WORKING PAPER

BEATING THE HEAT: HOW AIR CONDITIONER EFFICIENCY STANDARDS HELP INDIA AVERT POWER SHORTAGES AND CUT CONSUMER BILLS

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WORKING PAPER

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EXECUTIVE SUMMARY

1. THE CHALLENGE: LOOMING POWER SHORTAGES

India's power grid is buckling under the summer heat. Air conditioners (ACs) are fast becoming the single largest driver of peak electricity demand - contributing as much as 60-70 GW or 25%. ACs are power guzzlers, each consuming 100-150 times the electricity of an LED bulb.

And the scale of what's coming is staggering. India adds 10 to 15 million ACs every year, about 2 to 3 times the level of just a few years ago. As temperatures rise and household incomes grow, another 130 to 150 million units will likely be installed over the next decade. Without policy intervention, AC-driven peak demand could reach 120 GW by 2030 and 180 GW by 2035 — more than one-third of India's projected evening peak load.

Even with all under-construction generation and storage projects online, power shortages are expected as early as 2028.

2. THE SOLUTION: STRENGTHEN ROOM AC EFFICIENCY STANDARDS

India must continue building firm power capacity, particularly energy storage that captures cheap afternoon solar power and dispatches it in the evening. But there is a complementary resource that remains significantly underutilized: making ACs more efficient.

Experience from India and internationally demonstrates that Minimum Energy Performance Standards (MEPS), combined with comparative star labels, are among the most cost-effective policy tools for driving appliance efficiency at scale. The Bureau of Energy Efficiency's (BEE) planned 2028 MEPS (1-Star) revision — raising the effective minimum standard by approximately 25% — is a meaningful step in this direction. However, a single revision is insufficient. What is needed is a long-term policy roadmap, extending 8 to 10 years, that provides manufacturers with the certainty required to plan investments and accelerate market transformation.

Data shows that the Indian market is ready for an ambitious MEPS Revision roadmap like the following:

- **2028**: Set MEPS at ISEER 4.3 as already planned by BEE. 60% of the AC models offered in the market already meet this standard.
- **2030**: Set MEPS at ISEER 5.3 (equivalent to the current 5-star level). 1000+ AC models (15% of the models offered in the market) already exceed this efficiency level.
- **2033**: Set MEPS at ISEER 6.7 (equivalent to the most efficient AC currently available for sale in the Indian market). Both domestic and international manufacturers (e.g., Blue Star, Daikin) already offer models above ISEER 6.0 at competitive prices, implying supply chains are prepared.

This trajectory implies an annual efficiency improvement rate of 6–8% — consistent with India's G20 commitment to double the pace of energy efficiency gains.

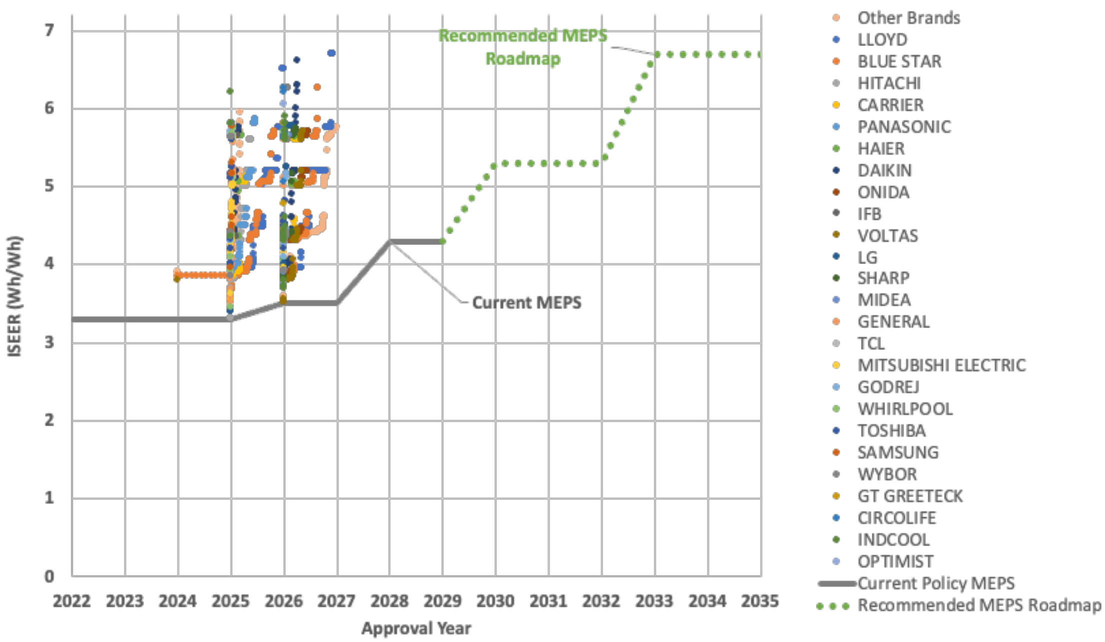

FIGURE ES-1: India's Room Air Conditioner units and the recommended MEPS (1-Star) trajectory. Each plotted point represents a variable speed AC unit offered for sale in India in 2026, with colors denoting manufacturers and the Y-axis reflecting AC efficiency in ISEER. Efficiency level for each unit is taken from its label as reported on the BEE website.

3. MASSIVE GRID AND CONSUMER BENEFITS

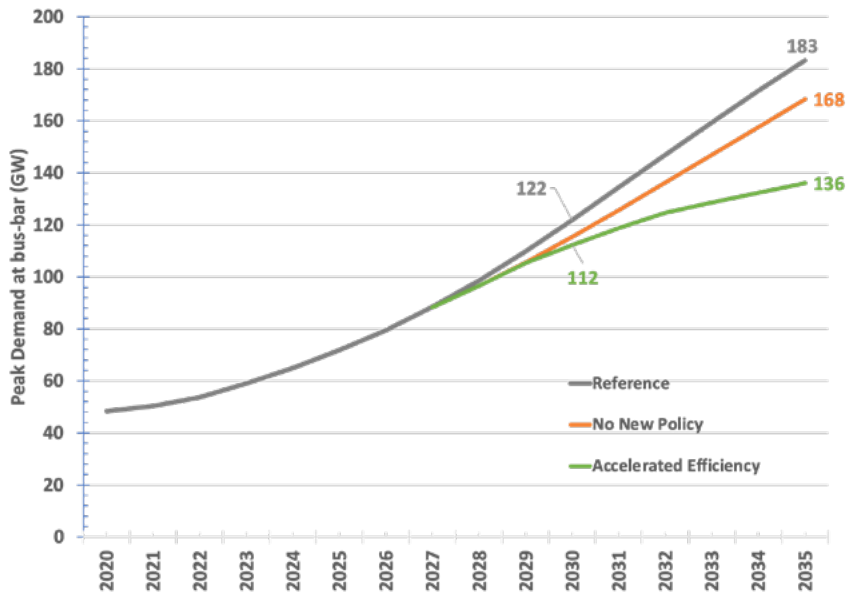

FIGURE ES-2: Projected national peak electricity demand due to ACs. The chart shows Reference case (historical efficiency gains), No New Policy case (no further MEPS revision after 2028), and Accelerated Efficiency case (recommended MEPS roadmap).

The 2028 MEPS revision alone, even without further tightening (No New Policy case), would reduce peak demand by approximately 7 GW by 2030 and 15 GW by 2035 relative to the baseline.

Sustained efficiency improvement under the accelerated roadmap shown above delivers substantially larger benefits:

- **Peak demand avoided:** 10 GW by 2030 and 47 GW by 2035 — averting supply shortfalls and saving an estimated ₹8 lakh crore (~$80 billion) in avoided power infrastructure investment.
- **Electricity savings:** 18 TWh per year by 2030, increasing to 86 TWh per year by 2035, equivalent to the annual output of 45 GW of solar capacity.
- **Net consumer savings:** ₹91,000 to 2,48,000 crore (~$9–25 billion) over the life of ACs, even after accounting for the incremental cost of higher-efficiency units.
- **Emissions reduction:** approximately 12 $MtCO_2$ per year by 2030 and 49 $MtCO_2$ per year by 2035 from avoided electricity generation (not including refrigerant-related climate impacts).

4. EFFICIENCY STANDARDS DO NOT RAISE PRICES

A common concern about tightening MEPS is that it will increase the cost of ACs for consumers. The evidence does not support this. Historical data from India and comparable markets show that AC prices continued to decline even as standards have become more stringent. Costs are primarily determined by economies of scale, competitive dynamics, and supply chain development, not by regulatory thresholds alone.

5. SUPPORTING MEASURES

Strengthened MEPS should be accompanied by complementary interventions:

- Expand bulk procurement programs (e.g., through EESL) to drive down costs and increase market penetration of ultra-efficient models.
- Revise AC test procedures to account for dehumidification performance, consistent with recent recommendations by the Global Cooling Efficiency Accelerator.
- Invest in demand-side cooling interventions — cool roofs, improved building design, and urban greening — to reduce the underlying cooling load.

6. THE COST OF INACTION

Weak or delayed MEPS revisions risk locking India into decades of inefficient cooling technologies, worsening shortages and driving costly grid expansion. Strengthening MEPS is not only a powerful energy savings strategy—it is also a crucial reliability tool and a necessary step toward India becoming a global leader in affordable, sustainable cooling.

