



Bangladesh National Cooling Plan for the Implementation of the Montreal Protocol



Ozone Cell, Department of Environment
Ministry of Environment Forest and Climate Change



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KIGALI
COOLING EFFICIENCY PROGRAM



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Acronyms and Abbreviations

AC	Air conditioner or air conditioning
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BHBFC	Bangladesh House Building Finance Corporation
BIDS	Bangladesh Institute of Development Studies
BMD	Bangladesh Meteorological Department
BNBC	Bangladesh National Building Code
BRAMA	Bangladesh Refrigeration Air Condition Merchant Association
BRTA	Bangladesh Road Transport Authority
BUET	Bangladesh University of Engineering and Technology
CAGR	Combined annual growth rate
CPD	Centre for Policy Dialogue
DoE	Department of Environment
EE&C	Energy efficiency & conservation
EECMP	Energy Efficiency & Conservation Master Plan
GHG	Greenhouse gas(es)
GoB	Government of Bangladesh
GSP	Good service practices
GWP	Global warming potential
HBRI	House Building Research Institute
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HPMP	HCFC Phase-Out Management Plan
HVAC	Heating, ventilation and air conditioning
LGED	Local Government Engineering Department
MAC	Mobile air conditioner (or air conditioning)
MDI	Metered dose inhaler
MEPS	Minimum energy performance standards
MLF	Multilateral Fund
MoEFCC	Ministry of Environment, Forest and Climate Change
MPEMR	Ministry of Power & Energy and Mineral Resources
Mtoe	Million tonnes of oil equivalent
NBR	National Board of Revenue
NDC	Nationally Determined Contributions
NHI	National Housing Institute
NOU	National Ozone Unit
NCP	National Cooling Plan
ODP	Ozone depleting potential
ODS	Ozone depleting substances
OEM	Original equipment manufacturer

PKSF	Palli Karma-Sahayak Foundation
PWD	Public Works Department
R&D	Research and development
RAC	Refrigeration and air conditioning
RAJUK	Rajdhani Unnayan Kartripakkha
REHAB	Real Estate and Housing Association of Bangladesh
RHD	Roads and Highways Department
SDG	Sustainable Development Goals
SME	Small and medium enterprise
SREDA	Sustainable and Renewable Energy Development Authority
TEAP	Technology and Economic Assessment Panel
Toe	Tonnes of oil equivalent
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VRF	Variable refrigerant flow

Executive Summary

Context

Cooling is a developmental need as well as a cross-sector requirement. In future, demand for cooling in Bangladesh will grow due to global warming, the rapid pace of economic growth, rising per capita income, population growth, and rapid urbanization.

Much of the country's cooling requirement is met using refrigeration and air-conditioning (RAC) technologies. These are based on the use of either synthetic or natural refrigerants. Most synthetic refrigerants have either an ozone depleting potential (ODP) and/or a global warming potential (GWP), and they are regulated for phasing out/phasing down to agreed schedules under the Montreal Protocol on Substances that Deplete the Ozone Layer, to which Bangladesh is a party. Bangladesh accessed the Montreal Protocol in August 1990 and ratified all the subsequent amendments. The Kigali Amendment to the Montreal Protocol provided an opportunity for maintaining and/or enhancing energy efficiency, while transitioning away from hydrofluorocarbons (HFCs). A significant proportion of total carbon emissions from RAC equipment is due to energy consumption, with the rest due to refrigerant leakage.

The building sector is one of the most important sectors of the economy, and its growth is linked with the country's development. The built environment will grow with rapid urbanization, leading to a growth in need for air conditioning and refrigeration. Energy efficiency in buildings is linked with the reduction of cooling requirements and energy consumption, thus delaying the phasing in of refrigerant-based RAC equipment.

Economic growth has led to a rapid increase in the automobile sector, and thus a significant rise in demand for transport air-conditioning, especially in-car air-conditioning. Cold chain and refrigeration – for the preservation of perishable foods, such as fruit and vegetables, dairy and fish and meat – has emerged as another large, rapidly expanding sector. There is scope for enhancing the energy efficiency of the cold-chain sector, while using new refrigerants which are economically viable and environmentally sustainable. The challenge for the industry is to move towards energy-efficient and environmentally friendly technologies.

Development of the 'Bangladesh National Cooling Plan for the Implementation of the Montreal Protocol'

Against the backdrop of cooling as a growing developmental need and the international environmental agreements to which Bangladesh is a signatory, UNDP, on behalf of the national ozone unit of the Ministry of Environment, Forest and Climate Change, has initiated the production of a cooling plan that will resonate with stakeholders in the public and private sectors. It will also help move Bangladesh towards sustainable and smart cooling strategies, in accordance with the Montreal Protocol, to phase out HCFCs and phase down use of HFCs, while contributing to achieving the Sustainable Development Goals.

To this end UNDP hired a national consultant to analyse the importance of the RAC sector in Bangladesh; to identify the gaps in energy efficiency; suggest mechanisms that can be used to work towards energy efficiency in the sector, and to identify the various institutional, policy and legislative changes required.

The work will have to be consolidated into the national cooling plan, which must be in line with the Kigali requirements, the Bangladesh NDC and the National Energy Efficiency and Conservation Master Plan, and other relevant strategies and action plans. Assessing cooling requirements across sectors and the associated refrigerant demand and energy use are the most important requirements for the cooling plan. The overarching goal of the National Cooling Plan (NCP) should be to provide sustainable cooling and thermal comfort for all while securing environmental and socio-economic benefits for society. There are six thematic areas in the NCP: space cooling in buildings; cold-chain and refrigeration; mobile (transport) air conditioning (MAC); the air conditioning and refrigeration servicing sector; refrigerant demand and alternative refrigerants; and energy efficiency.

