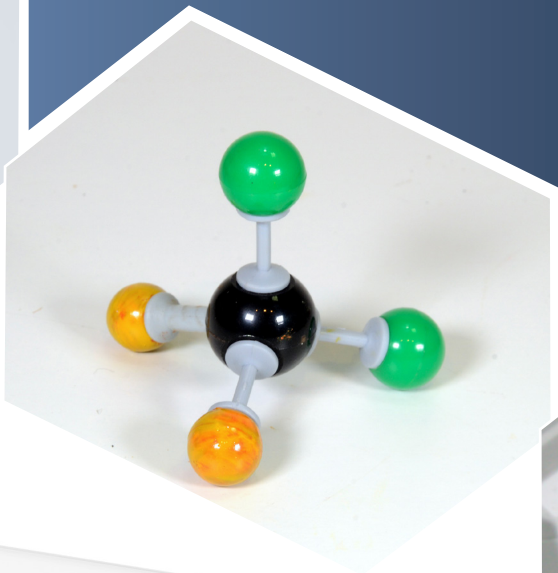

Mapping the Refrigerant Trends in India: An Assessment of Room AC sector

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SHAKTI
SUSTAINABLE ENERGY
FOUNDATION

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Shakti Sustainable Energy Foundation (Shakti) seeks to facilitate India's transition to a sustainable energy future by aiding the design and implementation of policies in the following sectors: clean power, energy efficiency, sustainable urban transport, climate policy and clean energy finance.

This paper provides insights regarding the Mapping the Refrigerant Trends in India: An Assessment of Room AC sector vis-à-vis refrigerant consumption. The is supported by Shakti Sustainable Energy Foundation (SSEF)

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Abbreviations

AC	Air-Conditioning
CAGRs	Compound Annual Growth Rates
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
RAC	Room AC
BEE	Bureau of Energy Efficiency
HVAC	Heating, Ventilating, and air-conditioning
TPES	Total Primary Energy Supply
VRF	Variable Refrigerant Flow
MEPS	Minimum Energy Performance Standards
EER	Energy Efficiency Ratio
ISEER	Indian Seasonal Energy Efficiency Ratio
MT	Metric Tonne
ODS	Ozone-depleting substances
ODP	Ozone-depleting Potential
HFO	Hydrofluoro olefin
HCFC	Hydrochlorofluorocarbon
HPMP	HCFC Phase-Out Management Plan
ICAP	India Cooling Action Plan
BAU	Business-as-usual

1. Introduction

India has been responsible for almost 10% of the increase in global energy demand since 2000. This demand is expected to increase to about 1250 (IEA estimates) to 1500 (Integrated Energy Policy Report estimates) million toe in 2030. Electricity demand in India was 938 TWh in 2012, which is expected to reach 2499 TWh by 2030 (India's NDC to UNFCCC). The electricity consumption in the industry and domestic sectors has increased at a much faster pace as compared to other sectors during 2006–07 to 2015–16 with compound annual growth rates (CAGRs) of 9.47% and 7.97%, respectively (Energy Statistics 2018, Ministry of Statistics and Programme Implementation, MOSPI). The estimated electricity consumption increased from 455 TWh during 2006–07 to 1001 TWh during 2015–16, with a CAGR of 8.19%. Of the total consumption of electricity in 2015–16, the domestic sector accounted for the second largest share (24.32%) marked by changing electricity consumption and peak demand patterns across urban centres in India.

At the same time, the room air-conditioning (AC) sector has very less penetration at around 7–9% in the country; however, the rise in demand is expected to occur at a CAGR of 15% in the period 2018–2020. The growth would mark an increase in emissions due to high global warming potential (GWP) refrigerant usage and electricity consumption. Therefore, it becomes vital for the nation to phase down high GWP hydrofluorocarbon (HFC)-based refrigerants and rapidly introduce low-GWP refrigerants and mechanisms to achieve energy efficiency in room AC (RAC) equipment. This study discusses the increase in refrigerant demand in three different policy scenarios, indicates the current refrigerant use and past trends, the key challenges, and possible interventions in the room AC sector.

1.1 Building Sector Energy Demand

Unprecedented rise has been seen in the domestic sector energy demand.[2] India is urbanizing rapidly – in 2010, about 31% of India's population was residing in urban areas, which is expected to grow to 50% by 2050 (CREDAI, CBRE, 2015), adding about 441 million to the urban population, while the number of urban households is expected to double by 2032. It is estimated that India would potentially have to build about 700–900 million m2 of residential and commercial spaces in the urban areas every year for the next 20 years (Bureau of Energy Efficiency [BEE] design guidelines for energy efficient multi-storied residential buildings). The per capita floor space requirement of the residential sector, which was 12.8 m2 in 2012, is estimated to grow to 35 m2 in 2050, which would increase the electricity demand manifold. Electricity demand in residential and commercial building sectors constitutes around 33% of the total electricity demand in India. Share of residential demand stands at approximately 24.32% of the total electricity demand. Figures 1 and 2 show electricity consumption patterns in commercial and residential buildings, respectively.