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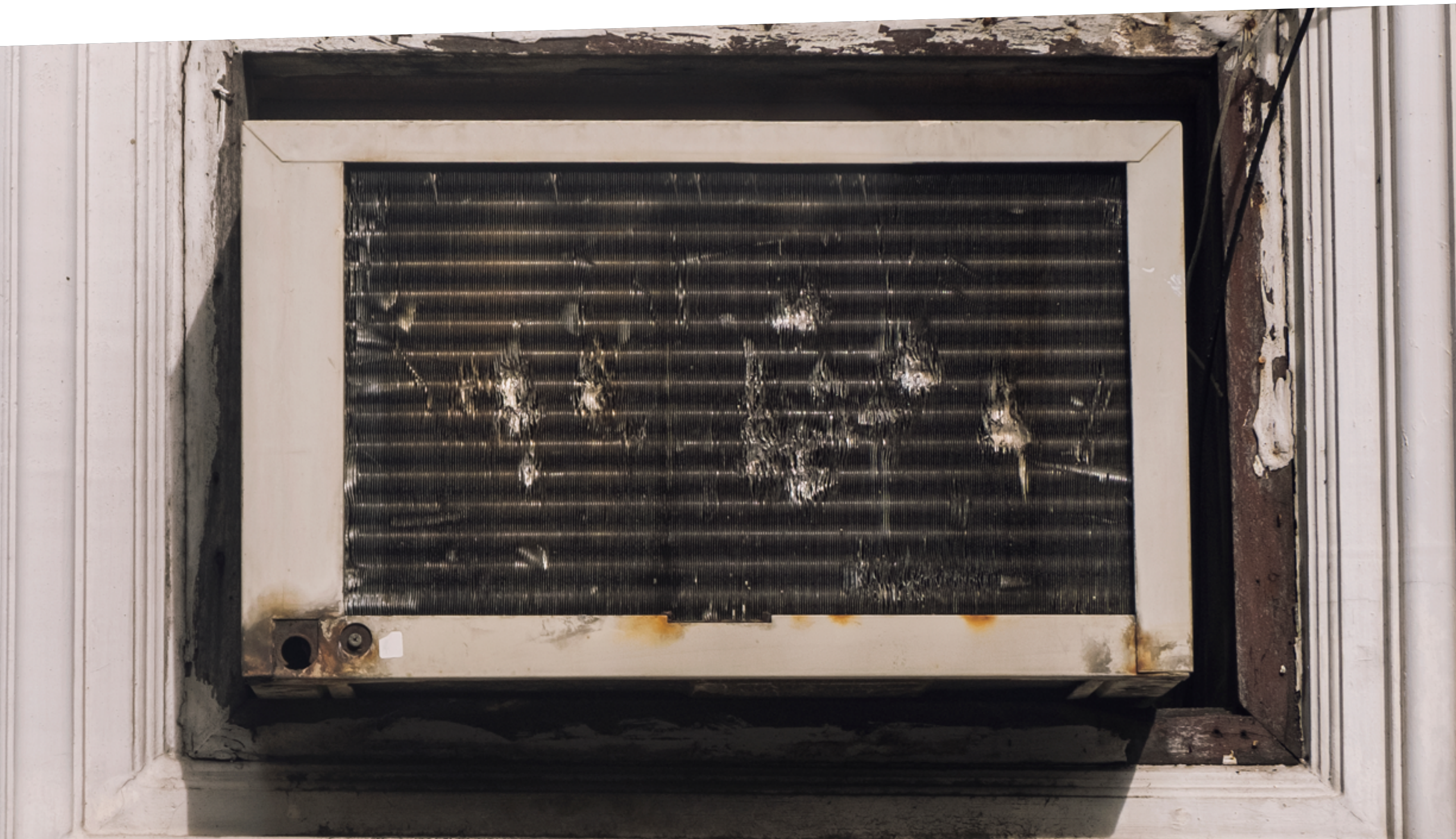

ABSTRACT

India is experiencing a rapid surge in electricity demand driven by room air conditioners (ACs), propelled by rising incomes, urbanization, and intensifying heat waves. Between 2025 and 2035, India is projected to add approximately 130 million new room ACs; absent targeted policy intervention, AC-driven peak load could exceed 180 GW by 2035, straining the power system and necessitating costly investments in new generation and grid infrastructure. This paper evaluates the potential of accelerating room AC efficiency improvements to address this challenge. We assess the Bureau of Energy Efficiency's (BEE) planned Minimum Energy Performance Standards (MEPS) revision to ISEER 4.3 by 2028, followed by a two-star ratchet every three years — bringing the MEPS to ISEER 6.7 by 2033, equivalent to the most efficient model currently available for sale on the Indian market. We find that this strategy could reduce peak demand by over 47 GW by 2035, avoid ₹8 trillion in generation and grid investments, and deliver up to ₹2.5 trillion in net consumer savings. Drawing on empirical data, we also find that efficiency standards are unlikely to increase appliance prices. A long-term efficiency roadmap, along with complementary programs, can position India as a global leader in sustainable and affordable cooling.

1. INTRODUCTION

1.1. RAPIDLY RISING SPACE COOLING DEMAND

India's electricity grid is under mounting stress. Peak demand crossed 270 GW on summer afternoons (3-4 PM) in recent weeks, buoyed in part by significant solar generation during daylight hours. But even after sunset the demand remains stubbornly high with night peaks (11 PM) exceeding 250 GW — levels that have pushed the grid on the brink of widespread power shortages and several thermal power plants under immense operational stress. A central driver of this pressure is the rapid proliferation of room air conditioners (ACs) in India in recent years.

ACs now contribute an estimated 70 GW — approximately 25% — of India's peak electricity demand, making them the single largest end-use driver of grid stress. Critically, this load does not recede at night: an AC consumes 100 to 150 times the electricity of an LED bulb, sustaining demand well into evening hours when solar generation has ceased and the grid is most strained.

Figure 1 illustrates this pattern through hourly load curves on peak demand days across summer and winter months, shown at the all-India level and for key urban regions including Delhi and Mumbai. Two features stand out. First, summer peak demand has risen sharply in just the last few years — a post-COVID acceleration that reflects rapidly growing AC ownership. Second, the load profile itself has changed in character: a pronounced afternoon peak is now accompanied by an equally elevated nighttime demand, as residences continue running ACs through the night in the absence of meaningful temperature relief after sunset.

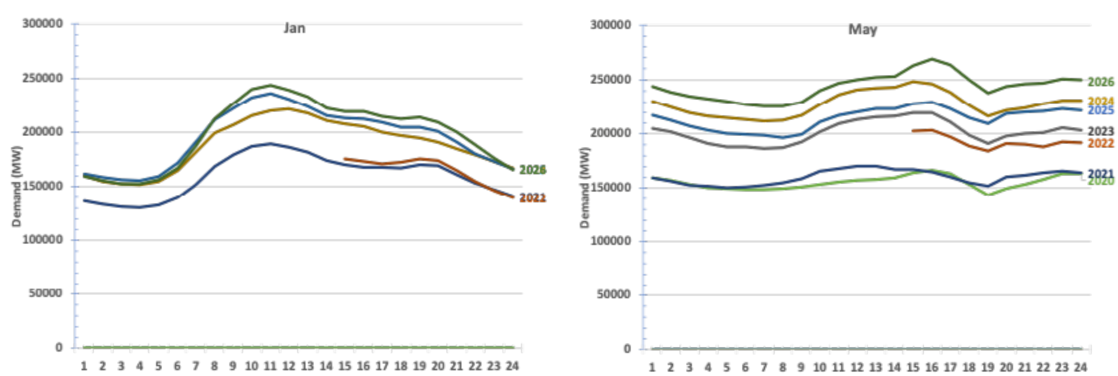

FIGURE 1 (A): Hourly demand (actual) on peak load days in India in January and May (2020-2026)

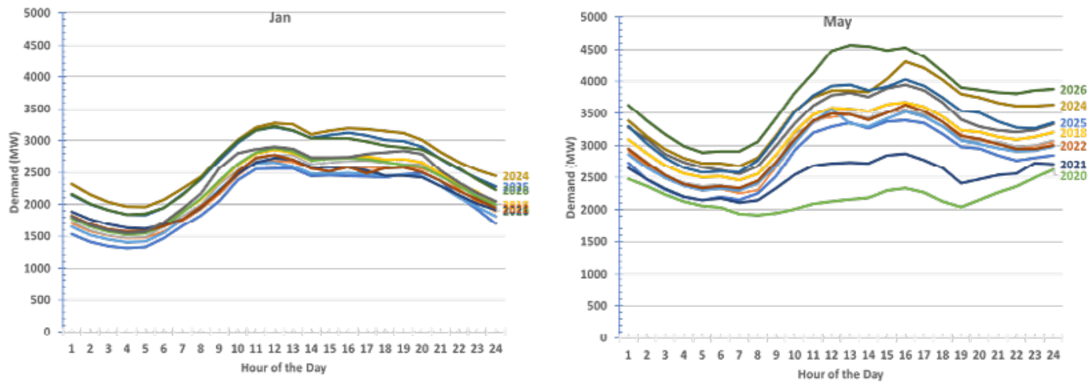

FIGURE 1 (B): Hourly demand (actual) on peak load days in Mumbai in January and May (2018-2026)

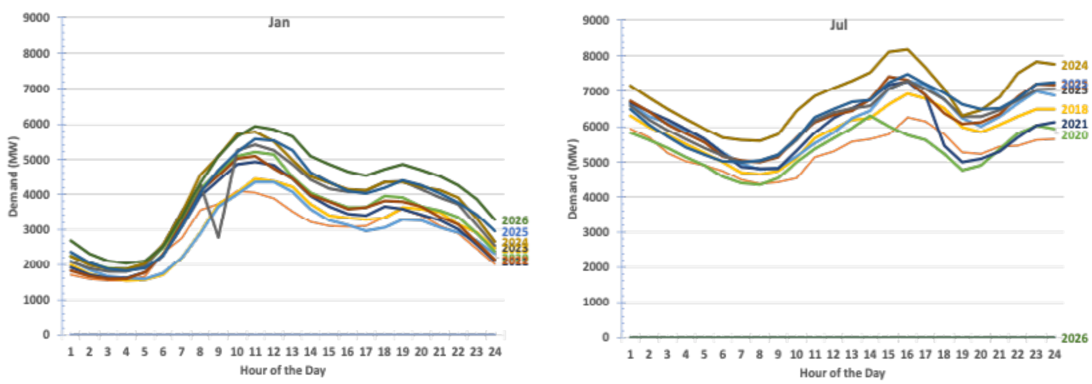

FIGURE 1 (C): Hourly demand (actual) on peak load days in Delhi in January and July (2018-2025)

The trajectory ahead compounds this challenge significantly. India currently installs 10 to 15 million AC units per year — two to three times the rate of just a few years ago. As temperatures rise and household incomes grow, an estimated 130 to 150 million additional units are projected to be installed over the next decade alone (Abhyankar et al, 2025). Absent policy intervention, AC-driven peak demand could reach 120 GW by 2030 and 180 GW by 2035, equivalent to nearly one-third of India's projected evening peak load (Abhyankar et al, 2025).