Synergies with existing government programmes and initiatives

The Energy Efficiency and Conservation (EE&C) Master Plan has set specific EE&C programmes to achieve energy saving in the building sector by the Sustainable and Renewable Energy Development Authority (SREDA). Under this EE&C Master Plan, three EE&C programmes are underway: energy management; energy efficient labelling and energy efficient buildings. These are targeted at large energy consuming entities and equipment in the industrial, residential and commercial sectors. According to the Master Plan, it is estimated that there will be 4.4 Mtoe / year of energy savings between 2015 and 2030. The National Housing Policy and the Bangladesh National Building Code are the most important policy and technical guiding documents for development of NCP.

Synergies with international commitments

Sustainable cooling is at the intersection of three international multilateral agreements: the Kigali Amendment to the Montreal Protocol, the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) and the 2030 Agenda for Sustainable Development.

Cooling is directly linked with the Montreal Protocol, through the refrigerants used in RAC equipment. The HCFC Phase-out Management Plan (HPMP) is currently being implemented. In Stage 1 of the HPMP, Bangladesh agreed to reduce HCFCs by 30 percent from the baseline by 2018, resulting in the phasing out of 24.53 ODP tonnes of HCFC. In the HPMP Stage 2 period, from 2019 to 2025, the areas for action are:

- the conversion of five AC manufacturing enterprises and one chiller manufacturing enterprise to phase out HCFC-22;
- a technical assistance programme for the servicing sector, regulatory actions, and monitoring the implementation of the HPMP; and
- the promotion of the use of alternative technologies and help to limit demand for HCFCs.

Situation analysis and assessment of cooling demand

Space cooling accounts for most cooling demand in Bangladesh. The average maximum temperature (average monthly maximum) in Dhaka has increased by about 1.6oC in the last 20 years, as shown in Figure A.

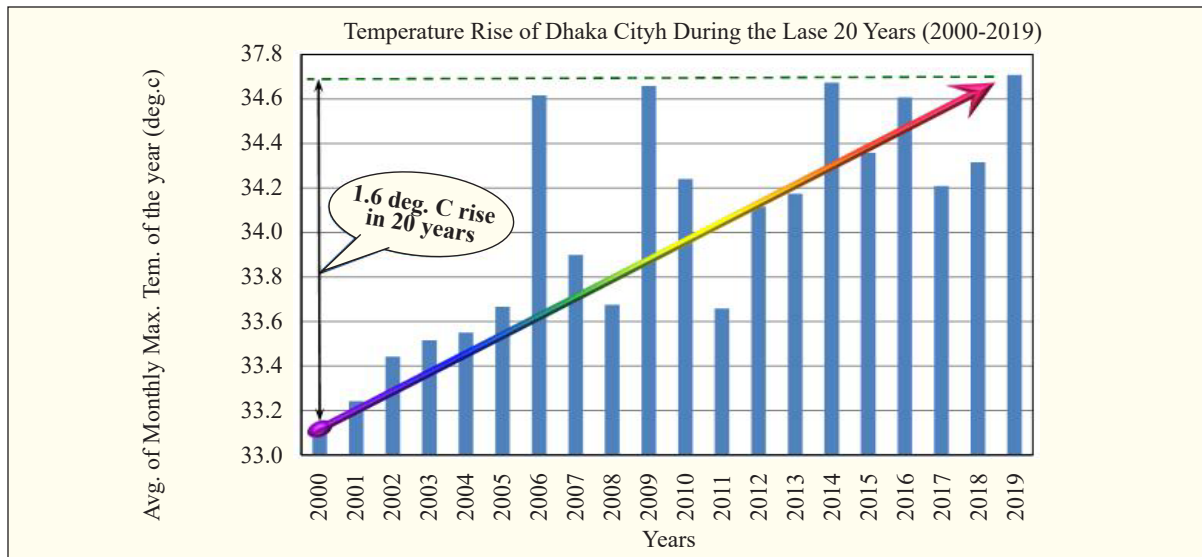


Figure A: Temperature in Dhaka City during the last 20 years

Residential sector current stock and future projections

The sales figures for refrigerators and air conditioners, from 2010 to 2019 according to the Bangladesh Refrigeration Air Condition Merchant Association (BRAMA), are presented in Figure B. These show an exponential increase in demand for refrigerators and air-conditioners over the last decade.

The Combined Annual Growth Rate (CAGR) of room air conditioners is about 22 percent between 2014 and 2019, and 17 percent between 2010 and 2019.

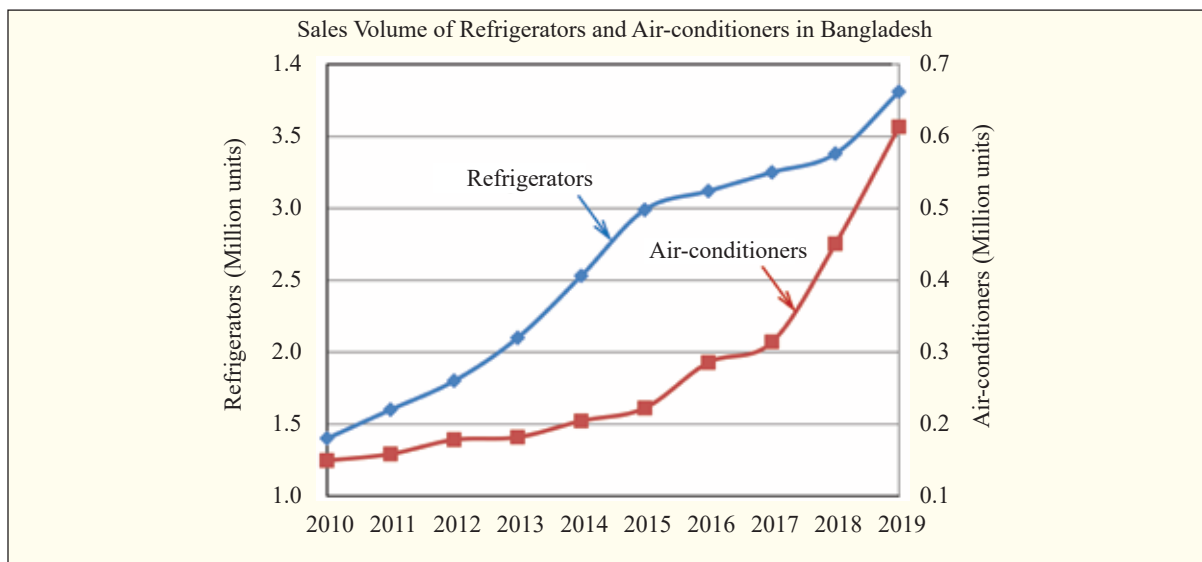


Figure B: Refrigerator and air conditioner sales volume in Bangladesh (2010 to 2019)

The stock of air conditioners in 2019 is estimated at 3.5 million units. Based on the average capacity of room air conditioners in the Bangladeshi market, this translates into 6.0 million tons of refrigeration (TR) (Figure C). Future demand is also given in Figure C.

