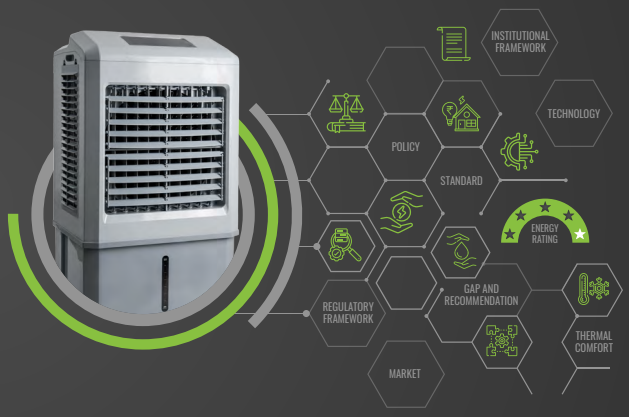
CHILDREN'S INVESTMENT FUND FOUNDATION

SHEETAL
Alliance for Sustainable Habitat, Energy Efficiency and Thermal Comfort for All

Alliance for an Energy Efficient Economy™

DECODING EVAPORATIVE AIR COOLERS



BACKGROUND

Access to cooling for attaining thermal comfort is no longer a luxury but, rather, a necessity for enhancing the overall quality of life, productivity, and well-being. Thermal comfort can be defined as a state where an individual is satisfied with the thermal environment, which is determined and affected by various factors, such as the microclimatic conditions—temperature, relative humidity, airflow, air temperature, dew-point temperature, and wind speed— and an individual's clothing insulation & metabolic rate. Achieving and experiencing thermal comfort is essential for an individual's psychological and physiological well-being.

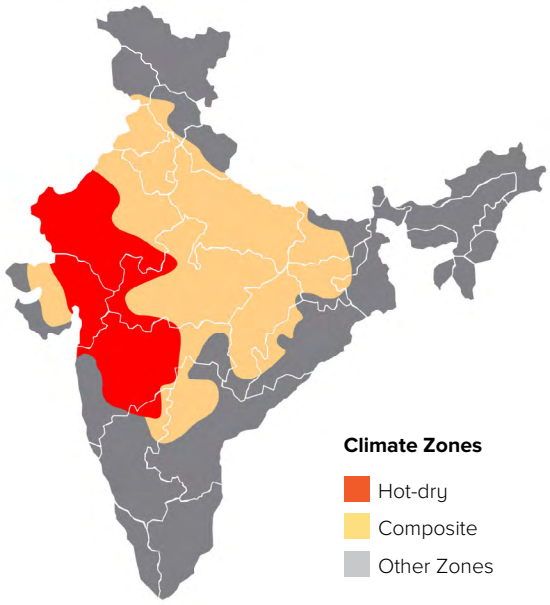


Figure 1: Climate Zones in India Where Evaporative Air Coolers Work Effectively

India is one of the countries with the lowest access to cooling globally but simultaneously has around **4 trillion person cooling degree days**. Currently, only a small fraction of the total residential population has access to room air conditioners (RACs), and a significant share of households will still not have access to RACs over the next 10-20 years, due to lack of purchasing power, for achieving thermal comfort. Despite RACs' low penetration, they contribute significantly to emissions based on their energy use as they use high Global Warming Potential (GWP) refrigerants, contributing significantly to the peak demand in metropolitan cities and space cooling energy consumption which is predicted to rise significantly by 2037-38. Therefore, **India is facing the challenge of providing access to affordable cooling for all while simultaneously mitigating climate change.**

With India's tropical climatic conditions and pressing climate need for cooling, there is a significant opportunity to increase the uptake of evaporative air coolers (EACs) in India's appliance market. **EACs could play a significant role in providing thermal comfort for all while also reducing the demand for refrigerants with GWP in India**. They are a sustainable and affordable space cooling technology alternative when compared to RACs, as they work on the simple principle of evaporation, where water is used as a natural refrigerant, and they function well in India's hot-dry and composite climatic zones as shown in Figure 1. In comparison to conventional RACs, EACs are 80-85% affordable, consume 80-90% less electricity, have low operational and maintenance costs, and are Non-GWP refrigerant-based space cooling solutions.

India's EAC market is projected to grow at a Compound Annual Growth Rate (CAGR) of 14.2% in 2019-25. With their growing demand and EACs' approximate lifespan of 12 years or more, there is a critical need to develop their Minimum Energy Performance Standards (MEPS) in order to lock in energy savings in the coming years, thus creating a level playing field and encouraging the adoption of energy-efficient EACs.