India's situation closely mirrors the trajectory of China two decades earlier. China's urban AC penetration rose from approximately 5% in the mid-1990s to nearly 100% by 2008, adding over 200 million units and an estimated 200 GW of peak load within 15 years. By 2023, urban AC penetration in China exceeded 150%, reflecting widespread ownership of multiple units per household. India now stands at a comparable inflection point. Average room AC ownership among urban Indian households is currently around 10%, rising to approximately 25% in higher-income segments, with significantly higher penetration already evident in cities such as Delhi, Mumbai, and Bengaluru.

1.2. INDIA'S ROOM AC EFFICIENCY STANDARDS AND UPCOMING REVISIONS

Energy efficiency improvement represents the most immediate and cost-effective lever available to moderate this demand trajectory. Room ACs in India fall under the mandatory star labeling program administered by the Bureau of Energy Efficiency (BEE). The labeling system uses a 1-star to 5-star scale based on annual energy consumption, with the 1-star label acting as the de facto Minimum Energy Performance Standard (MEPS). Historically, BEE has revised label thresholds every few years, with the last update occurring in 2026, and the next revision is scheduled for 2028. The forthcoming 2028–2029 label revision will not only revise the efficiency levels, but would eliminate the 1-star label for variable speed room ACs, with 2-star label becoming the de-facto MEPS, raising the MEPS floor to an Indian Seasonal Energy Efficiency Ratio (ISEER) of 4.3, or a nearly 25% revision compared to the current 2026 MEPS level, as shown in table 1.

TABLE 1: ISEER levels for star labels for variable speed room ACs in India

	2016-20	2021-25	2026-27	2028-29
1-star	3.1	3.3	3.5	—
2-star	3.3	3.5	3.8	4.3
3-star	3.5	3.8	4.1	4.7
4-star	4.0	4.4	4.7	5.2
5-star	4.5	5.0	5.3	5.8

Data sources: BEE (2018-2025)

Although India's current MEPS remain considerably less stringent than those of peer economies including China, the 2028 revision constitutes a significant step toward alignment with international best practice.

The objective of this paper is to assess the impact of the 2028 MEPS revision — and of sustained efficiency improvement beyond it — on India's peak electricity demand, consumer economics, and power sector investment requirements through 2035.

2. INDIA'S ROOM AC MARKET HAS OUTPACED THE EFFICIENCY STANDARDS

As of May 2026, more than 1,000 inverter AC models—representing approximately 15% of all listed units—carry ISEERs above 5.3, thereby exceeding the current 5-star threshold. The most efficient units available on the Indian market achieve an ISEER of 6.7 for 1-ton cooling capacity, and multiple brands, including Lloyd, Blue Star, Daikin, Wybor, and Circolife, offer models with ISEERs above 6.0. Across the broader market, nearly 60% of listed units exceed an ISEER of 4.3, over 30% surpass 4.7, and 15% exceed 5.3 (figure 2).

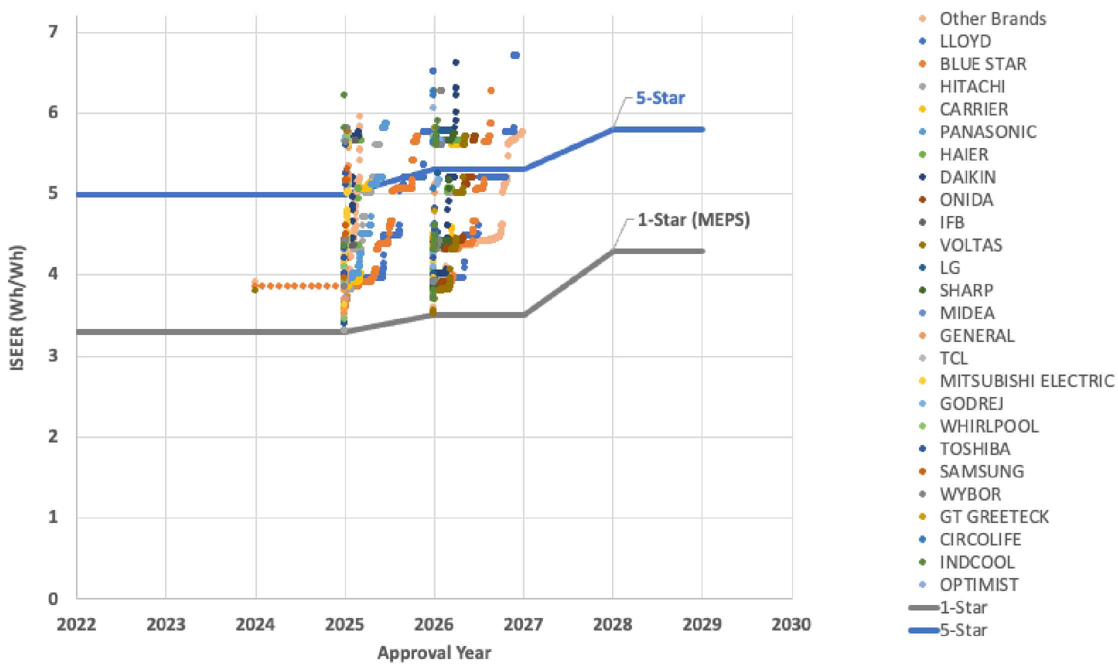

FIGURE 2: India's room AC units efficiency and star labels. Each plotted point represents a variable speed AC model offered for sale in India in 2026, with colors denoting manufacturers and the Y-axis reflecting AC efficiency in ISEER.

Data Source: BEE (2026) - www.beestarlabel.com

Notwithstanding this technological progress, market sales remain concentrated in the mid-efficiency segment. 3-star models typically account for about 60% of total sales, while 5-star models represent about 20%. Evidence from consumer surveys indicates that purchasing decisions are disproportionately influenced by upfront cost rather than lifecycle economics, and that distribution channels frequently favor lower-efficiency models.

By comparison, India's MEPS remain considerably below those of China, Japan, and South Korea, where leading models operate at significantly higher than the efficiency of India's current market average, indicating that substantially higher performance levels are technically attainable with commercially available technology.

3. METHODS

This analysis assesses the impacts of accelerating room AC efficiency improvements in India on peak demand, electricity consumption, and consumer benefits through 2035, building on prior work. Specifically, it evaluates the effect of the planned 2028 MEPS revision and examines outcomes under a scenario in which a comparable pace of efficiency improvement is sustained beyond the current labeling period.

3.1. SCENARIOS FOR ANALYSIS

Three scenarios of room AC efficiency improvement are assessed:

Reference. This scenario follows BEE star-label thresholds prior to the 2028 MEPS revision and assumes that efficiency improvements continue at the historical rate of one-star ratchet every three years — that is, the 2-star threshold of the preceding cycle becomes the new 1-star standard — corresponding to an annual efficiency gain of approximately 2–3%. Under this trajectory, the 1-star level is projected to reach an ISEER of 4.3 by 2033, which coincides with the level stipulated under the 2028 MEPS revision. This scenario serves as the reference case for the analysis.

No New Policy. This scenario incorporates the 2028 MEPS revision — raising the minimum standard to an ISEER of 4.3, but assumes no further revision thereafter, holding the MEPS constant through 2035.

Accelerated Efficiency Improvement. This scenario assumes that following the planned 2028 revision, MEPS thresholds are tightened at twice the historical rate beginning in 2030, equivalent to a two-star ratchet every three years — that is, the 3-star threshold of the preceding cycle becomes the new 1-star standard. The resulting trajectory is as follows:

- By 2028, MEPS reaches ISEER 4.3, consistent with existing planned policy.
- By 2030, MEPS advances to ISEER 5.3, equivalent to the current 5-star level.
- By 2033, MEPS reaches ISEER 6.7, equivalent to the most efficient room AC model currently available for sale on the Indian market — an approach analogous to the top-runner program applied in Japan.

This scenario implies an annual efficiency improvement rate of approximately 5–6%, more than double the rate under the Reference scenario, and is consistent with India's stated policy objective of doubling the rate of energy efficiency improvement.

Figure 3 presents the projected MEPS levels across the three scenarios through 2035.