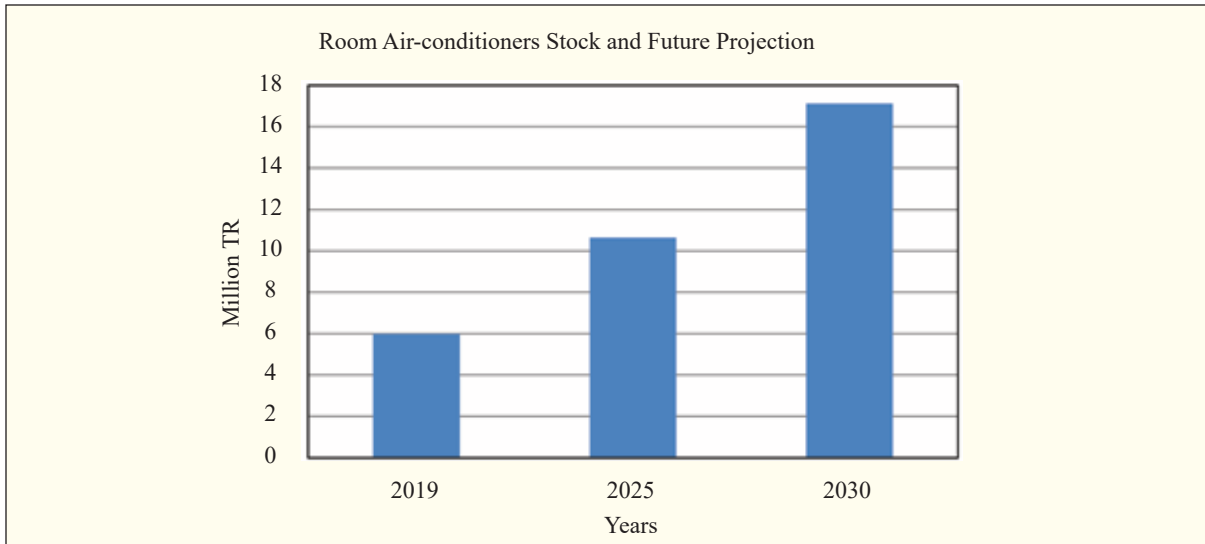


Figure C: Projection scenario of room air conditioners from 2019 to 2030

Refrigeration and cold chain

Domestic refrigerator sales saw a steady combined annual growth rate of 15 percent in the last decade. It is estimated that this trend will continue for another five or six years, reaching saturation point in 2024-25, when it will start to decline, as shown in Figure D.

The volume of refrigeration and air conditioning systems in the commercial and industrial sectors is less significant than in the domestic sector, as set out fully in this report.

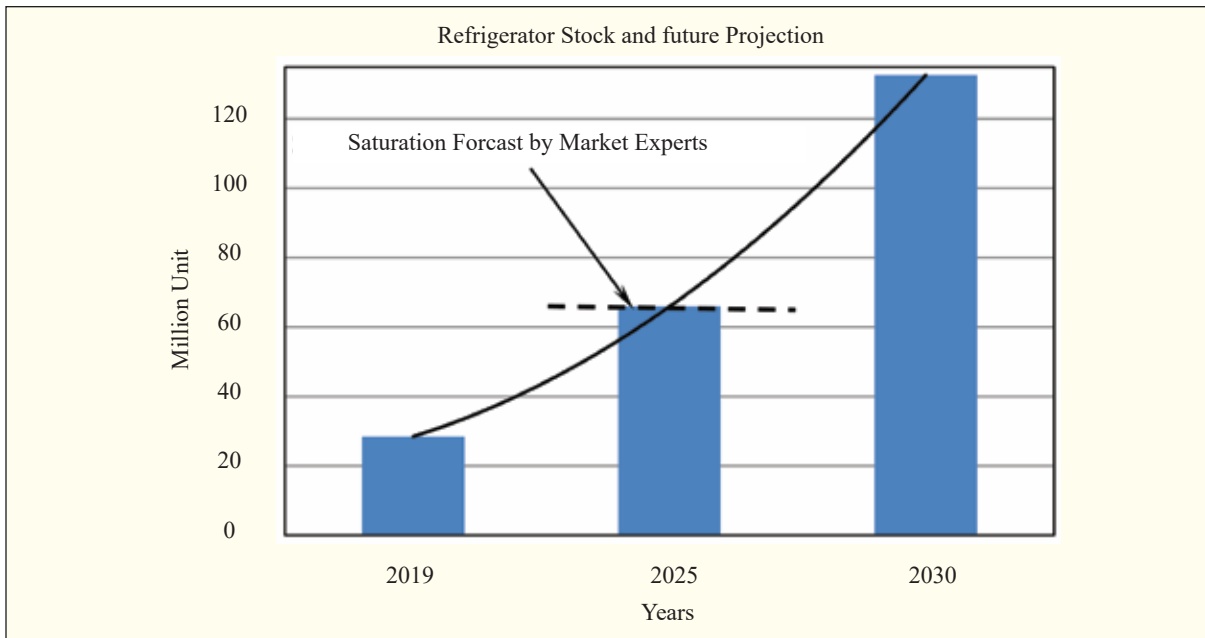


Figure D: Projection scenario of domestic refrigerator demand from 2019 to 2030

Current stock of HCFCs and the transition to low ODP refrigerants

Air conditioning manufacturing sector

The RAC industry produces window and split units for domestic use only. Six companies have the largest share of HCFC-22 consumption. Figure E shows the amount of R-22 consumed in the air conditioner manufacturing / assembly sector is close to 40 percent of total ozone depleting substance (ODS) consumption.

