IETP

India Energy Transformation Platform

Decarbonising India

Low Carbon Options to Meet Space-Cooling Electricity Demand in Urban Residential Buildings

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Supported by: Shakti Sustainable Energy Foundation and Swiss Agency for Development & Cooperation

1 About IETP

The India Energy Transformation Platform is an independent, multi-stakeholder group of experts aiming to develop an informed narrative on India's strategies for meeting its Nationally Determined Contributions (NDCs) through non-linear, transformative solutions. This unique initiative, jointly conceptualised by Center for study of Science, Technology & Policy (CSTEP) and Shakti Sustainable Energy Foundation (SSEF), hopes to ensure that India stays ahead of the curve and cements its leadership in the global transition to clean energy – even beyond 2030. Over the past year, the platform has supported research across four themes- decentralised energy systems, renewable energy dominant electricity system, industrial process heat, and urban cooling demand- exploring novel technology options to help develop low-carbon energy pathways up to 2050. The project teams (under each theme) have undertaken rigorous study and have thus put forth their results and recommendations in the form of the following policy brief.

2 Rationale

Space cooling is the fastest growing energy usage in buildings globally. Multiple studies have looked at space cooling demand projections for India and a sharp increase is expected in the next two to three decades. The Government of India has taken a lead in preparing the India Cooling Action Plan (ICAP). According to ICAP, a large part of this future demand has been attributed to the adoption of room air conditioners (RAC), and 80-90% of the RAC stock is expected to be concentrated within the residential sector by 2037-38.

The objective of this study is to assess low carbon and cost-effective solutions for achieving deep cuts in space-cooling requirement and associated cooling electricity demand from India's urban residential sector during 2020 to 2050. The scope of the study is limited to urban residential buildings where a majority of the RAC applications are foreseen in the immediate future.

3 Key Recommendations

International Energy Agency estimates that by 2050, 45% of India's peak electricity demand is expected to result from space cooling alone, with the largest share coming from room air conditioners (RACs) in urban residential buildings. Reducing space cooling requirement through energy-efficient building envelope[1], is the starting point for low-carbon cooling future. Urgent action is required to mainstream energy-efficient building envelope in both new and existing residential buildings. Following are three key recommendations:

Inclusion of "Energy-Efficient Building Envelope" in housing and cooling related Government Policies

- "Housing for All" policy is amended to include provision of thermal comfort through energy-efficient building envelope as an essential attribute in Pradhan Mantri Awas Yojana (PMAY).
- "India Cooling Action Plan (ICAP)" is amended to state primacy of energy-efficient building envelope design in low-carbon cooling future.
- Bureau of Energy Efficiency's building energy efficiency strategy, which is overwhelmingly focussed on new construction, should be expanded to include retrofit of existing buildings.

With these amendments in place, energy-efficient building envelope will become an essential feature of all future construction under PMAY; and mainstreaming energy-efficient building envelope will get integrated in ICAP implementation.

Market Transformation Initiative for Building Materials and Technologies

A range of proven technologies and products are available in the market to meet energy-efficient building envelope specifications, but their market share is small. A market transformation programme is recommended to address barriers related to under-developed supply chains, low levels of consumer awareness, performance uncertainties and risks, high costs, and split incentives. To begin with, the market transformation initiative could cover four categories of products:

- Bricks/ blocks with low thermal conductivity (e.g. Autoclaved Aerated Concrete-AAC blocks, hollow clay blocks)
- High performance windows (e.g. double glazed windows)
- External movable shading (e.g. external roller blinds, shutters)
- Roof tiles with low thermal conductivity and/or high Solar Reflectance Index (SRI). (e.g. cool roof tile, hollow clay roof tile)

Inclusion of energy efficient building materials in building codes; standards and labelling programmes for building materials; incentive led manufacturing; and training and capacity building are some of the important actions of the market transformation initiative.

Focused Industry led R&D Initiative for Next Generation Energy-Efficient Building Envelope Technologies

A focused industry led R&D initiative should be launched to develop next generation (medium to long term) of energy-efficient materials and technologies for building envelope. To begin with, three technologies have been identified for further assessment and exploration:

- Radiative cooling film technology to reject heat from roof
- Aerogel based renders, plasters, bricks, and roof tiles to reduce heat gains
- Smart windows to reduce heat gains and improve daylighting

A systematic study is required to prepare a technology roadmap. Based on this technology roadmap, a focused industry led R&D initiative should be launched.

1 Building envelope refers to building materials, products and components used in the construction of the buildings' roof, walls, external doors, windows and shading. The properties of the building envelope determine heat transfer from outside to inside the building.

4 Findings

A bottom-up model was developed to estimate the space-cooling requirement while meeting the "thermal comfort for all" aspiration. An assessment of technologies (building envelope and space cooling) was carried out along with a review of various approaches used globally to mainstream energy-efficient building envelope. The analysis resulted in the following findings:

- Improvement in building envelope in new construction and retrofitting of existing buildings, can help in reducing the space cooling requirement from 2914 TWh_{th}/y (terra-watt hour thermal per year) [2]to 2006 TWh_{th}/y in the year 2050, which is 30% lower compared to business as usual.
- Through improvement in both building envelope and cooling technologies as per "deep-cut scenario", the cooling electricity demand can be reduced to 267 TWh/y (terra-watt hour electricity per year) in 2050, which is almost 55% less compared to the BAU scenario.
- Almost 50% reduction in the average heat gains from the building envelope is possible through commercially available building materials and technologies. Upto 30% reduction is possible at no or very low additional cost.
- In the Indian context, instead of relying only on a top-down approach based on implementation of Energy Conservation Building Code, a hybrid approach aimed at market transformation is expected to yield better results.

The study provides a summary of the cooling technologies. No specific recommendations on cooling technologies have been provided as there are several ongoing initiatives like Global Cooling Prize, BEE's standards and labelling programme on air-conditioners, which are aimed at increasing the energy performance of cooling technologies.

5 Conclusion

Under the deep-cut scenario:

- India can provide "thermal comfort for all" in all its urban residential buildings in 2050 by using only 26% of the current annual electricity generation.
- Electricity saving of 316 TWh/y is possible as compared to "BAU scenario" for the year 2050, which is equivalent to 259 million tonnes of CO_2 emission reduction per year for the year 2050.
- 391 GW of power generation capacity addition can be avoided, which is equivalent to avoided investment of INR 15-20 lakh crores on new power plants.

2 This is the unit for defining the space cooling requirement which is the amount of thermal energy that needs to be removed from inside buildings to maintain thermal comfort.

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