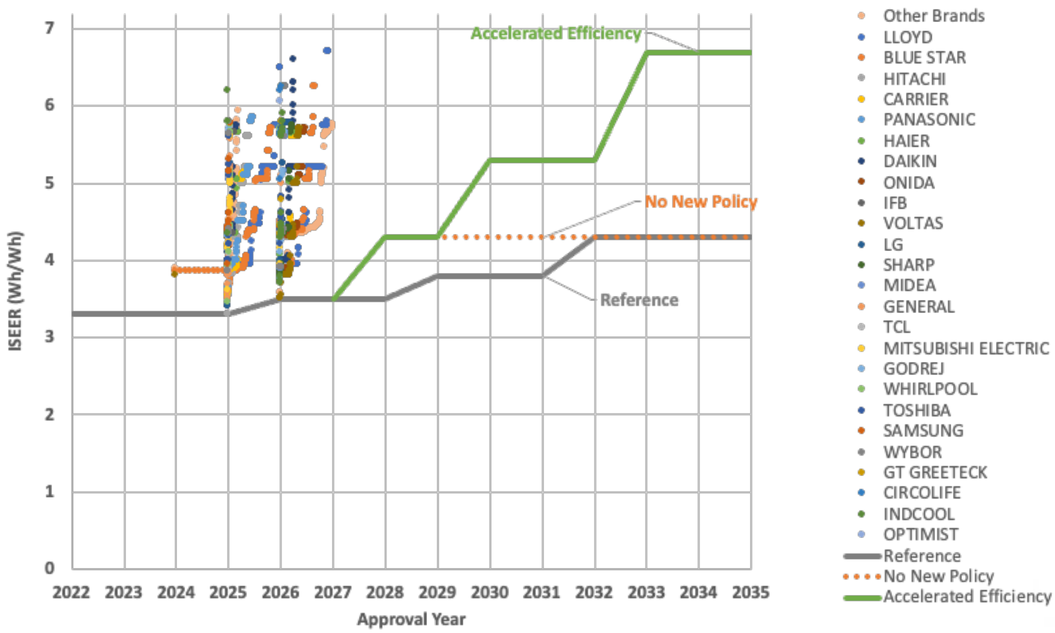

FIGURE 3: India's Room AC Units and MEPS in the Reference, No New Policy, and Accelerated Efficiency scenarios. Each plotted point represents a variable speed AC model offered for sale in India in 2026, with colors denoting manufacturers and the Y-axis reflecting AC efficiency in ISEER.

3.2. ROOM AC STOCK

We project that between 2025 and 2035, room AC sales will increase by 2.5 times, adding over 130 million new ACs into the system, resulting in a massive increase in space cooling energy consumption and peak demand.

TABLE 2: Projected Room AC Sales and Estimated Stock in India

	2020	2025	2030	2035
Room AC Sales (million units/yr)	7.5	14	23	34
Room AC Stock (million units)	45	72	126	202

3.3. ADDITIONAL METHODS AND ASSUMPTIONS

The analysis draws on a stock turnover model, incremental cost estimates, and consumer benefit calculations developed and documented in Abhyankar et al. (2025). That study provides full details on AC sales growth projections, the stock turnover model, electricity tariff and usage assumptions, the conversion from ISEER to peak coincidence-adjusted load, and transmission and distribution loss parameters. The present analysis applies those methods and assumptions directly. Please refer to Abhyankar et al. (2025) for complete methodological documentation.

4. RESULTS

4.1. ROOM AC EFFICIENCY WILL BE CRUCIAL FOR AVOIDING LOOMING POWER SHORTAGES

As shown in table 2, India is projected to add 130 million additional room ACs between 2025 and 2035. We find that **without targeted policy action (Reference case), room ACs could account for over 120 GW of peak demand by 2030 and 180 GW by 2035** (figure 4), representing nearly 30% of the country's projected evening peak load. The 2028 MEPS revision alone (No New Policy Case) would help in avoiding the peak demand by 7 GW by 2030 and 15 GW by 2035, implying substantial benefits in the long run (figure 4).

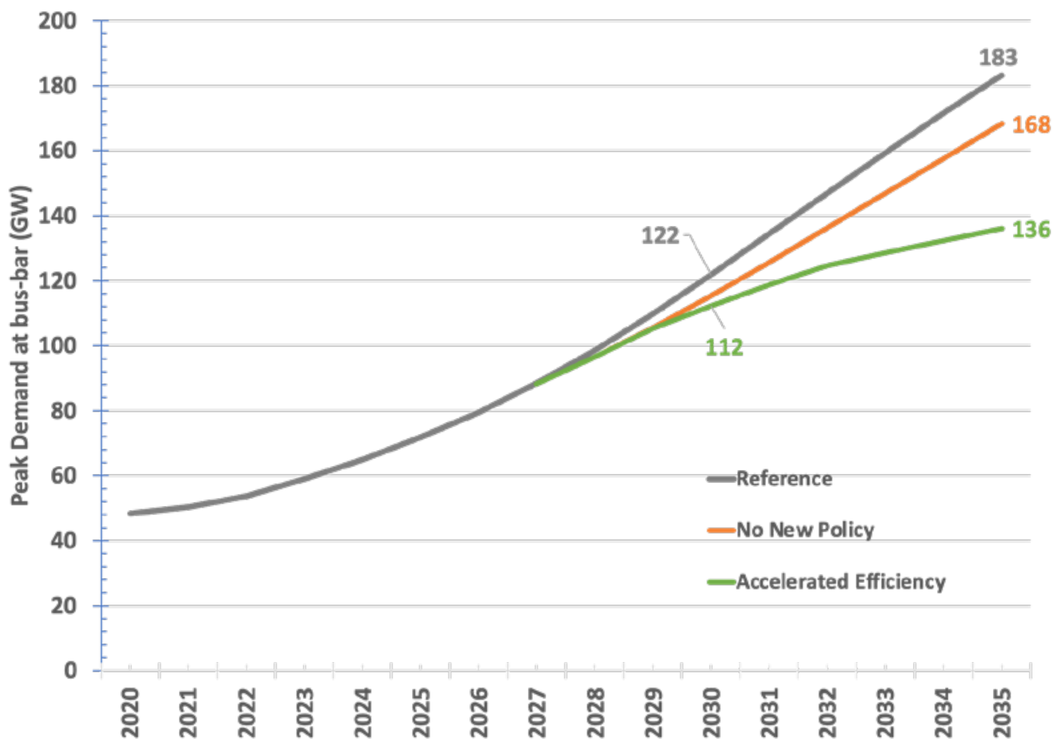

FIGURE 4: **Projected peak demand (national) due to room ACs in Reference, No New Policy, and Accelerated Efficiency scenarios**

However, the benefits of continuing the efficiency improvement along a similar trajectory beyond 2028 are massive. Under the Accelerated Efficiency Improvement scenario—where after the 2028 MEPS revision, MEPS are tightened by two-star levels every three years starting in 2030—**AC-driven peak demand can be reduced by 10 GW by 2030 and over 47 GW by 2035**. This is equivalent to avoiding the need for 95 large (500 MW) thermal power plants (~$60 billion in generation capacity), along with ~$25 billion in additional transmission and distribution infrastructure.

Efficiency improvements can also provide critical near-term relief to the power system. For instance, if India's electricity demand continues to grow at about 6.5% annually—consistent with recent post-COVID trends—evening peak demand is expected to rise by 72 GW between 2026 and 2030, with room ACs alone accounting for roughly 40% of this increase. Even after factoring in 44 GW of under-construction firm generation that is expected to be commissioned by 2030 (coal, nuclear, and hydro) and ~20 GW of energy storage, India could face a 8 GW peak capacity shortfall (table 3). However, accelerating room AC efficiency improvements starting in 2028 could reduce peak demand by approximately 10 GW by 2030, effectively eliminating the risk of peak power shortfalls.

If peak demand grows faster than 6.5% per year, or if there are delays in commissioning new firm generation, the peak power shortages could be as high as 26 GW (table 3). The role of AC efficiency improvement becomes even more critical in those cases as it can narrow the projected shortfall by half.

These outcomes underscore the strategic value of appliance efficiency as a demand-side resource. Tightening room AC standards is therefore not only a long-term energy savings measure, but also an immediate and essential tool for strengthening grid reliability.

TABLE 3: Projected evening peak demand, under-construction *firm* generation capacity, and peak shortfall in 2030

	Formula	Demand growth = 5% p.a.	Demand growth = 6.5% p.a.	Demand growth = 8% p.a
Evening Peak in 2026	A	250	250	250
Evening Peak in 2030	B	304	322	340
Net addition to the evening peak demand	C = B - A	54	72	90
New Firm Capacity (Under Construction / contract, incl storage)	D	64	64	64
Net Firm Capacity Shortfall	E = C - D	0	8	26
Peak Demand Reduction due to room ACs	F	7	10	13
Potential Peak Shortages	G = E - F	0	0	14

Note: All numbers in GW and all-India aggregate. Totals may not match due to rounding. “Firm” capacity includes only thermal (coal, nuclear, and hydro) and excludes any other renewable capacity. This is a simplistic exercise for developing an intuitive understanding. These are NOT simulation results. An implicit assumption behind this simplistic calculation is that the maximum firm capacity support by the existing generation capacity cannot go beyond 2026 summer levels (~250 GW). Also, RE generation is not given any evening peak capacity credit. Finally, all new hydro capacity, including ROR plants have been generously given full capacity credit. No delays are assumed in commissioning the under-construction power plants.

Data source for under construction capacity: CEA (2026a; 2026b)

4.2. EFFICIENCY IMPROVEMENTS DO NOT LEAD TO HIGHER AC PRICES: EMPIRICAL EVIDENCE FROM GLOBAL MARKETS INCLUDING INDIA

A common concern regarding aggressive AC efficiency revisions is the potential for increased room AC prices, making them less affordable for consumers. However, empirical data from global markets, including India, consistently show that improving AC efficiency does not result in higher consumer prices. On the contrary, efficiency improvements often coincide with lower costs, driven by economies of scale, enhanced manufacturing processes, and competitive market dynamics. This evidence dispels the notion that stricter efficiency standards lead to higher prices, reinforcing that consumers can benefit from both improved efficiency and affordability.