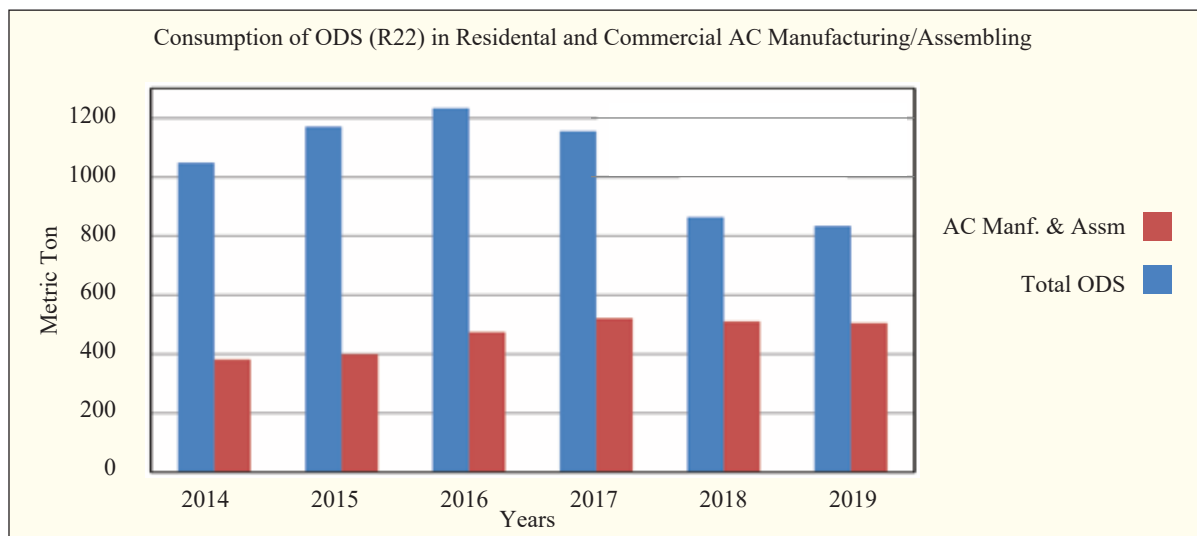


Figure E: Comparison of ODS (R-22) consumption in residential and commercial air conditioner manufacturing/ assembling with respect to the national total

Refrigeration and air conditioning servicing sector

ODS R-22 consumption by the RAC servicing sector is close to 60 percent of total ODS consumption (Figure F). Industrial air-conditioning, including chillers, is not a significant portion.

There is a wide variation in failure rates, depending on the knowledge and skill levels of technicians. The technicians primarily work in the informal sector, without proper access to technology and training. Room air conditioners and commercial refrigerators generate the biggest demand for servicing.

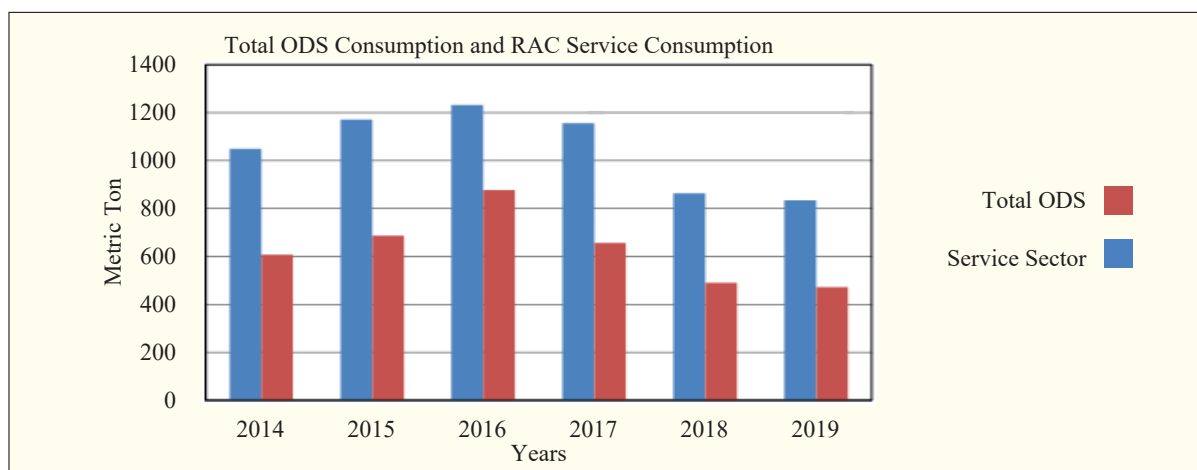


Figure F: Comparison of R-22 consumption in the RAC service sector with total R-22 consumption

ODS and ODS alternatives imports and consumption

Consumption of imported ODSs between 2014 and 2019 is shown in Figure G. This shows a decrease in demand, linked to the Montreal Protocol. Figure G also shows an increase in demand for imported ODS alternatives between 2014 and 2019 which is also in line with implementation of the Protocol. Demand for ODS alternatives has increased sharply, with a CAGR of 25 percent for the last five years, and ODS demand has decreased at a CAGR of 12 percent over the last four years.