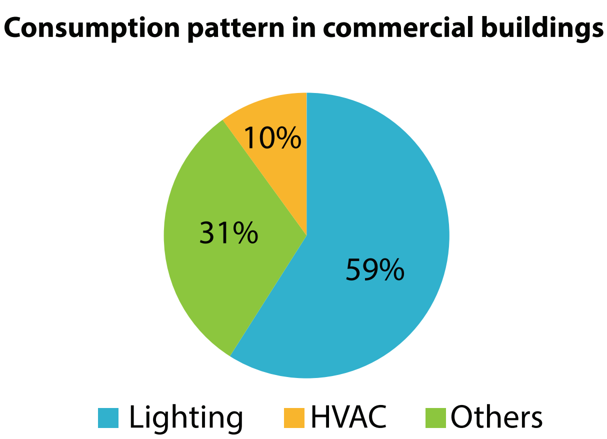


Figure 1: Typical electricity consumption pattern in commercial buildings

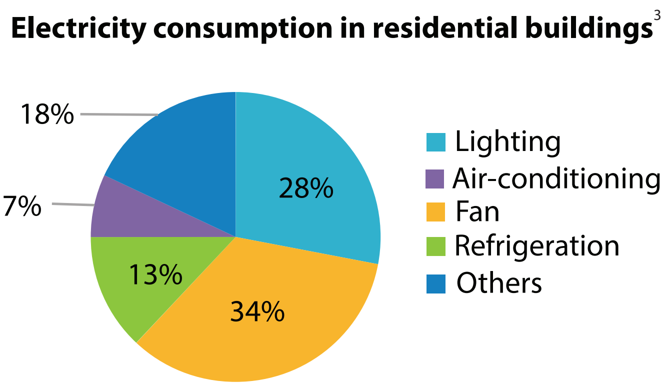


Figure 2: Electricity consumption in residential buildings

[2] *http://mospi.nic.in/sites/default/files/publication_reports/Energy_Statistics_2018.pdf*
[3] *http://www.gbpn.org/sites/default/files/08.%20INDIA%20Baseline_TR_low.pdf*

1.2 Heating, Ventilation and Air-Conditioning Segment

In the building sector, heating, ventilating, and air-conditioning (HVAC) devices take a major portion in the electricity consumption in residential, commercial, and industrial applications, leading to tremendous pressure on energy sources, and ultimately impacting the climate. Space cooling is likely to consume around 56% of the total primary energy supply (TPES) by 2027–28.[1] Currently, space-cooling requirements in India are predominantly met by fan and room air conditioners in residential buildings, and chillers and variable refrigerant flow (VRF) in commercial buildings. However, still a very low percentage of Indians (around 5–6%) use air conditioners for comfort. The share of various AC equipments in the segment is given below and it can be seen that room AC occupies the largest share at 50% (BEE).

Segment Share of Air Conditioning (2011-12)

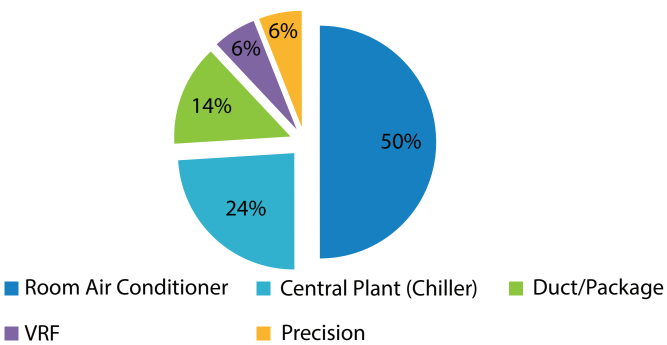


Figure 3: Share of different technologies in space cooling (Source- AIACRA, Francis Kanol, Kanvic Analysis)

1.3 Room Air Conditioner Market: Growth and Energy Efficiency

The room air conditioner market has been growing at a CAGR of 12% over last 5 years. In India, the current annual demand of RAC is approximately 7.6 million units (2018). However, the market is minimal as compared to other developing countries such as China, where the room air conditioner demand was around 43.48 million by 2017 itself (world air conditioner demand by region - JRAIA).

As per the current market of room air conditioners, fixed-speed split ACs cater to the majority of the market and are a priority segment for manufacturers. In the total AC market of 7.66 million (2018), fixed-speed ACs constitute around 54 million units and variable-speed ACs account for the remaining 22 million.[4] Air conditioners of capacity 1.5 tonnes and 1 tonne constitute the major share of the market. The following figure shows the increasing pattern of inverter AC penetration in the market.

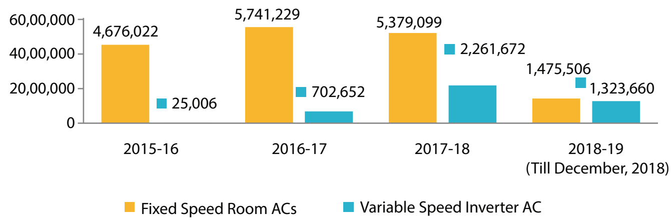


Figure 4: Variation of inverter AC and fixed-speed share in the market (Source-BEE)

1.4 Energy Efficiency

BEE launched the Standards and Labelling Program for RACs in year 2007. Initially the program was started in a voluntary phase for fixed-speed air conditioners, up to a rated cooling capacity of 10,465 watts (9,000 kcal/hour).

Subsequently, the star rating for room air conditioner was made mandatory in 2010. Scope was expanded in 2015, to include cassette ACs, floor-mounted and ceiling-mounted ACs.

Since 2007, BEE upgraded the standards for the first time in 2012 and set the minimum energy performance standards (MEPS), energy efficiency ratio (EER) at 2.5 from 2.3. Similarly, the Bureau tightened the MEPS in 2014 and ratcheted up from EER 2.5 to 2.7. Star-5 in 2010 (threshold for 5 star in 2010 was EER- 3.1) became Star-1 in 2018 (threshold for 1 star in 2018 was ISEER- 3.1) as per new Indian Seasonal Energy Efficiency Ratio (ISEER) methodology.

BEE expanded its scope of policy measures to cover high-efficiency variable-speed drive technology RACs (inverter AC), which is the next-generation efficiency product in the market. The air conditioner performance would be tested as per Indian conditions and rated using the ISEER. In 2018, the Bureau merged the program for fixed and inverter AC, and implemented the ISEER methodology for evaluating the performance for fixed speed as well. The current energy performance standard levels are shown in Table 1.