4.2.1. JAPAN

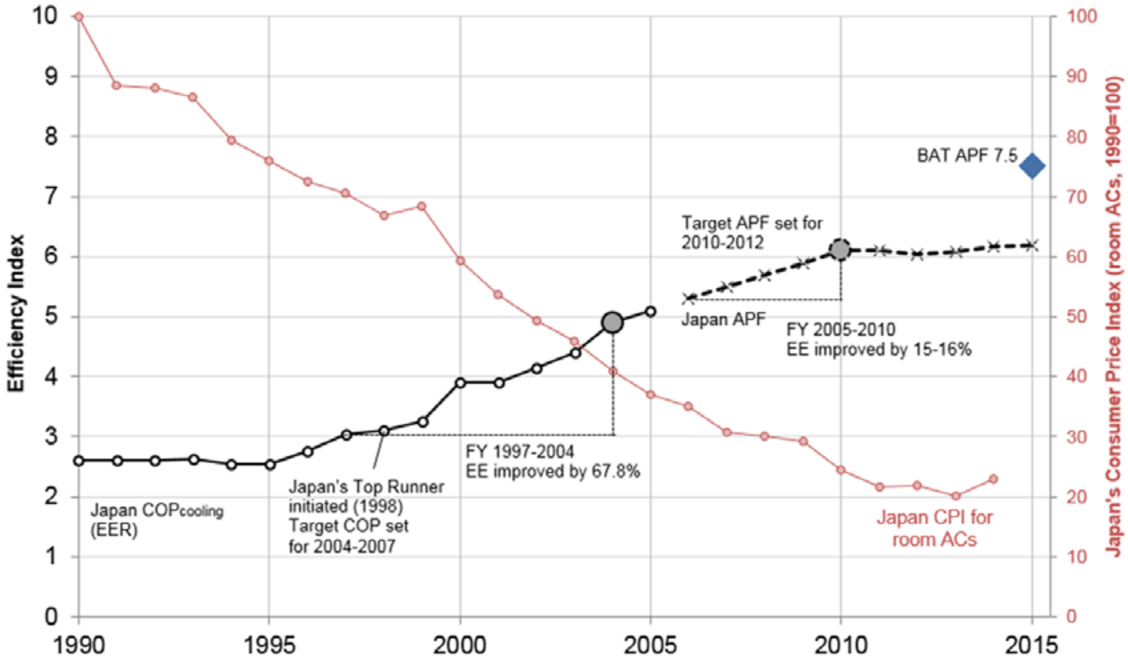

FIGURE 5: Room AC efficiency index (black) and room AC consumer price index (red) in Japan (1990-2015). Between 1995 and 2010, AC efficiency nearly doubled, while inflation-adjusted AC prices reduced by 80%.

Figure 5 illustrates trends in room AC efficiency in Japan, measured as coefficient of performance (COP) and annual performance factor (APF), alongside inflation-adjusted consumer price index (CPI) for room ACs.

One of the main policies to promote room AC energy efficiency in Japan is the Top Runner program launched in 1997. The program mandated that, by 2004, all AC manufacturers had to have a sales-weighted, fleet-average COP of 5.3 (W/W) for small ACs and 4.9 (W/W) for larger ACs, which was ~60% more efficient than the market average efficiency in 1997 (representing an improvement of more than 7.5%/year). This target COP was determined by the COP of the most efficient AC model available on the market at the time. Industry met this target by producing more efficient ACs and discontinuing the sale of inefficient ACs. Manufacturers used several technical measures to improve efficiency, including incorporating variable-speed compressors, micro-channel heat exchangers, and electronic expansion valves. Significant efficiency improvements were also achieved by increasing the size of heat exchangers and increasing refrigerant flow. Between 1995 and 2005, room AC efficiency in Japan improved by nearly 100% (from a COP of 2.55 to 5.10, a rate of 7.2% per year). Prior to the Top Runner program, room AC efficiency had not improved substantially over time in Japan.

In 2006, a new target was established for 2010, which required a further improvement of about 20%. The efficiency metric was changed to APF to enable accurate crediting of the savings achieved by variable-speed/inverter ACs and their performance in both cooling and heating mode. Industry also met the 2010 target.

The top runner program was successful in increasing the average room AC efficiency by over 90% since 1996, while inflation-adjusted prices declined by more than 80%. The rate of price reduction remained steady, even as efficiency improved substantially. Electricity prices did not exhibit a rising trend during this period, suggesting that efficiency improvements were not driven by changes in electricity costs but rather by market forces and technological advancements.

4.2.2. KOREA

In 1992, the Korean government implemented the Energy-Efficiency Label and Standard Program to improve the energy efficiency of key products, including appliances and vehicles, that account for a majority of the country's energy consumption (Lee, 2010). Mandatory MEPS were published in 2002 and took effect in 2004 for window and split AC units up to 23-kW cooling capacity. In September 2011, the government launched the Energy Frontier Program, which sets energy-efficiency criteria for key appliances at 30-50% more efficient than grade 1 (which was the most efficient criterion in 2011). The first phase of the program included four major appliances: TVs, refrigerators, ACs, and clothes washers (Lee, 2010). Samsung and LG together make up more than 80% of the Korean AC market. Industry experts indicate that both brands want most of their models to qualify under the Grade 1 or the Frontier criteria to be competitive in the market. Therefore, these efficiency requirements, despite being voluntary, have likely driven overall efficiency improvement in ACs on the Korean market.

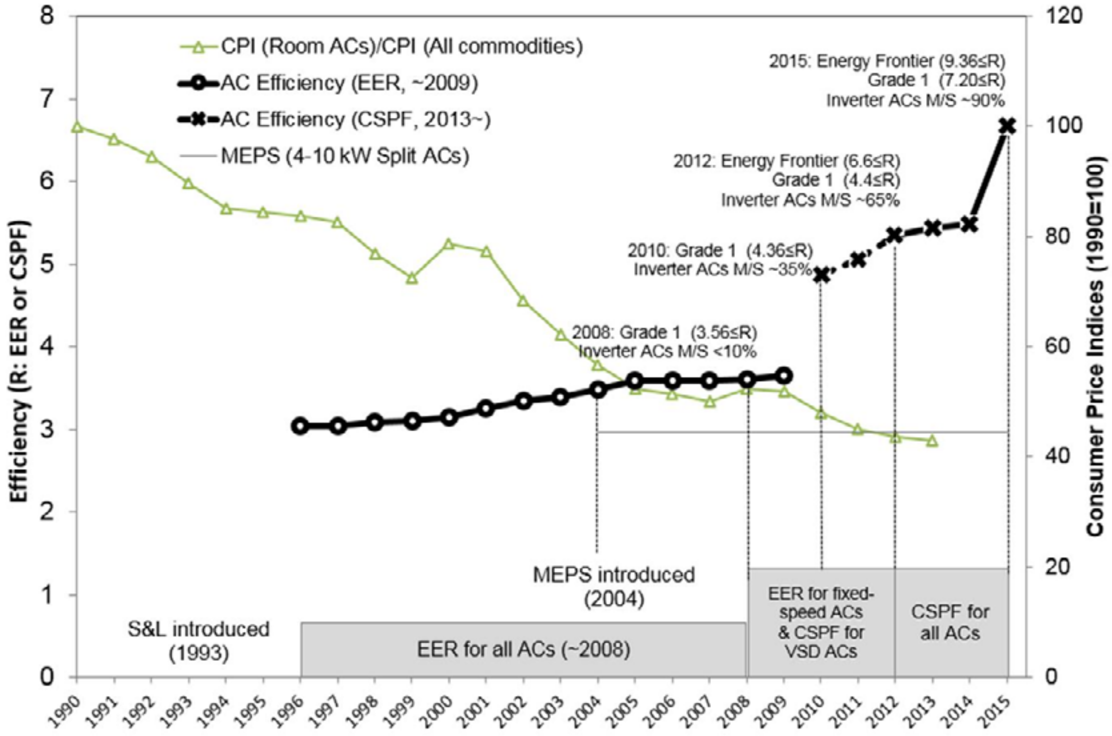

FIGURE 6: Room AC efficiency index (black) and room AC consumer price index (green) in Korea (1990-2015)

Sources: EERs for 1996-2008 are product-weighted averages (IEA, 2010). Mixed efficiencies with EER and CSPF for 2009-2010 and CSPF for 2013-2015 are product-weighted averages estimated using Korean Energy Agency's (KEA's) database (KEA, 2015). CPIs are from (KOSIS, 2014). Variable speed drive (inverter) ACs are estimated to account for more than 85% of the AC sales in the market in 2013 and more than 90% of AC sales in 2015 (KEA, 2015). The dotted lines are authors' estimates.

Figure 6 shows that the Grade-1 efficiency criterion has increased efficiency requirements by more than 100% since 2008, and most new models by LG and Samsung meet either the Grade 1 or the Frontier criteria, resulting in significant improvement in average AC efficiency compared to 2008 levels. The share of inverter/variable-speed ACs increased from less than 10% to more than 90% within a span of eight years, and efficiency improved by more than 100% (~12% per year). During this period, inflation-adjusted room AC prices (CPI) continued to decline.

4.2.3. INDIA

Between 2007 and 2023, driven primarily by BEE's S&L policies and global technological trends, room AC efficiency in India improved by 60%. At the same time, inflation-adjusted air conditioner prices nearly halved, reinforcing the idea that higher efficiency does not necessarily lead to increased costs (figure 7).