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cheaper and consume
80-90%
less electricity than air conditioners

India's EAC market is projected to grow at a CAGR of
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ALIGNMENT WITH ICAP

The report is aligned with the recommendations of the India Cooling Action Plan (ICAP) 2019. The report lays the stepping stones for policymakers to move forward towards the development of MEPS for EACs. It nudges thought processes towards the standardisation of India's EAC market. The report sheds light on the EAC's technological feasibility, and applicability provides an overview of India's EAC market scenario and the existing national institutional and regulatory mechanism for improving appliance energy efficiency. The report also draws recommendations for India's EAC sector based on the review and comparison of the EAC standards adopted nationally and internationally. The report has been prepared under the umbrella of the ongoing SHEETAL project, which is supported by the Children's Investment Fund Foundation, to facilitate the implementation of ICAP recommendations. The report is envisioned to act as a catalyst for influencing policymakers to facilitate improvements in EAC performance and standardise the existing market through the development of the MEPS framework for EACs in India. In the long term, the report will facilitate increased access to efficient and sustainable space cooling technologies to achieve thermal comfort by promoting the use of standardised EACs. It will also contribute to the wider market adoption and mainstreaming of Non-GWP refrigerant-based space cooling technologies in India.

KEY HIGHLIGHTS AND OBSERVATIONS

The following are the key highlights and observations from the report:

- The report has provided detailed information on the different types of EACs based on their structure, technology description, working principle, and applications. A glimpse into the detailed information on different types of EACs is mentioned in Table 1, in the form of a comparison of EAC technologies.

Table 1: Comparison of Evaporative Air Cooling Technologies

Parameters	Direct Evaporative Air Cooler (DEC)	Indirect Evaporative Air Cooler (IEC)	Indirect-direct Evaporative Air Cooler (IDEC)
Capacity (approx.)	10-120 L	1,000-80,000 CFM	1,000-80,000 CFM
Cooling medium	Cooling pad	Heat transfer through HE	Combination of DEC & IEC
Efficiency	More efficient than IEC	Less efficient than DEC	Most efficient
Specific Humidity content in supplied air	Yes	No	Yes, but less than DEC
Relation between enthalpy and dry and wet-bulb temperatures	Dry-bulb temperature: Decreases Wet-bulb temperature: Constant Enthalpy: No change	Dry-bulb temperature: Decreases Wet-bulb temperature: Decreases Enthalpy: Decreases	Dry-bulb temperature: Decreases Wet-bulb temperature: First reduces than remain constant Enthalpy: Decreases
Operation and maintenance	Easy in comparison to IEC& IDEC	Medium in comparison to IDEC & DEC	Difficult in comparison to IEC & DEC
Applications (most optimal)	Residential	Large-scale commercial and industrial spaces where specific humidity in the supply air has to be avoided	Large-scale commercial and industrial spaces where there is a significant temperature drop requirement and the ambient air has low humidity content
Adaptability with climatic zones	Hot-dry	Composite/Hot-dry	Composite/Hot-dry

- The report also provided a brief overview of the Indian EAC market and institutional framework. Currently, India's organised EAC market accounts for a 30% market share of the overall EAC market, with the remainder captured by the unorganised EAC market.
- The report highlighted that the unorganised sector uses offline market distribution channels and retail shops, whereas the organised sector employs both offline and online market distribution channels. The EAC market is segmented into residential and commercial, according to the EAC application. Preliminary stakeholder consultations indicated that DECs are majorly in demand in the residential sector, and the demand for IDECs is expected to grow multifold in the commercial and industrial sector in the near future due to potential IDEC applications and lower energy consumption in comparison to air conditioners.

➔ The report has also provided a detailed comparison of the select parameters covered with respect to the performance of EACs under India: IS 3315:2019 Quality and Testing Standard, Australia: AS/NZS 2913-2000 Testing Standards, Iran: 4910-2 MEPS & Label, USA (California): CEC-410-2017-002 Appliance Efficiency Regulation, ASHRAE Testing Standards (133&143) and ECC Rating Standard for EAC as shown in Table 2.