1.5 Refrigerants in Room Air Conditioner Segment

The above sections provided insights into the AC demand, thereby energy demand and energy efficiency status in the

[1] *http://www.indiaenvironmentportal.org.in/files/file/DRAFT India%20Cooling%20Action%20Plan.pdf*

[4] *http://www.beestarlabel.com/Home/EnergySavings*

Table 1: Star Rating Plan valid from January 1, 2018 to December 31, 2019

Indian Seasonal Energy Efficiency Ratio (kWh/kWh)		
Star level	**Minimum**	**Maximum**
1 Star	3.1	3.29
2 Star	3.3	3.49
3 Star	3.5	3.99
4 Star	4.0	4.49
5 Star	4.5	

Source- BEE

country. The formidable AC demand, which India is poised to witness, would substantially impact its global warming commitments and emissions intensity. The second vital aspect of AC is refrigerant use. The world witnessed the use of refrigerants from ozone-depleting substances (ODS) to substances with high GWP. It is pertinent to consider the impact of refrigerants on warming.

A refrigerant is a substance or mixture, usually a fluid, used in a refrigeration cycle.

This fluid medium is used for convective heat transfer within the refrigeration or AC unit.

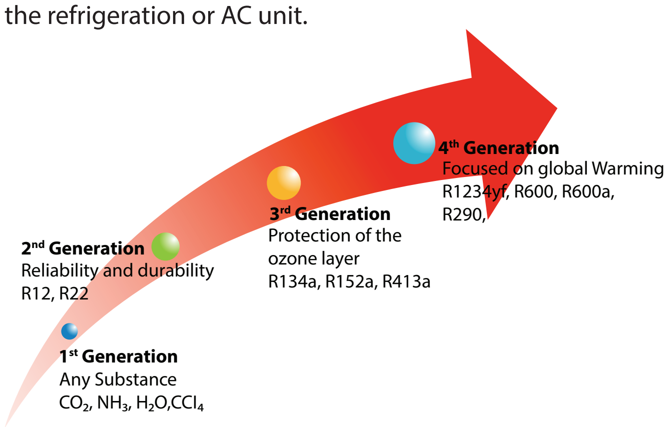


Figure 5: Generations of refrigerants (Source: Science Direct)

From Table 2, it is shown that the only ozone-depleting refrigerant is R22, while R290 is a highly flammable class 3 refrigerant. The rest are not flammable. R410a has the highest GWP. It is widely accepted that R290 and R32 are the most promising refrigerants as they are environment friendly and clean, whereas R290, although flammable, can be safely handled during installations and servicing. In addition, there is not much clarity on hydrofluoro olefin (HFO) and alternate refrigerants in the RAC segment.

1.6 International Policies – Montreal Protocol: Kigali Amendment

In the winter of 2016, nearly 197 countries got together in Kigali, Rwanda to mark incremental progress in overcoming differences, drawing upon creativity, compromises, and trust towards finally reaching an agreement, which is ambitious, balanced, and unique. Countries came together to adopt a deal to phase down global climate warming HFC emissions under the Montreal Protocol, drawing a set of differentiated baselines and freeze years within both Article 5 and non-Article 5 countries. India took responsible steps to move up its ambition from an initial proposal to phase down HFCs from 2031 to a schedule, which begins phasing down HFCs 3 years earlier.

Given the high growth nature of the Indian economy, which is yet to peak its production and demand for refrigeration/cooling, the step came as a strong message from the Indian delegation to Kigali on its leadership in contributing to do more with the limited time and resources available. However, leapfrogging its ambition by 3 years would have an implication on the pace at which Indian manufacturing and refrigerant gas industry could transition itself in line to match India's goals.

The unprecedented level of cooperation and commitment by all countries during the Montreal Protocol is considered

Table 2: Comparison of the refrigerants used in the room air conditioning

S.no	Refrigerant	ODP	GWP[5]	Type	Flammability	Toxicity
1	R 410A	0	2088	HFC	No flame propagation (A1 – ASHRAE Code)	Lower toxicity A1
2	R22	0.055	1810	HCFC	No flame propagation (A1 – ASHRAE Code)	Lower toxicity A1
3	R32	0	675	HFC	Lower flammability (A2L – ASHRAE Code)	Lower toxicity B2L
4	R290	0	3	Propane	Higher flammability A3	Lower toxicity A3

[5] *http://www.unep.fr/ozonaction/information/mmcfiles/7809-e-Factsheet_Kigali_Amendment_to_MP_2017.pdf*

as the most important leading factor for its success. There are separate phase-down schedules for Article 5 countries and non-Article 5 countries. Moreover, Article 5 parties are further divided in two groups based on their phase-down schedules.

India falls under group 2 as far as HFC phase down is concerned. India will complete its phase down in four steps from 2032 onwards with cumulative reduction of 10% in 2032, 20% in 2037, 30% in 2042, and 85% in 2047. Following figures elucidate the phase-down schedules for various Article 5 countries.[6]

1.7 Domestic Policies

Since the early 1990s, the Government of India has been preparing itself to the phase out of ODS and has developed national strategies for faster, inclusive, and effective implementation of India's ambitious pledges to the Montreal Protocol. Over the past two decades, India has successfully implemented ODS phase-out projects that have enabled industry to smoothly and systematically transition to ozone-friendly alternatives.

Accelerated Hydrochlorofluorocarbon Phase-Out Plan – India adopted an ambitious target to phase out hydrochlorofluorocarbon (HCFC) earlier than 2040 to 2030 and has set developed strategies to this effect.

- HCFC Phase-Out Management Plan (HPMP) – Stage-I – Plan comprises of a combination of interventions such as technology conversions, policies and regulations, technical assistance, training, awareness, coordination, and monitoring in selected HCFC consuming sectors, to be implemented for the period 2012 to 2015, to enable compliance with the 2013 and 2015 control targets for consumption of HCFCs. The results obtained so far include a) identification of appropriate non-ODS technologies in foam manufacturing sector for the phase out of HCFC and 15 system houses that develop pre-blended polyols with environment-friendly blowing agents for rigid polyurethane foams, and b) formulation and implementation of the ODS (Regulation and Control) Amendment Rules, as per the Gazette of India published in April 2014.
- HCFC Phase-Out Management Plan (HPMP) (2017–2023) – Stage II – India is willing to move towards adoption of comparatively low GWP refrigerant like R32 and low-GWP refrigerant such as R290 in the second HCFC Phase-Out Management Plan.