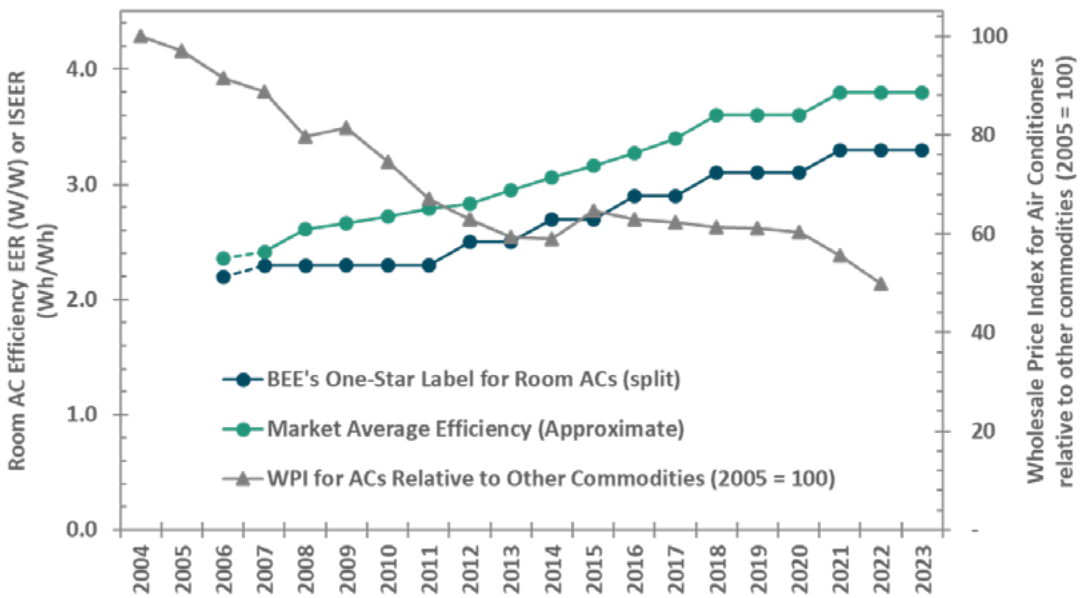

FIGURE 7: ***Figure 7: Room AC efficiency (blue, green) and room AC wholesale price index (grey) in India (2006-2023)***

Note: Efficiency metric uses EER prior to 2016, and ISEER after 2016.

Data Sources: Bureau of Energy Efficiency. (2018) [15] and Office of the Economic Adviser. (2023). [16]

Market research in India indicates that energy efficiency is not the primary driver of AC retail prices. Instead, pricing is shaped by brand positioning, product differentiation, smart connectivity, and stock availability. Notably, several no-frills 5-star (or higher) models are available at prices comparable to the market average for 2-star or 3-star units, dispelling the notion that efficiency improvements necessarily increase consumer costs.

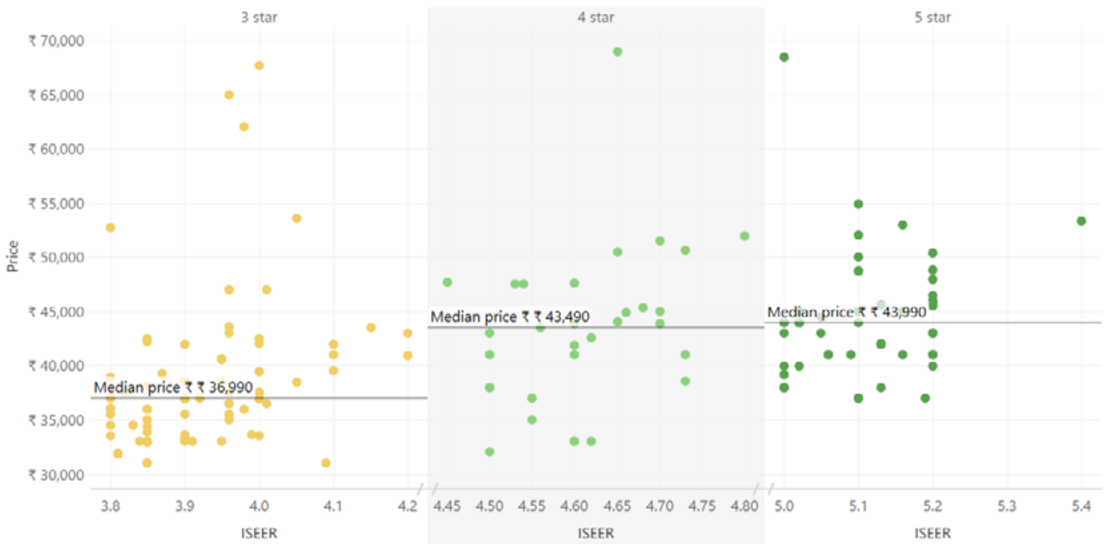

FIGURE 8: Room AC retail prices (2024) against efficiency levels (ISEER)

Source: Chunekar et al (2024)

Figure 8 shows the actual retail prices of room ACs in India in 2024, plotted against their efficiency levels (ISEER), confirming that efficiency has a weak correlation with AC prices. While the median price difference between 3-star and higher-efficiency models is approximately Rs 7,000, some super-efficient models (ISEER 5.2) are priced similarly to the median 3-star AC. Additionally, 4-star and 5-star models show little to no price difference. These findings suggest that brand reputation, unique product features, and stock availability play a more significant role in determining AC prices than energy efficiency alone.

4.3. ROOM AC EFFICIENCY INCREASE WILL RESULT IN MASSIVE CONSUMER SAVINGS

Our analysis finds that accelerating room AC efficiency improvement is highly cost-effective for consumers. The electricity bill savings over the appliance life significantly outweigh the incremental cost of purchasing a more efficient unit (figure 9).

Let us take an example of the 2028 MEPS revision. The existing (2026) MEPS or the one-star efficiency level is ISEER 3.5. With the 2028 revision, MEPS will be revised to ISEER 4.3. Figure 9 compares median retail prices and estimated annual electricity costs for these two efficiency levels, assuming a marginal tariff of ₹8.9/kWh and 1,250 operating hours per year.

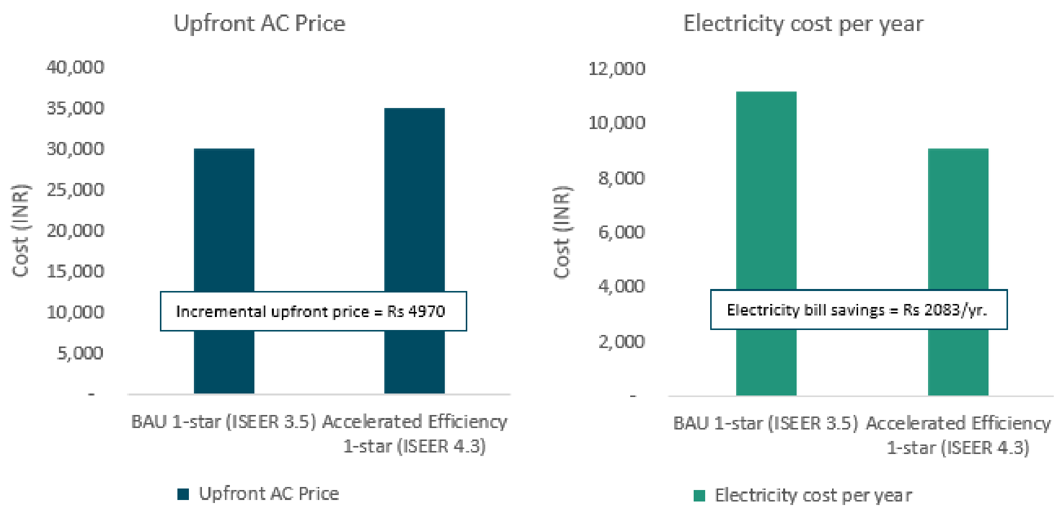

FIGURE 9: Estimating the consumer benefit for an individual consumer (1 ton)

Note: For estimating consumer electricity bill savings, it is crucial to use marginal electricity tariffs rather than average electricity tariffs because the savings from increased energy efficiency primarily reduce consumption in the highest tariff block, where electricity rates are the most expensive.

The incremental upfront price of a median 1-ton AC with ISEER 4.3 is Rs 4,970 compared to an median ISEER 3.5 AC. The higher-efficiency AC consumes 233 kWh less per year, resulting in annual electricity bill savings of Rs 2,083. This implies a payback period of under two and a half years. Over the life of the AC, the net consumer benefit, estimated as NPV of electricity bill savings minus the incremental upfront price, would be as high as Rs 7,000. For commercial consumers, where marginal electricity tariffs are significantly higher, the net consumer benefits will increase and the payback period will shorten further. The consumer economics would look very similar for a 1.5 ton AC, where the incremental upfront price would be Rs 8,000-10,000 and the annual electricity bill savings would be Rs 3,000-3,500, implying a payback period of 2.5-3 years and a net consumer benefit of about Rs 9,000.

Note that these consumer benefit assessments are highly conservative, as they are based on current market retail prices. However, as discussed in the previous section, historical trends show that as MEPS tighten, room AC prices continue to decline in real terms at the same rate. This suggests that future MEPS revisions are unlikely to impose additional costs on consumers.

In aggregate, the impact of improved efficiency is substantial. Under the Accelerated Efficiency Improvement scenario, **annual room AC energy consumption could be reduced by nearly 20 TWh per year by 2030, and by nearly 86 TWh per year by 2035**—equivalent to the output of over 45 GW of solar PV capacity (figure 10). On the other hand, in the No New Policy case (no further MEPS revision after 2028), the annual saving in energy consumption would be limited to 11 TWh/yr by 2030 and 22 TWh/yr by 2035, highlighting the benefits of sustained and aggressive MEPS revision beyond 2028.

