the economic costs of lower workplace productivity and infrastructure failures.

Long-term cooling strategies are needed to keep city residents; buildings and communities cool which will lead to savings in energy and resulting costs.

References

1. Ahmedabad Heat Action Plan, 2018
2. Energy Conservation Building Code (ECBC) 2017
3. Eco-Niwas Samhita 2018 [Energy Conservation Building Code – Residential (ECBC-R)] (Part I: Building Envelope)

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