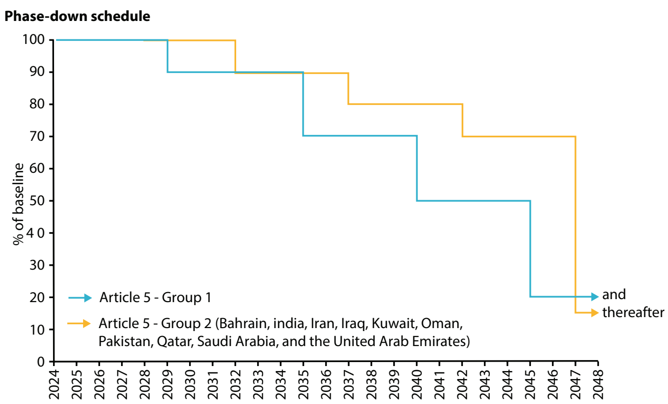


Figure 6: Graphical representation of HFC phase-down schedule

	Article 5 Parties: Group 1		Article 5 Parties: Group 2	
Baseline Years	2020, 2021 & 2022		2024, 2025 & 2026	
Baseline Calculation	Average production/consumption of **HFCs** in 2020, 2021, and 2022 *plus* 65% of **HCFC** baseline production/ consumption		Average production/consumption of **HFCs** in 2024, 2025, and 2026 *plus* 65% of **HCFC** baseline productionn/ consumption	
Reduction steps Freeze	2024		2028	
Step 1	2029	10%	2032	10%
Step 2	2035	30%	2037	20%
Step 3	2040	50%	2042	30%
Step 4	2045	80%	2047	85%

Figure 7: HFC phase-down schedule for A-5 countries

[6] *http://www.unep.fr/ozonaction/information/mmcfiles/7809-e-Factsheet_Kigali_Amendment_to_MP_2017.pdf*

India Cooling Action Plan:

On March 8, 2019, Ministry of Environment, Forest and Climate Change released India Cooling Action Plan (ICAP) to address the India's cooling needs and challenges through a holistic approach.

The ICAP seeks to provide an integrated vision towards cooling across sectors encompassing *inter alia* reduction of cooling demand, refrigerant transition, enhancing energy efficiency, and better technology options with a 20-year time horizon. The ICAP provides short-, medium-, and long-term recommendations across different sectors while providing linkages with various programmes of the government aimed at providing sustainable cooling and thermal comfort for all. An implementation framework is also set forth to coordinate the implementation of these recommendations.

Scope and Limitations of the Study

The objective of the study is threefold, viz. a) to analyze refrigerant consumption trends, b) to track the progress of the AC industry within the context of national and international commitments vis-a-vis policy framework, and c) to recommend key focus areas requiring action. Energy demand from AC, equipment energy efficiency, policies on low GWP refrigerants and refrigerant use in the sector have been presented and detailed in the study. Each key indicator such as energy efficiency, refrigerant consumption, and policy (Montreal Protocol Commitments, ICAP, Kigali, etc.) was sought to be covered; however, the study did not entail any primary data collection, but was based on desktop research on published reports, industry websites, and among other things, chiefly consisted of key inputs from various stakeholders and sectoral experts across government departments and ministries. Well-reasoned estimates were made for data points with inaccuracies and gaps, especially in the case of HFCs, which have not been monitored historically.

1.8 Approach and Methodology

The study follows a mixed approach, taking into account information being undertaken or envisaged to be undertaken under various governmental and non-governmental initiatives in the AC sector:

- Review of policy documents, action plans, research articles and websites' collection of data available in the public domain, such as reports and industry websites
- Stakeholder engagement in the form of one-to-one meetings and expert interviews
- Expert consultations with industry, other academic and research organizations

After collection of data, various scenarios for refrigerant consumption were drawn; key messages on refrigerant use, energy efficiency in room AC, and their policy implication in meeting the Kigali Amendment objectives were analyzed. Multiple industry websites were referred for compilation of data on available AC models and their specific refrigerant use, in order to extrapolate and estimate the share of refrigerant use in total available air conditioners in the country. In addition, parallels were drawn between refrigerant use and energy efficiency of the model.

It is pertinent to mention that since HFC's use has historically not been reported, obtaining data on HFC's use in room AC sector was difficult. Also, the actual consumption values of HFCs are not available in the public domain. In the first approach, meetings were held with refrigerant producers, AC and refrigeration equipment manufacturers to gather information on historical HFC use in the country and future demand in the sector. Demand projections for different refrigerants were done based on information gathered from available literature and stakeholder discussions.

2. Results and Analysis

2.1 States and Trends of Refrigerant Usage

India is party to the Kigali Amendment (2016) and therefore, committed to phasing down HFCs' use from 2028. In this context, it becomes pertinent to track RAC industry trends and identify gaps in meeting the Kigali Amendment targets. HFC consumption in India was not monitored or reported before the Amendment, which poses huge challenges to both policymakers and industry in creating efficient HFC phase-down schedules. Also, questions on the issues such as sectors to be focussed and alternative availability for the HFCs need to be addressed before the forthcoming phase-down schedule. In addition, the Amendment has special focus on enhancing and maintaining energy efficiency alongside the HFC phase down. Therefore, energy efficiency of the equipment also becomes the focal point along with refrigerant transition.