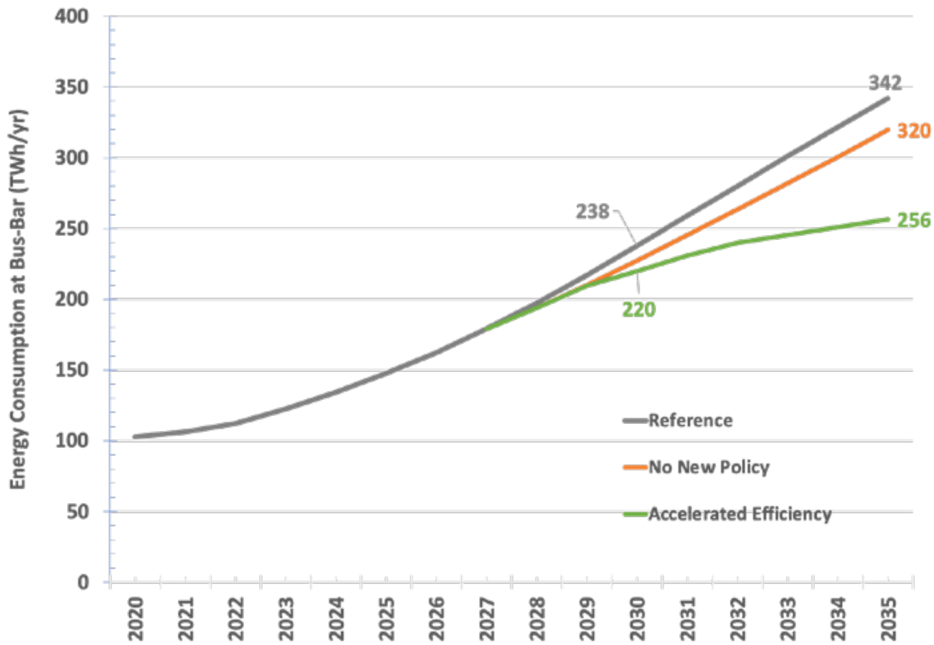

FIGURE 10: Room AC Energy Consumption at bus-bar (national total)

To quantify the **aggregate consumer benefit**, we estimate the **NPV** of electricity bill savings minus any additional purchase cost, for all units sold between 2028 and 2035. We consider two cases for estimating the upfront price of efficient ACs:

i. ***Realistic***: Accelerating efficiency improvements do not increase inflation-adjusted AC prices relative to the BAU scenario, consistent with the observed trends in India, Japan, and Korea (Taylor, Spurlock, & Yang, 2015; Van Buskirk, Kantner, Gerke, & Chu, 2014).

ii. ***Conservative:*** AC prices do increase as a result of accelerated efficiency improvements. We estimate the incremental prices based on detailed engineering cost assessments and actual retail market prices (see Abhyankar et al, 2025, Abhyankar et al 2017, Shah et al., 2016 and appendix for details).

Figure 11 shows the aggregate net consumer benefit from Accelerated Efficiency Improvement between 2028 and 2035.

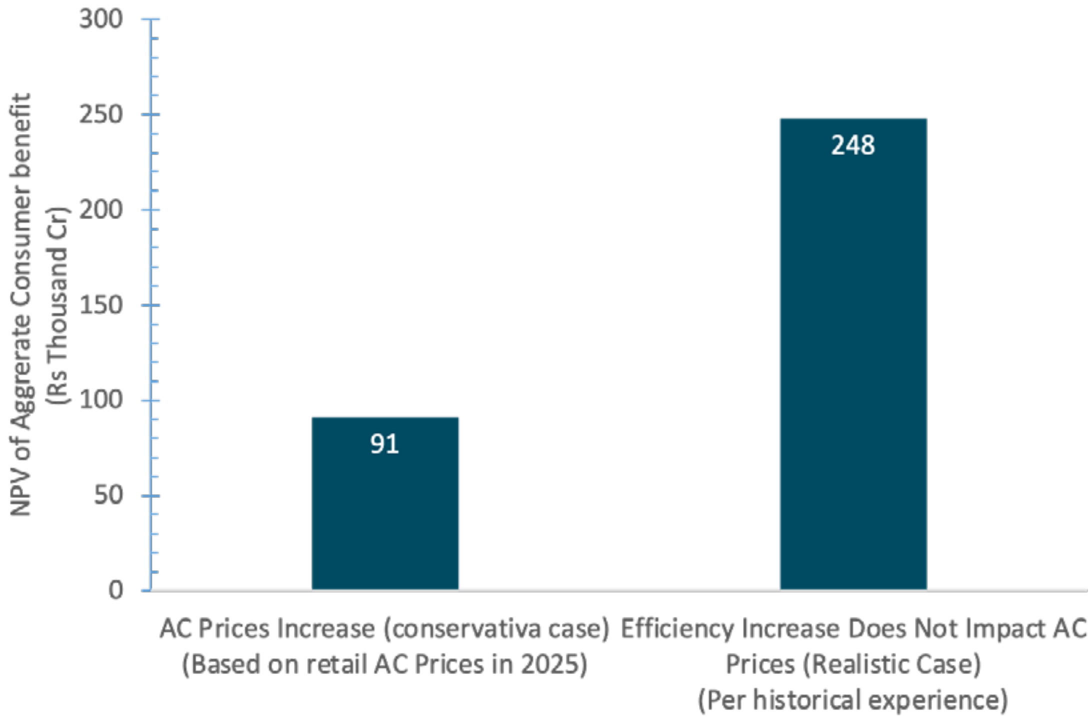

FIGURE 11: *NPV of net consumer benefit from accelerated efficiency improvement*

Key Assumptions: Hours of room AC use: 1,250 hours/yr; marginal electricity tariff: Rs 8.9/kWh in 2025 increasing at 2% per year; Discount rate: 8% for estimating NPV; median life of AC: 7.3 years. Note that the net benefits estimates are merely indicative because the electricity prices and hours of use may change in the future.

Between 2028 and 2035, **net consumer benefit would range from Rs 91,000 crore (US$ 9 billion)** in the conservative case (if AC prices increase with efficiency) **to Rs 248,000 crore (US$ 25 billion)** in the realistic case (if efficiency improvements do not impact AC prices).

While manufacturers may face additional costs to produce higher-efficiency models, these are largely captured in incremental retail prices. Moreover, tighter efficiency standards can offer scale / volumes to efficient products and may help lower their manufacturing costs and prices, as observed empirically in multiple countries. Additionally, they can strengthen the global competitiveness of Indian AC manufacturers, opening up export opportunities and incentivizing local production of high-performance components. A broader evaluation of industry-side effects would further reinforce the case for accelerated MEPS—but even without this, the consumer and system-level benefits are both clear and compelling.

4.4. EFFICIENCY IMPROVEMENT WILL RESULT IN SIGNIFICANT EMISSIONS SAVINGS

This energy consumption saving translates to significant electricity supply-side greenhouse gas (GHG) emission savings: approximately 12 MtCO_2 per year by 2030 and 49 MtCO_2 per year by 2035 in Accelerated Efficiency case (Figure 12), based on India's projected grid emission factors. In the No New Policy case, electricity supply-side GHG emissions would reduce by 7 MtCO_2 per year by 2030 and 13 MtCO_2 per year by 2035 relative to the Reference case. Note that these figures reflect only the emissions avoided from reduced electricity generation and do not account for refrigerant-related climate impacts.

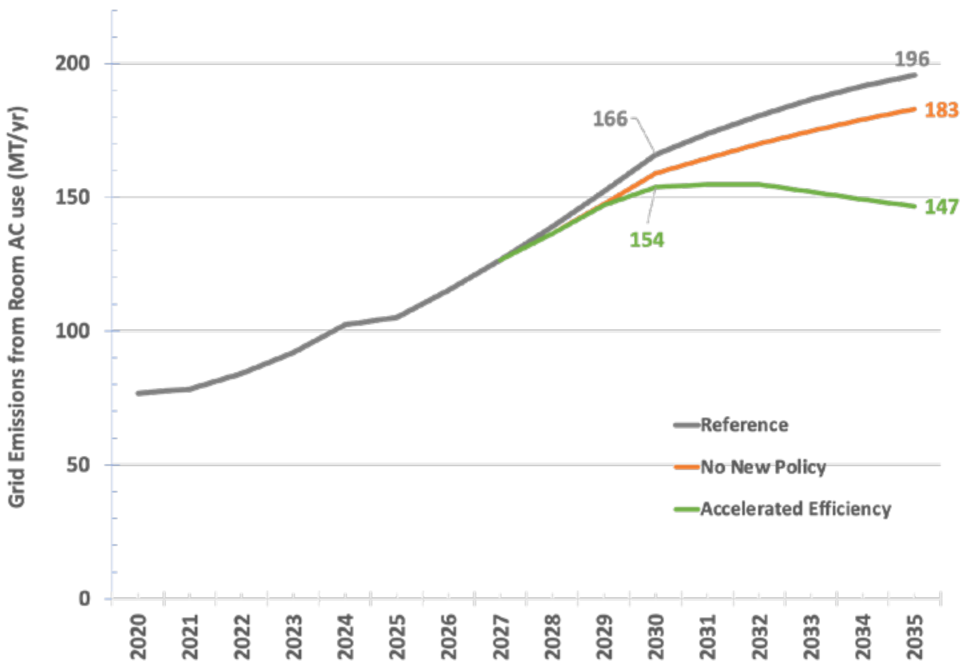

FIGURE 12: Electricity supply-side greenhouse gas emissions in CO2e (not including any refrigerant-related climate impacts).