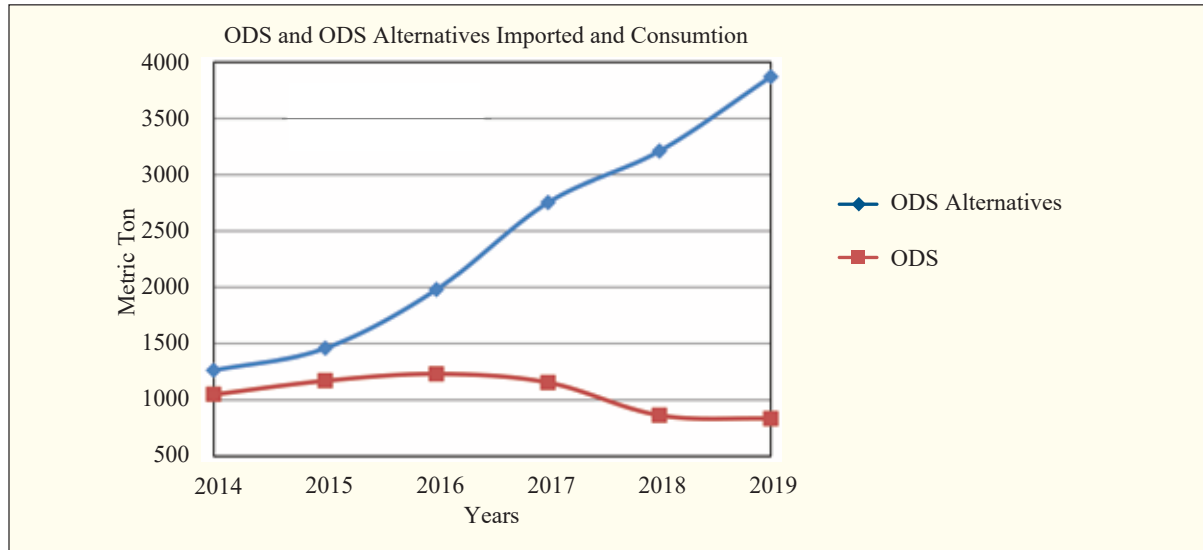


Figure G: ODS and ODS alternatives imported and consumed from 2014 to 2019

Projections on refrigerant demand and its pathways

Figure G shows that R-22 imports are gradually decreasing. This is because, under the Montreal Protocol, Bangladesh must reduce consumption by 35, 67.5 and 97.5 percent by 2020, 2025 and 2030 respectively, from the baseline average of 2009 and 2010. (Figure H).

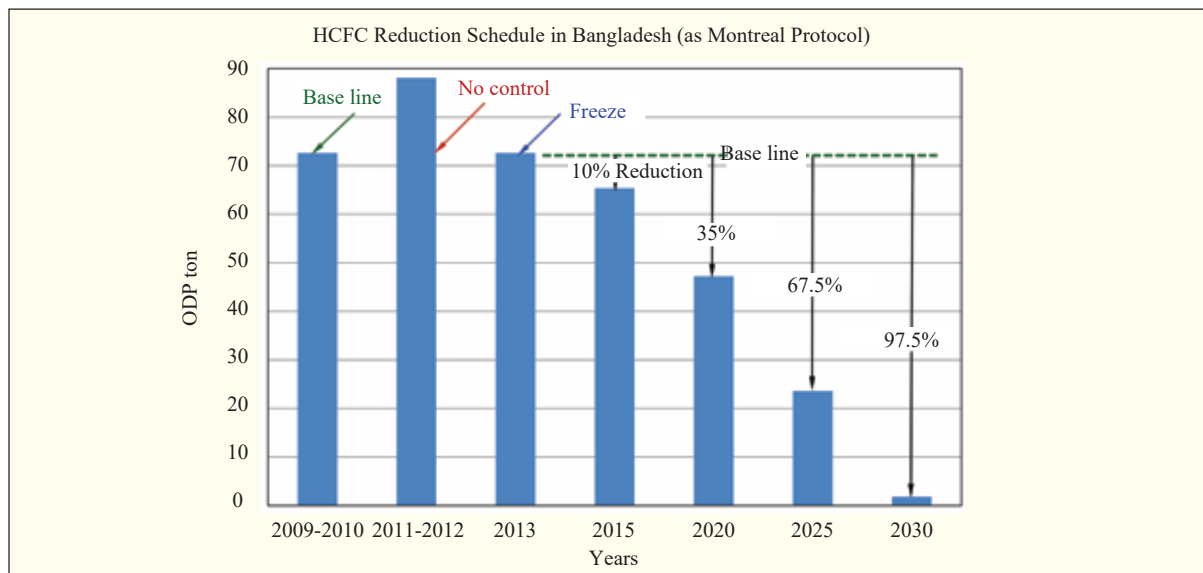


Figure H: HCFC Baseline, freeze, 10%, 35% and 67.5%, 97.5% reduction schedule

The next five years' consumption is based on fresh survey data of CAGR values from 2014-2019 (see Figure I). The HFC consumption estimate for 2020 to 2024 is business-as-usual. The projection is calculated assuming the historical growth rate of R-134a was 22 percent. In the air conditioning sector, the main use of R-410A showed a compound growth rate of 100.94 percent, and that for R-32 was 55.97 percent.

Analysis of RAC sector energy efficiency and conservation potential

Residential sector

The residential sector's share of consumption is around 53 percent. If all existing home appliances were to be replaced by the highest efficiency products available in the current market, there could be a significant reduction in energy consumption. It is estimated that a maximum reduction of 28.8 percent is possible in the residential sector.

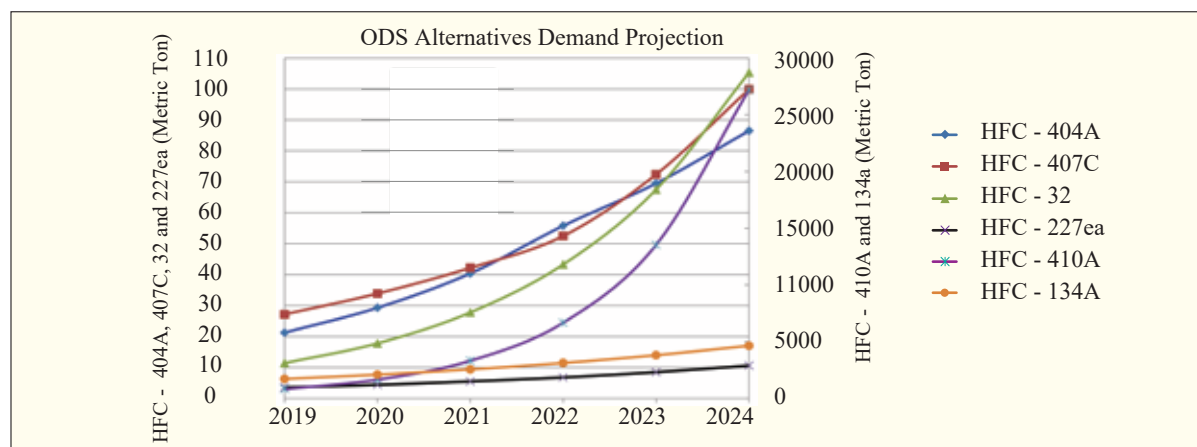


Figure I: Business-as-usual projections of ODS alternatives demand (tonnes) from 2019 to 2024

In the RAC sector, electric fans for cooling consume about 60 percent of total residential energy. Current technology, using efficient motors, offers the potential for a 25 percent energy saving.