2.1.1 Refrigerant Use Share

In this section, prevalent room air conditioner models and refrigerant use within these available models have been documented. The share of refrigerants is not to be confused with the actual refrigerant consumption, which is dependent on the sale of AC models employing a particular refrigerant. For instance, while the majority of RAC models may employ R32, the model that employs R22 may have more sales and therefore, the consumption of R22 seems higher. The projections in the latter sections would make that distinction. Currently, there are about five types of refrigerants in use in the room AC sector. These include HCFCs like R22, HFCs such as R32, R410A, R407C, and natural refrigerants like R290. HCFCs are being phased out and will be fully phased out by 2030. However, since the inception of the Kigali Amendment, use of refrigerants other than HFCs and low GWP types has picked pace in the Indian market. In Figure 8, a comparison of refrigerant's use in available AC models has been presented for the years 2016–17 and 2017–18.

Some of the key points to be noted are

- The use of R22 has decreased from 50% in 2016 to 38% in 2017. This indicates that the phase down of R22 is in line with the Montreal Protocol (towards achieving 67.5% reduction in HCFC production and consumption by 2025).
- The usage of R410a has decreased from 41% to 36%.
- The share of clean refrigerants has increased, considering R32 usage rose from 8% to 17%.
- R290's (propane) usage has increased from a mere 2% in 2016 to 6% in 2017, showcasing a threefold increase. This also highlights the importance the market is placing on hydrocarbon-based low GWP refrigerants.

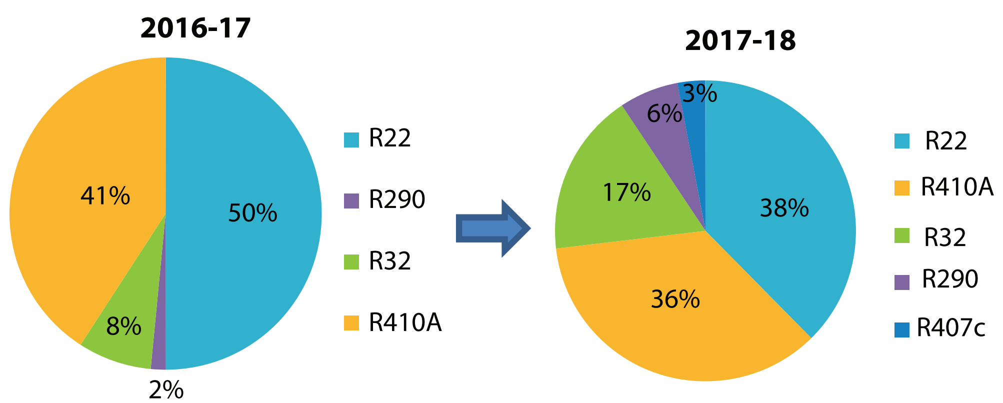


Figure 8: Percentage share of refrigerant in air-conditioning sector in 2016–17 and 2017–18, respectively

**(Data are based on the manufacturers' websites)*

The share of HCFCs has decreased significantly from almost 50% to 38%, which may be an indicator that pushes towards following the Montreal Protocol schedule may have had influence on the market. While HFC's usage has increased, it is still in line with the Kigali Amendment phase-out schedule, which would start in the year 2032 in India. The increase has not been significant. At the same time, natural refrigerants have seen a marked increase indicating that these are possible replacements for HFCs in the upcoming years apart from being competitive in the market.

2.1.2 Refrigerants and Efficiency

The Kigali Amendment called for consideration of equipment energy efficiency alongside refrigerant transitions. In this context, impact on the energy efficiency of room AC due to refrigerant choice was also analyzed. Market-ready room AC models in combination with different refrigerants were compared. Figure 9 shows that maximum achievable energy efficiency of the models, which use low GWP R32 and R290 refrigerants, showcases higher efficiencies than the models using high GWP refrigerants. The change in efficiency can partially be attributed to the optimization in design required in RAC equipment for each refrigerant. This could potentially accelerate adoption of low GWP refrigerants and energy-efficient equipment in tandem.[7]

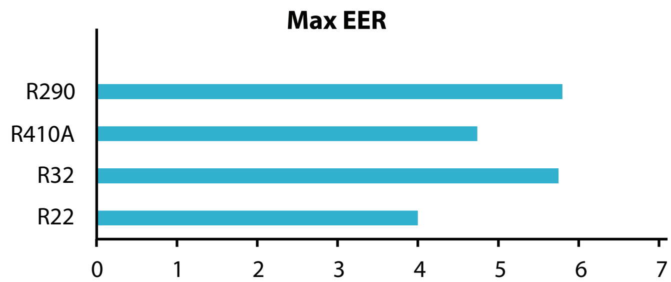


Figure 9: Energy efficiency ratio of AC models with R32 and R290 (Source- Manufactures websites)

2.2 Refrigerant Demand Analysis

In the following section, domestic refrigerant demand has been projected till 2030. This projection timeline was important from the context of the planned phase-down schedule of HFCs as per the Kigali Amendment. In forecasting the demand for refrigerants, key parameters such as the growth of the refrigerant in the room AC sector, probable high GWP–low GWP transitions, availability of refrigerants etc., have been considered. The following table highlights key points of difference in the three scenarios projected in the following section:

Table 3: Comparison of characteristics for different scenarios

Business as usual	New policies	Ambitious
HCFC will be phased out according to the Montreal Protocol and HPMP II	HCFC phase down in par with Montreal Protocol. Implementation of ICAP influences HFC use management	Successfully meeting the ICAP refrigerant reduction targets – total refrigerant demand would be reduced by 25% in the year 2030. HCFC will see phase out with Montreal Commitments
Predominantly HFC will replace HCFC	HFC rise not as steep as business as usual, owing to rise in low GWP refrigerant use	HFC rise will be curbed, management and planning will be in tandem with ICAP
Increase in low GWP refrigerant's use shall remain gradual	Rapid rise in low GWP refrigerant	Low GWP refrigerant will see a rapid rise and total refrigerant demand will reduce owing to policy interventions and successful implementation of the ICAP