Table 2: Comparative Summary of EAC Performance Parameters

Parameters	IS 3315	ASHRAE Testing Standards (133 & 143)	Australia (AS/NZS 2913-2000)	California, USA (California Code of Regulations, Title 20)	Iran Appliance Label & MEPS (4910-2)	ECC rating standards (RS/9/C/004-2018, RS/9/C/005-2018, & ECE)
Water Consumption	⊗	⊗	⊗	⊗	⊗	✓ As defined in section 6.5 'Water Flow' in ASHRAE 133-2015
Water Entertainment	⊗	✓ ASHRAE 133-2015	⊗	⊗	⊗	⊗
Water Quality	⊗	✓ ASHRAE 133-2015	⊗	⊗	⊗	✓
Power Consumption	✓	✓	✓	✓	✓	✓
Noise Level	✓	⊗	✓	⊗	⊗	⊗
Design & Build	✓	⊗	⊗	⊗	⊗	⊗
Air Flow	✓	✓	✓	✓	✓	✓
Evaporative Cooling Effectiveness	✓	✓	✓	✓	✓	✓
Static Pressure/ Pressure Drop	✓	✓	⊗ Not Specified	⊗ Not Specified	⊗ Not Specified	✓
Testing Protocols	✓	✓	✓	✓	✓	✓
MEPS	⊗	⊗	⊗	⊗	✓	⊗
Guidance & Instructions for Manufacturers	✓	⊗	⊗	⊗	⊗	⊗
Eco-mark	✓	⊗	⊗	⊗	⊗	⊗
Detailed Specifications w.r.t. EAC Type	⊗	✓	⊗	⊗	⊗	✓

✓ Parameter Covered ⊗ Parameter NOT Covered

All the international standards/regulations cover power consumption, airflow, and cooling/saturation effectiveness. However, only ASHRAE and ECC have touched upon parameters related to water efficiency, and only Iran has established MEPS for EACs.

RECOMMENDATIONS

From the review of MEPS and testing standards for EACs adopted or developed internationally and nationally, the report has identified gaps and suggested recommendations to bridge those gaps. A glimpse into those gaps and recommendations for the current national-level institutional and regulatory framework, which will facilitate the development of the S&L framework for EACs in India, is shown as shown in Table 3:

Table 3: Gaps & Recommendations for India's EAC sector

Type	Gaps at National & State Level	Recommendations
Policy & Regulatory Related	Absence of MEPS & label for EACs at the national level.	The Seasonal Energy Efficiency Ratio (SEER) would be an ideal parameter to evaluate the energy performance of an EAC annually. For the development of the performance label of EACs in India, a comprehensive comparative assessment of different labelling programs available globally could be undertaken, which will facilitate in providing recommendations specific to the Indian climatic conditions for the label development. The central level nodal agencies can take up this recommendation.
	Lack of "ecosystem" for EACs.	There is a requirement to build an "ecosystem" around EACs in India, including testing infrastructure, operation & maintenance services, training & development, and integration with academia. For the development of this ecosystem, financing will be an essential parameter. The central level nodal agencies can take up this recommendation.
	Lack of trained experts.	A limited number of trained sectoral experts in the field of evaporative air cooling are available in India. Capacity buildings workshops could be conducted by CSOs and State level Nodal Agencies for increasing the number of trained sectoral experts and technicians.
	Lack of testing standards or protocols for different types of EACs.	State-level Nodal Agencies with support from civil society organisations (CSOs) or any other association working in appliance energy efficiency could be appointed as the knowledge partners that could support the S&L program in framing set energy performance testing standards for different types of EACs.
	Lack of EAC testing infrastructure.	Mapping and gap assessment of the existing government, private, and industry test labs in India available for EAC performance testing should be undertaken.
	The IS for EACs do not consider water efficiency as a parameter.	IS for EACs could also focus on water consumption and its efficiency levels as a critical parameter to cover the overall performance of EACs.
Research & Design Related	Lack of discussion about thermal comfort or the need for space cooling technologies for academic institutions (such as schools, kindergartens, and universities) and EACs' potential application in these settings.	A technology assessment study should be undertaken in schools, kindergartens, universities, and other academic institutions to determine which type of EAC is best suited for these settings for achieving thermal comfort.
	Lack of literature available and research on unlocking the market and technology potential of EACs in the commercial sector.	An in-depth market transformation potential study is required to assess the actual potential of EACs in the commercial segment.

WAY FORWARD

The development of the MEPS framework will provide an opportunity to standardise this product segment, increasing its mass adoption and, ultimately, increasing access to cooling and thermal comfort for all, as well as providing other related co-benefits such as a reduction in GWP and GHG emissions. Nevertheless, it is essential to first assess the present market, future growth, and energy-saving potential of EACs in the commercial sector, as there is extremely limited information available on the commercial EAC market compared to the residential EAC market. Getting ahead of the demand curve and setting robust MEPS for EACs could help in establishing market-leading performance and setting India's EAC industry ahead of other international competitors. This could position India as the market leader for export opportunities, in addition to domestic trade, and could contribute towards economic recovery, along with supporting the Government of India's 'Atmanirbhar Bharat' initiative. Therefore, focused efforts are required to leverage the existing EAC technology in the commercial sector and develop its MEPS to enable wider market adoption. AEEE's follow-up report on this subject will thus focus on the market assessment of EACs in the commercial sector of India.

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