The refrigerator / freezer sector has the potential to save 55 percent of energy, by using variable speed compressors, and high-performance heat insulation. Air conditioning systems have the potential to save 50 percent, by using high COP with large heat exchanging coils and variable speed compressors.

The energy efficiency rate and energy efficiency and conservation (EE&C) potential of home appliances (Energy Efficiency and Conservation Master Plan up to 2030, 2016, SREDA) are shown in Table A. This reveals the benefits of using energy efficiency equipment in GWh/year (i.e., in terms of electricity consumption / cost).

Table A: Energy Efficiency rate and EE&C potential of home appliances

Appliance	EE Technology	Currently Energy Consumption (GWh/year)	EE Rate	EE&C Potential (GWh/year)
Fan	High efficiency motor	6,181	-25%	1,545
Refrigerators / Freezers	Variable speed compressor, high-performance heat insulation	2,299	-55%	1,264
ACs	High COP with large heat exchanging coil and variable speed compressor	2,237	-50%	1,119

Commercial sector (buildings)

Air conditioning consumes around 50 percent of the energy used in commercial buildings, with lighting using between 10 and 30 percent. The potential for energy-saving in these two categories is as follows:

- Air conditioning: 50 percent savings by applying highly efficient ACs with inverter technology;
- Lighting: 50 percent savings by applying highly efficient lighting system, such as LED lamps, T5 fluorescent lamps with electronic ballasts or utilizing sunlight.

It is expected that simple replacement of air conditioners and lighting systems with highly energy efficient ones can save about 50 percent of total electricity consumption in the commercial sector. However, it is not easy to introduce EE&C measures for all buildings, and therefore a realistic figure is an estimated 10 percent.

The Cooling Action Plan

Rationale

Cooling is a cross cutting issue, and therefore an integrated and long-term approach across sectors is required. The data for cooling demand in the different sectors and in the limited timeframe provide a trend, rather than definitive estimates.

Demand for cooling is growing rapidly in Bangladesh. In 2008, Bangladesh had 1.51 million air conditioner units; by 2019 it had reached 3.5 million.

Sustainable cooling can only be achieved with the following interventions:

- a reduction in cooling load;
- passive cooling interventions for buildings;
- moving towards more energy efficient RAC equipment;
- operational efficiency enhancements; and
- the introduction of new and alternative technologies.

This report contains proposals for project ideas, policy and regulatory measures and other necessary interventions for a National Cooling Plan.

Implementation and monitoring framework for the proposed Plan

The Bangladesh National Cooling Plan (BNCP) requires a framework for effective coordination, implementation and monitoring. There is also a need for active collaboration among relevant ministries, government departments, industry associations, civil society, the private sector, and other concerned stakeholders.

There is a proposal for two committees: a Steering Committee and a Coordination and Monitoring Committee:

Steering Committee: to be chaired by the Secretary of the MoEFCC. This will be the highest decision-making body to provide policy guidance for the implementation of the BNCP recommendations, including integration across and allocation to relevant ministries and agencies.

Other members shall include a high level representative (DG, Chairman or President) from the Ministries of Power & Mineral Resources; Industry; Finance; DoE; SREDA; NBR; BSTI; ME-BUET; Chem.Engg.-BUET; Technical Education; BRAMA; ASHRAE; RAC Manufacturing Assoc.; RAC Importer Assoc.; Cold Storage Assoc.

The membership secretary shall be the Joint Secretary (Environment), MoEFCC.

The Coordination & Monitoring Committee: to be chaired by the Director General, Department of Environment. Other members shall include high-level representative (DG, Chairman, President) from the Ministry of Industry; SREDA; NBR; ME-BUET; Chem.Engg.-BUET; Technical Education; BSTI; BHBFC; BNBC; BRAMA; ASHRAE; RAC Manufacturing Assoc.; RAC Importer Assoc.; Cold Storage Assoc.

The membership secretary shall be the Project Director, Institutional Strengthening, National Ozone Unit, DoE.

Conclusions

- the Bangladesh National Cooling Plan for the implementation of the Montreal Protocol stands on three basic pillars: the Kigali Amendment to the Montreal Protocol; BNBC, and EE&CMP.
- in line with the BNBC and EE&CMP, additional recommendations have been suggested as potential project ideas and / or policy and regulatory measures for inclusion in the National Plan.
- it is hoped that strict compliance to the BNBC; proper and timely implementation of EE&CMP programmes; the adoption of innovative policies to introduce environmentally friendly and energy efficient alternatives to HFC; and the implementation of the additional interventions, as suggested in the National Plan, will move the country in the right direction.
- a Monitoring and Coordination Committee – to oversee the monitoring, verification and enforcement of the activities set out in the plan – is recommended to ensure that the Plan achieves its aims and objectives.

Section A: Setting the scene

1. Introduction

1.1 Cooling is a development need

Cooling is a development need as well as a cross-sectoral requirement. In Bangladesh, cooling requirements are increasing as the country's economy is growing. New economic and industrial activities are taking place, while individual and household purchasing power are increasing commensurately with the pace of economic growth. In addition, climate change is also likely to generate increased cooling needs.

In short, cooling demand in Bangladesh will grow in the future due to global warming, the rapid pace of economic growth, increasing per capita income, population growth and rapid urbanization, particularly in view of the currently low penetration of air conditioning in the country.