[7] *https://www.energy.gov/sites/prod/files/2016/07/f33/The%20Future%20of%20AC%20Report%20-%20Full%20Report_0.pdf*

2.2.1 Assumptions for Demand Scenario

The following assumptions have been made for forecasting the HFC demand scenario based on the inputs received from various industry stakeholders on refrigerant use in the room AC sector and available literature in the public domain:

- HCFCs would be phased out as per schedule under the Montreal Protocol. The refrigerant market is expected to grow at around 8.5% per annum till 2026 and at around 7% from 2027 onwards.
- Large-scale transition to next-generation low GWP products has been assumed to take place after 2028 as A5 Group-2 nations (including India) are required to start phase down from 2032 onwards. India is allowed to use the current range of products without any restrictions till 2030/31. This transitioning timeframe should allow India to continue to remain self-sufficient as adequate time for technology development and commercial-scale production would be available.
- Based on the available data and interaction with industry stakeholders, India has already been shifted towards medium- and low-GWP refrigerants in room AC sector such as R32 and R290.
- The current consumption baseline for the HCFCs, HFCs, and low GWP refrigerants is 64.5%, 35%, and 0.5%, respectively, in 2017.

2.2.2 Business-as-Usual Scenario

Figure 10 shows the estimated refrigerant demand in the business-as-usual (BAU) scenario for room air conditioners. Demand under BAU scenario has been projected for various refrigerants keeping the same share of low GWP alternatives in overall pool of refrigerants' use in room AC sector till 2030. HCFC would follow the Montreal Protocol schedule to phase out by the year 2030. The industry would continue to replace HCFCs with predominantly HFCs, while HCs would continue to have less than 1% share in the total demand.

It is observed that by 2019, HFC demand would surpass HCFCs and continue to rise to more than 45,000 metric tonnes. While at the same timeline, low GWP variants, owing to the reduced share are seen to rise insignificantly. It is assumed that beyond the assessed timeline, low GWP refrigerant demand may pick up following the Kigali schedule while India inches towards phasing down HFCs as per Kigali Amendment timelines.

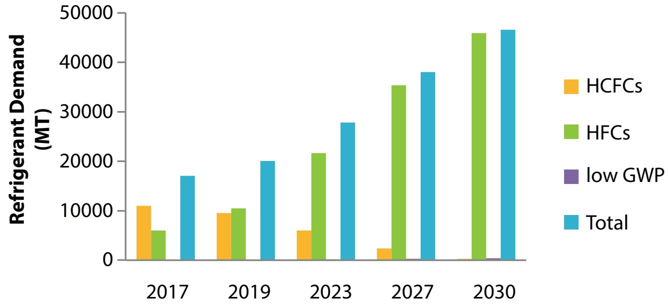


Figure 10: Estimated demand of refrigerants (MT) in room air conditioners (BAU scenario)

Note: BAU includes HCFC phase-out schedule

2.2.3 New Policies Scenario

In this scenario, it is expected that the effect of Kigali Amendment and implementation of the ICAP[8] would impact the refrigerant demand dynamics, where natural refrigerant demand would get a boost as compared to BAU. This scenario considers the rise of low GWP refrigerants more rapidly as compared to the BAU scenario. Effective policy implementation would boost the production of low GWP variants in the country and allow for the replacement of HFCs. While HFCs dominate the first half of the assessed timeline, their rise is not steep owing to low GWP refrigerants as replacements. Clearly, HCFCs are observed to have phased out by 2030, while low GWP refrigerants rise to nearly 10,000 metric tonnes. The year 2025 shows an interesting cross-over between reducing HCFC demand and rising low-GWP refrigerant demand.

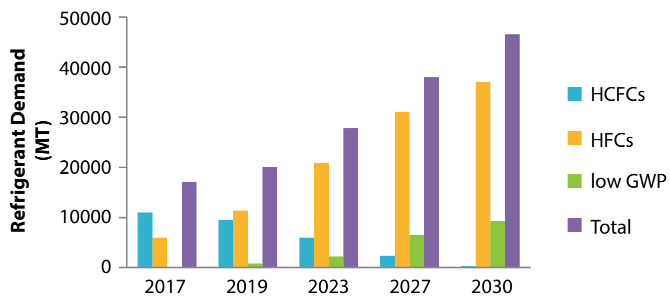


Figure 11: Estimated demand of refrigerants (MT) in stationary air conditioners (new policies scenario)

2.2.4 Ambitious Scenario

In this scenario, the goals identified in the ICAP regarding reducing the cooling demand and thereby refrigerant demand through various policies, have been considered. The ICAP targets reduction in refrigerant demand by up

[8] http://www.indiaenvironmentportal.org.in/files/file/DRAFT-India%20Cooling%20Action%20Plan.pdf

to 30% by 2038. Considering the ICAP implementation as the target, we have estimated the refrigerant demand in the ambitious scenario, where the total refrigerant demand would be reduced by 25% in the year 2030, while the share of the low-GWP alternatives would continue to grow faster as compared to HFCs.

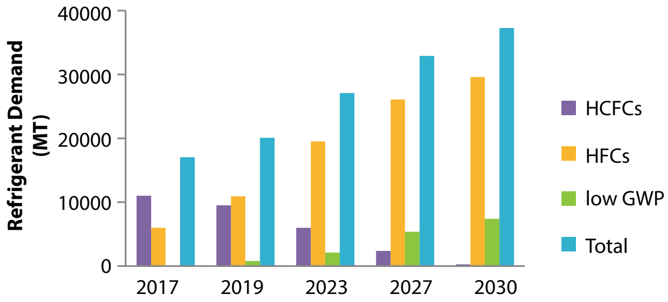


Figure 12 : Estimated demand of refrigerants (MT) in stationary air conditioners (Ambitious Scenario)

2.2.5 Hydro fluorocarbons growth projections

To have better understanding of the impact on achieving Kigali targets, Figure 13 elucidates on the comparative analysis of the HFCs demand in all of the above-mentioned scenarios. It is clearly evident that in case of HFCs growth, ICAP implementation would play an important role as the HFCs demand would reduce in both the alternate and intervention scenarios through industry shifting towards non-GWP refrigerant along with total refrigerant demand reduction due to domestic policies under ICAP implementation approach.