5. POLICIES AND PROGRAMS TO ACCELERATE ROOM AC EFFICIENCY IMPROVEMENT

5.1. A CLEAR CASE FOR ACCELERATED STAR LABEL RATCHETING

Experience in India and internationally shows that MEPS and comparative star labels are among the most effective tools for driving appliance efficiency. In India, 3-star ACs dominate the market, and the average unit sold typically aligns with the 2- or 3-star efficiency level—even as labeling thresholds have remained relatively lenient in recent years.

To accelerate market transformation, it is essential to strengthen the MEPS (1-star level) rather than just nudging the upper end of the star scale. If MEPS revisions remain weak or infrequent, the market risks drifting toward lower efficiency tiers, blunting the overall impact of the labeling program. Importantly, this does not necessarily mean more frequent updates—just the ambition of each revision cycle needs to be much steeper.

A long-term policy roadmap, similar to Japan's Top Runner Program, can offer the clarity and direction needed to guide manufacturers, utilities, and consumers toward more efficient technologies.

We strongly recommend the following long-term trajectory for MEPS:

- **2028**: Set MEPS at ISEER 4.3 (per the current revision schedule).
- **2030**: Set MEPS at ISEER 5.3 (equivalent to the 5-star level in the existing schedule).
- **2033**: Set MEPS at ISEER 6.7 (equivalent to the most efficient model currently available for sale in the Indian market).
- **2035**: Ensure that ISEER 7.4 (globally best available commercial technology) becomes the market average (3-star).

Figure 13 illustrates the recommended MEPS trajectory (green line) alongside BEE's historical and current policy (black line).

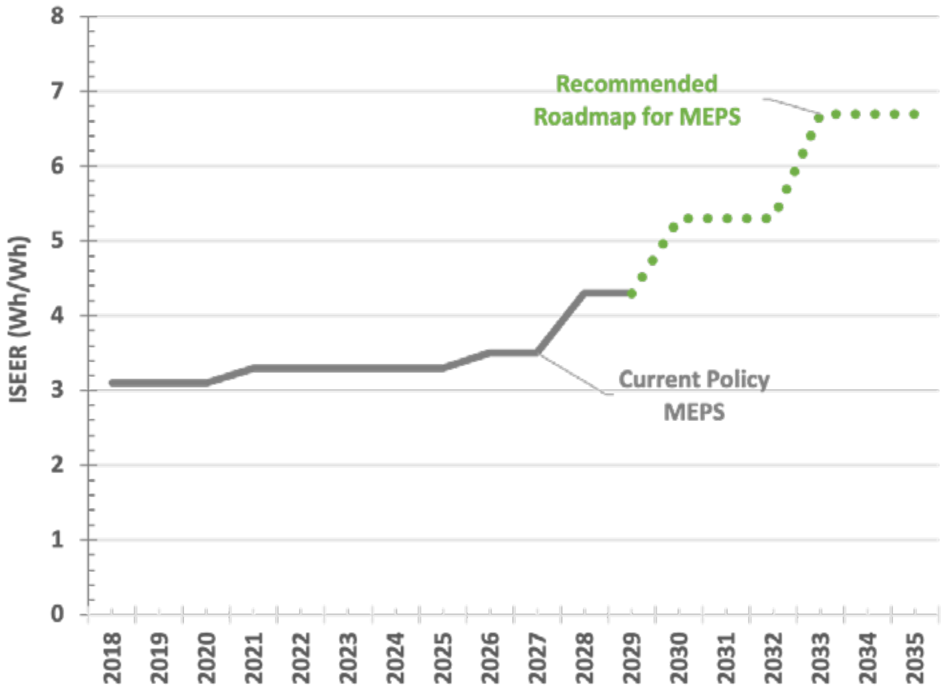

FIGURE 13: Recommended trajectory for room AC (variable speed) MEPS (green line). The chart also shows BEE's current policy as well as historical MEPS levels (grey line).

This pathway would more than **double the historical rate of efficiency improvement** (from 2–3% to 6–8% per year), ensuring that Indian efficiency standards stay aligned with the country's global commitments, such as those under the G20. This would not only reduce peak demand and electricity consumption but also help India avoid locking in inefficient technologies that would persist in the market for years.

5.2. BULK PROCUREMENT AND INCENTIVES TO SUPPORT MEPS TIGHTENING

While tightening standards is essential, complementary programs are needed to scale demand for efficient products and smooth the transition for manufacturers and consumers.

India has already demonstrated the success of this approach. Programs like EESL's Super-Efficient AC Procurement Initiative—inspired by the UJALA LED program—have shown that large-scale, aggregated procurement can drive down costs and rapidly transform the market. Such initiatives also serve to prime the supply chain for mass production of high-efficiency units.

Targeted incentive programs can further accelerate adoption by addressing upfront cost barriers, especially among lower-income households. However, program design must be carefully calibrated to minimize free-rider effects—where consumers who would have purchased efficient models anyway benefit from subsidies. Lessons from Mexico's refrigerator replacement program (Boomhower & Davis, 2014) suggest that smaller, well-targeted incentives can be just as effective as larger ones.

Bulk procurement and incentives also play a critical role in introducing ultra-efficient models into the market—such as globally most efficient products or the global cooling prize winner products —creating a pipeline for future MEPS revisions.

5.3. EXTEND THE EFFICIENCY FRAMEWORK TO OTHER COOLING TECHNOLOGIES

As India's cooling demand diversifies, it is important to extend energy efficiency policies to other types of space-cooling equipment, including Chillers, Variable Refrigerant Flow (VRF) systems, ducted and packaged ACs, and rooftop units. Applying a similar accelerated trajectory to these products will require enabling measures, including: (a) development of standardized test procedures, (b) expansion of testing lab capacity, (c) definition of appropriate efficiency metrics, and (d) integration of standards with building codes and regulatory frameworks. These steps will ensure that India builds a comprehensive, forward-looking cooling efficiency ecosystem—not just for room ACs, but across all major cooling segments. This will be essential to achieving national energy security, climate goals, and resilient infrastructure planning.

6. KEY CAVEATS

While this analysis presents a compelling case for accelerating room AC efficiency improvements in India, several key caveats must be acknowledged:

- **Dehumidification Performance and Real-World Energy Savings:** The efficiency scenarios in this analysis are based on the current ISEER metric, which primarily reflects sensible cooling performance under standard test conditions and does not fully account for latent heat (moisture) removal. In India's hot-humid climate, dehumidification constitutes a significant share of an AC's energy load — on highly humid days, more than half of total energy consumption can be attributed to moisture removal. ACs optimized for latent removal can deliver equivalent comfort at higher thermostat setpoints, with each 1°C increase in setpoint reducing cooling electricity use by approximately 6–8%. As India updates its test procedures to incorporate dehumidification performance, future efficiency metrics may better reflect real-world energy savings, potentially yielding benefits beyond those estimated here.

- **Frontier Technologies from the Global Cooling Prize:** The MEPS assumed in the Accelerated scenario, ISEER of 6.7, corresponding to the most efficient models currently available in the Indian market — may itself prove conservative if next-generation technologies from the Global Cooling Prize (GCP) reach commercial scale. GCP-winning prototypes demonstrated up to five times lower climate impact and approximately 50% lower energy consumption than typical ACs, using novel thermodynamic cycles and low-GWP refrigerants. If manufacturers commercialize these designs during the analysis period, as planned for the mid-2020s, the efficiency potential of the market could exceed the bounds modeled here. This analysis does not account for such step-change improvements, and actual savings could be substantially higher under a favorable technology deployment trajectory.

- **Uncertainty in Future Market and Technological Trends:** The projections in this study assume that historical trends in efficiency improvements, cost reductions, and market dynamics will continue. However, external factors—such as supply chain disruptions, global technological advancements, and shifts in consumer preferences—could alter these trajectories.

- **Impact of Climate Change and Cooling Demand Growth:** As climate change intensifies, rising temperatures may lead to higher-than-anticipated cooling demand, potentially offsetting some efficiency gains. Additionally, urban heat island effects and changing weather patterns could further accelerate AC adoption, influencing energy and peak load forecasts.

- **Behavioral and Socioeconomic Factors:** While efficiency improvements lower per-unit energy consumption, the rebound effect—where consumers use more cooling due to lower operating costs—could partially offset expected energy savings. Additionally, socioeconomic factors, such as income growth and increased AC affordability, may drive higher adoption rates, impacting overall electricity demand.
- **Manufacturing and Supply Chain Considerations:** While Indian AC manufacturers already produce high-efficiency models, rapid regulatory changes could pose challenges related to scaling up production capacity, ensuring component availability, and maintaining cost competitiveness. Strategic industry support and incentives may be required to smooth the transition.
- **Electricity Tariff and Consumer Savings Assumptions:** Our consumer savings estimates depend on assumed electricity tariffs and usage patterns, which may change over time. Future electricity pricing reforms, variations in peak vs. off-peak tariffs, and demand-side management programs could influence the actual financial benefits realized by consumers.
- **Implementation Challenges in Policy and Standards Revisions:** The effectiveness of proposed MEPS and labeling revisions depends on strong regulatory enforcement, compliance monitoring, and periodic policy updates. Past experience suggests that delays in implementation or weak enforcement mechanisms could limit the impact of efficiency policies.
- **Integration with Other Cooling Strategies:** While improving AC efficiency is a critical strategy, it must be complemented by broader cooling interventions, including passive cooling techniques (e.g., cool roofs, shading, and ventilation), efficient building design, and demand-side management programs. A holistic approach is necessary to achieve sustainable cooling growth.

Despite these caveats, the findings strongly support an accelerated efficiency trajectory as a cost-effective and necessary strategy to manage India's growing cooling demand, reduce peak electricity loads, and enhance consumer benefits. Proactive policy interventions—aligned with global best practices—can enable India in achieving its goal of becoming a global leader in sustainable and affordable cooling technologies, ensuring both energy security and economic competitiveness in the years ahead.

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