A large part of the country's cooling requirement is met using refrigeration and air conditioning (RAC) technologies, which are based on the use of either synthetic refrigerants or natural refrigerants. Most synthetic refrigerants either have an ozone depleting potential (ODP) and/or a global warming potential (GWP) and are regulated for phasing out or phasing down under the Montreal Protocol on Substances that Deplete the Ozone Layer, to which Bangladesh is a party.

Bangladesh acceded to the Montreal Protocol in August 1990 and ratified all the subsequent amendments. ¹The Kigali Amendment to the Montreal Protocol provided an opportunity to maintain and/or enhance energy efficiency while transitioning away from hydrofluorocarbons (HFCs) within the realm of the Protocol. It is widely acknowledged that a significant share of total carbon emissions from RAC equipment is due to energy consumption, with the remainder due to refrigerant leakage.

The building sector is one of the most important sectors of the economy, and its growth is linked with national development. It is a thriving sector and a major consumer of energy in urban centres. The built environment of Bangladesh is set to grow with rapid urbanization, so the requirement for air conditioning and refrigeration will also increase. Building sector interventions not only offer substantial potential for introducing energy efficiency to reduce energy consumption but also to phase out ozone depleting substances that are used as refrigerants in RAC equipment. Energy efficiency in buildings is linked with a reduction in cooling requirements and energy consumption, thus delaying the phasing in of refrigerant-based RAC equipment.

The rapid increase in the automobile sector, linked to economic growth, has led to significant growth in transport air conditioning, especially in-car air conditioning. Other modes of transport – such as buses and trucks, and especially 'reefer' (refrigerated) vehicles – will also grow, leading to increased transport air conditioning demand in the future. Railways and water vessels also have a small share in this sector.

¹Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, Kigali, October 2016, <https://treaties.un.org/doc/Publication/CN/2016/CN.872.2016-Eng.pdf>

Cold chain and refrigeration is another major emerging sector. The preservation of perishable foods like fruits, vegetables, dairy products, fish and meat is expanding rapidly, while the cold chain plays a crucial role in maintaining the efficacy of vaccines during transport and storage. There is scope to enhance the energy efficiency of the cold chain sector whilst selecting new refrigerants which are economically viable and environmentally sustainable. The challenge for the industry is to move towards energy-efficient and environmentally friendly technologies.

1.2 Towards the development of the Bangladesh National Cooling Plan for implementation of the Montreal Protocol

Against the backdrop of cooling as a growing developmental need and the international environmental agreements to which Bangladesh is a signatory, UNDP, on behalf of the National Ozone Unit of the Ministry of Environment, Forest and Climate Change (MoEFCC), has taken the initiative to develop a cooling plan. The plan adopts a triple-sector approach to resonate with multiple stakeholders in the public and private sectors and help move Bangladesh towards sustainable and smart cooling strategies in line with the Montreal Protocol. This involves phasing out hydrochlorofluorocarbons (HCFCs) and HFCs, while supporting the Sustainable Development Goals. To this end, UNDP hired a national consultant draw up this plan.

1.3 Aims and objectives

The consultant was asked to identify:

- the importance of the RAC sector in Bangladesh;
- gaps in energy efficiency;
- mechanisms that can be used to work towards energy efficiency in the cooling sector; and
- the institutional, policy and legislative requirements to do so.

The work will be consolidated into a National Cooling Plan (NCP), which must be in line with the Kigali requirements; the Bangladesh Nationally Determined Contributions (NDC); ²the National Energy Efficiency and Conservation Master Plan; and other relevant strategies and action plans.

The principal objective of the NCP is to identify the necessary interventions to provide sustainable cooling and thermal comfort for all, while securing environmental and socio-economic benefits for society. The NCP for Bangladesh needs to be in line with the Montreal Protocol.

The specific tasks for the consultant were to:

- assess cooling requirements across sectors and the associated refrigerant demand and energy use over the next 15-20 years;
- map the technologies available to cater for future cooling requirements, including passive interventions, refrigerant-based technologies, and alternative technologies such as not-in-kind technologies;
- suggest interventions in each sector to provide for sustainable cooling and thermal comfort for all;
- investigate the skilling of RAC service technicians; and
- examine research into and development of alternative technologies.

²Roadmap and Action Plan for Implementing Bangladesh NDC, Transport, Power and Industry Sectors, 2018, Ministry of Environment, Forest and Climate Change (MoEFCC), Government of the People's Republic of Bangladesh, https://moef.portal.gov.bd/sites/default/files/files/moef.portal.gov.bd/page/ac0ce881_4b1d_4844_a426_1b6ee36d2453/NDC%20Roadmap%20and%20Sectoral%20Action%20%20Plan.pdf

1.4 Methodology and approach

To develop the NCP, six themes were examined:

- space cooling in buildings;
- the cold chain and refrigeration;
- transport air conditioning;
- the air conditioning and refrigeration servicing sector;
- refrigerant demand and alternative refrigerants; and
- energy efficiency.

The most critical input for the development of the Bangladesh NCP has been data related to cooling requirements across the sectors. The consultant has collated the best available nationwide data from public and private agencies, including various trade associations and inputs from experts on various thematic areas of cooling.

The consultant used, inter alia, government publications (where available), industry estimates, marketing surveys from manufacturing industries and research publications from various institutions to examine projections of demand for cooling, refrigerants and energy.

1.4.1 Data collection

Data were collected on the present stock of cooling appliances, including historically installed bases, current refrigerant demand, current energy consumption, current per capita income, etc. Relevant economic and social data were collected for future projections of national cooling demand.

To determine the current stock of cooling appliances, data were collected from the residential/domestic, commercial and industrial sectors as well as on the import and exports of these appliances. The appliances include, but were not limited to, a range of refrigeration and air conditioning equipment, cooling appliances only, and mobile / transport RAC equipment. The Bangladesh Bureau of Statistics (BBS) and National Ozone Unit (NOU) were the main sources of data. Refrigerant import data collected from importers was cross-verified with the data from the National Board of Revenue (NBR). In this regard, the Ozone Depleting Substances (ODS) report and the ODS Alternatives Survey, conducted by UNDP in 2019 in Bangladesh and the SME surveys on RAC, conducted by UNDP Dhaka in 2016 and 2017 were found to be very helpful.