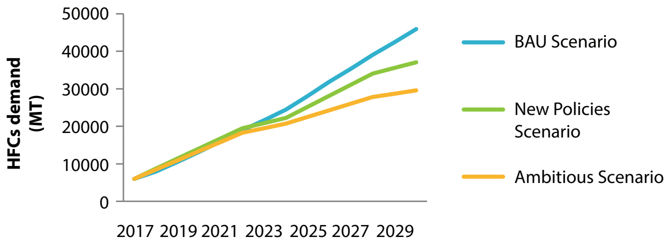
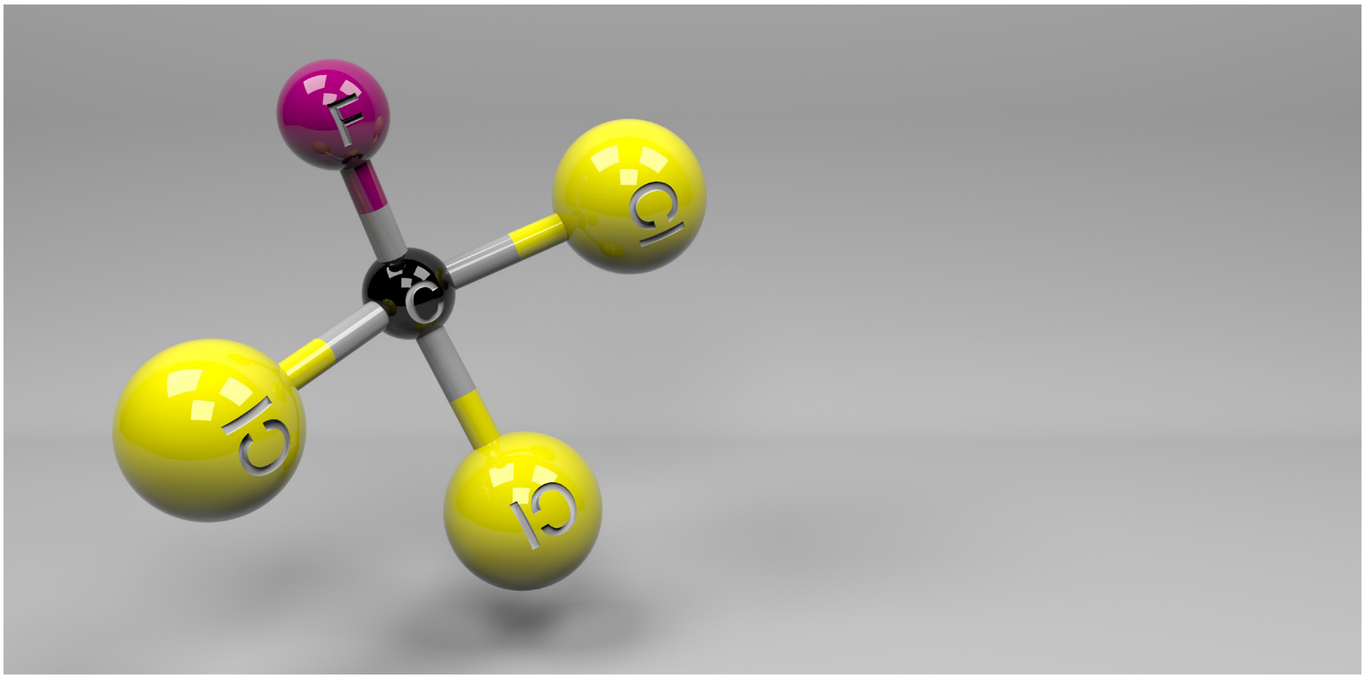


Figure 13: Comparison of estimated demand of HFCs (MT) in stationary air conditioners in various scenarios



3. Implications

3.1 Policy

India's refrigerant demand and type of refrigerant used in the room air conditioner segment would have long-term implications on its power sector, climate commitments, and AC industry. Improving the energy efficiency of room ACs is one of the most viable and cost-effective methods to address the power sector challenges.

International commitments: Kigali Amendment to the Montreal Protocol appeals to the nations to undertake the dual tasks of phasing down high-GWP refrigerant use alongside improving equipment energy efficiency. While, India has placed mandatory standards and concurrent refrigerant phase-down plans, the Amendment provides an opportunity to look deeper into novel methods to accelerate to super-efficiency and low-GWP refrigerant use, in tandem with its international counterparts.

The aforementioned scenarios showcase that in the 2030s, significant focus would be needed on developing new low-GWP products and/or promoting existing low-GWP products, to meet the refrigerant requirements. The BAU scenario indicates a phase-out of HCFC use by 2030 in-line with the Montreal Protocol requirements. The BAU HFC rise is significant and unchecked; however, with interventions such as increasing penetration of low-GWP refrigerants inter alia this rise is seemingly in control, allowing for a slightly faster start of HFC phase-out planning. Rapid rise of low GWP refrigerants is seen to rise in the new policies and ambitious scenarios, which show a positive outlook for the sector.

In parallel, India's international commitments are ambitious and have enabled faster adoption of measures in the country. The Article 5 nations function as cooperative peers that share common goals and objectives, besides sharing common HFC phase-down schedules beginning from 2031.

» HCFC Substitution

HFCs are substituting HCFCs as the HCFC phase out began in 2012. HCFC-22 use in RAC segment has already started transitioning to HFCs. All these transitions have happened largely due to the market forces and availability of viable substitutes.

» Refrigerant Replacement Options

The refrigerants currently in use in the RAC segment are HCFC-22, R-410A, HFC-32, and R-290, while there are a limited number of techno-commercially viable low-GWP refrigerant options such as HFC-32 and R-290.[9,10]

3.2 Technology

Air conditioning industry and refrigerant production industry: Owing to Kigali commitments and national level interventions such as the ICAP, the RAC technology's tilt towards highly efficient equipment is imminent. From Minimum Energy Performance Standards (MEPS) of 3.1 ISEER, a possible leapfrogging can occur within the forthcoming years. As far as the refrigerant industry is concerned, key changes are centered at increasing penetration of low-GWP refrigerants and HFC alternatives. And since policies are built around refrigerant transition pathways, the industry is likely to see rapid change in not just the upstream sector but also the downstream sector, where servicing would be ramped up in tandem with manufacturing. In other words, it would affect the entire supply chain of the refrigerant industry.

3.3 Demand Side

Peak demand and energy consumption: Increasing penetration of super-efficient equipment is critical as India is poised to witness a marked increase in peak electricity demand. The CAGR path points towards a dramatic threefold rise in electricity demand by 2030. The Standards and Labeling Program, since its inception, has been aiming to improve equipment efficiency in regular intervals. The program can find support in leapfrogging from market transformational initiatives like procurement of super-efficient products in bulk to rapidly achieve economies of scale.

Consumer behaviour, livelihood and co-benefits: Awareness towards energy efficiency and climate change has increased in the recent years. Consumers have been seen opting for higher efficiency products consciously. This is a healthy sign that would play a central role in the nation's future policies. On the other hand, the demand side shifting towards newer technologies and refrigerants would give the service and technical sectors a boost. This would potentially provide employment opportunities for servicepersons.

[9] *UNEP Technical Options Committee on Refrigeration, Air-conditioning and Heat Pumps (RTOC) 2014*

[10] *UNEP TEAP progress report 2017*

4. Way forward

The report concludes with key takeaways to address cooling needs from a developing country perspective. Although, phase out and transition towards low-GWP refrigerants is a priority in the larger global context, important consideration needs to be given to affordability of the equipment as well. Without finding or enabling off-takers for high-energy-efficient products, a transition would be highly difficult.

The analysis above reveals that the industry is rapidly moving towards use of HFCs and relatively low-GWP HFCs. In addition, amidst low clarity on the plausible replacements for HFCs in the context of technology readiness and affordability, the industry's stance towards HC needs to be recorded. The policymakers, however, have favored HCs as they have shown tremendous potential as climate-friendly replacements for HFCs. The favorability may also have been influenced by the beginning of the HFC phase down and replacement in the developed world. As the market opens up more for HCs, the industry might find greater clarity in adopting HC-based refrigerants in the coming decade.

Technologically, the aim would be to reduce the refrigerant charge size and obtain higher economy overall. This deliberation could get fast-forwarded if platforms for knowledge-sharing amongst international peers emerge, giving greater flexibility in terms of experimentation with different technology options before hard implementation on ground. Such collaborations could also foster mutual growth and sharing responsibility for climate commitments.

Since the analysis forecasts a slower low-GWP refrigerant growth in the BAU scenario owing to technological and market barriers, key focus could be laid on increasing manufacturing capacity in the country, not only for development of refrigerants but also of energy-efficient cooling equipment. The cooling sector could greatly benefit from increased local capacity, which could additionally cater to the growing demand. While technology transfer and knowledge-sharing platforms are leveraged, the learning could be applied at home, by incentivizing local entrepreneurs and businesses aiming to contribute in the cooling space.

Beyond policy and technological options, the service sector needs to be looked into with deeper focus. Service technicians form a key stakeholder group, both in the formal and informal sectors. Training and creating awareness towards novel technologies and refrigerants is vital. Development of training materials, consolidation of training infrastructure, institutionalizing the training network, and emphasizing quality in training are essential components.

In addition, an important aspect that needs to be looked into, for short term, is the penetration of energy-efficient equipment. This can be achieved through market transformation mechanisms, which involve novel business models to achieve economies of scale much faster. There are examples of market transformation initiatives undertaken in the country in the past, which may render as stepping stones to designing effective programmes. Nodal agencies, think tanks, and other policymakers could be the relevant actors to carry out such programmes.

The above also gives way to understanding consumer perspectives, their preferences, cooling needs, and specifically, the way they address their cooling needs. For instance, addressing practices such as overcooling would also be crucial in reducing peak demand.

Overall, the movement of cooling transition in the country would revolve around the following key aspects, wherein all the other action points would converge:

» Increasing the proportion of relatively low-GWP HFCs-based refrigerant in the mix; such as HFC 32. (India has already embarked on this path).

» Use of natural refrigerants like hydrocarbons, HFOs, and CO_2, wherever possible.

» Reduce usage of R410a and R407C till on account of newer alternatives being developed.

The following image entails the key actions needed using different instrument:

Policy

- Implementation of the ICAP - development of roadmap on thematic sectors
- Refrigerant phase-down actions in sync with Kigali timeline
- Ratcheting MEPS faster
- Enabling international collaborations through R&D and industry knowledge exchange

Technology

- Building manufacturing capacity for energy-efficient equipment
- Enabling transition towards low-GWP refrigerants by building manufacturing capacity equivalent to future refrigerant demand
- Technology transfer, matching international standards, building domestic capability

Demand Side

- Consumer behavior analysis
- Build consumer awareness towards energy efficiency and conservation
- Market transformation tools need to be employed

Servicing/co-benefits

- Building training infrastructure for current and future service technicians
- Training on new RAC technologies and refrigerant handling - experiential learning in collaboration with industry
- Market readiness of the servicing sector, in tandem with policy and industry shift

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