In general, a top-down approach was followed in collecting data and information, but in certain cases where end-use data was available, it was possible to cross-verify through a bottom-up approach. The following agencies were approached and consulted for relevant data and information:

- Bangladesh Bureau of Statistics (BBS);
- National Board of Revenue (NBR);
- Bangladesh Refrigeration Air Condition Merchant Association (BRAMA);
- Sustainable Renewable Energy Development Authority (SREDA);
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE);
- House Building Research Institute (HBRI);
- National Housing Authority (NHI);
- Public Works Department (PWD);
- Rajdhani Unnayan Karttripakkha (RAJUK);
- Department of Urban and Regional Planning, Bangladesh University of Engineering and Technology (BUET);

- Real Estate and Housing Association of Bangladesh (REHAB);
- Manufacturers / Assemblers of RAC equipment;
- Cold Storage Association;
- Mobile Air Conditioner Merchant Association;
- Retail chains / Shopping malls;
- Centre for Policy Dialogue (CPD); and
- Bangladesh Institute of Development Studies (BIDS).

Various trade associations were formally invited to attend consultation meetings organized at the Department of Environment (DoE) that ozone cell officers and UNDP representatives also participated. There were follow-up meetings with some of these agencies.

There were meetings with individual experts associated with previous studies, including surveys on ODS and / or alternatives and experts in fields relating to RAC trade and business. They include:

- Md. Shajahan, Consultant, World Bank, Dhaka and former ADG, Department of Environment and former Project Director, ozone related projects in DoE;
- Mr. Belal Ahmed, President, ASHRAE – Bangladesh Chapter;
- Dr. Hirendra Kumar Das, National Consultant, UNDP, Dhaka;
- Mr. Siddique Zubair, member (EE&C) SREDA and additional secretary to the government;
- Mr. Al Emran Hossain, President, Bangladesh Green Building Academy;
- Md. Monower Hossain, Chairman, Energy Regulatory Commission, former secretary, Power Division and Former Director General, Department of Environment; and
- Dr. S. K. Purkayastha, Project Coordinator, INS Project, UNDP, Dhaka.

1.4.2 Current stock and future projections on cooling demand

It was difficult to collate data and information on current stock as digital data are often not available. Although data are available for climate modeling and economic projections, research on growth projections for residential and commercial cooling spaces is sparse. The same is true of forecasts for the chain cooling and refrigeration sectors. Predictions for future cooling demand in these sectors has therefore been attempted using the best judgement of experts, alongside marketing surveys and industry projections in the relevant sectors.

Consideration was given to:

- future climate change, including the expansion of warming days;
- projected economic growth (growth rate, per capita income);
- population growth;
- the trend towards greater urbanization; and
- future electricity penetration across the country.

1.4.3 Selection of the plan period

Following consultation with the Ozone Cell and UNDP, it was agreed that the consultant would prepare a short- and medium-term plan, targeting 2030. This means that it coincides with the SDGs timetable, ³the Bangladesh National Energy Efficiency and Conservation Master Plan up to 2030 (EECMP) ⁴and the Nationally Determined Contribution (NDC) under the Paris Agreement, which also targets 2030.

³Sustainable Development Goals: Bangladesh First Progress Report 2018, Government of the People's Republic of Bangladesh, [https://www.undp.org/content/dam/bangladesh/docs/Publications/Pub-2019/SDGs-Bangladesh_Progress_Report%202018%20\(1\).pdf](https://www.undp.org/content/dam/bangladesh/docs/Publications/Pub-2019/SDGs-Bangladesh_Progress_Report%202018%20(1).pdf)

⁴Energy Efficiency and Conservation Master Plan up to 2030, 2016, SREDA, Government of the People's Republic of Bangladesh, http://www.sreda.gov.bd/d3pbs_uploads/files/policy_2_energy_efficiency_and_conservation_master_plan_up_to_2030.pdf

Projections over a longer period may be misleading because of a lack of available data and analysis. This plan contains the best estimates possible for the various sectors, given the limited time and resources available to the project. The figures provide a trend rather than definitive estimates, as data from differing sources may contain underlying assumptions.

Therefore the Bangladesh NCP should not be regarded as a static document and should respond to the evolving knowledge and technology landscape, and to social and economic development. It should be seen as an open-ended document to be further developed as future empirical evidence emerges.

1.4.4 Synergistic actions for securing environmental and socio-economic benefits

Synergistic actions which take a holistic view of cooling across sectors will have a higher impact than actions taken in isolation.

Synergies with existing government programmes and initiatives

The government is implementing a range of policies and programmes in energy efficiency, urban development and housing. In the energy sector, the Ministry of Energy and Mineral Resources is implementing several energy efficiency initiatives through the Sustainable and Renewable Energy Development Authority (SREDA), including the preparation of the EECMP⁵, energy audit regulations, etc., which now play a pivotal role.

The EECMP has established energy efficiency and conservation (EE&C) programmes to achieve energy saving in the building sector. Three EE&C programmes are underway: an energy management programme, an energy efficiency labelling programme and an energy efficiency buildings programme. These are targeted at heavy energy consuming entities and equipment in the industrial, residential and commercial sectors. According to the estimates in the masterplan, 4.4 Mtoe per year of energy saving is expected between 2015 and 2030.

The most important policy and technical guiding documents in the urban development and the housing sector are the national housing policy and the Bangladesh National Building Code (BNDC)⁶2016. SREDA has also been entrusted to develop and harness renewable sources of energy. Substantial work has been undertaken on the demand side of energy management and there are standard labelling programmes for cooling appliances such as room air conditioners, fans and refrigerators⁷.

The government also focuses on the mass transit sector. There is a special focus on the development of public transport facilities, including metros for intra-city movement and railways for inter-city travel. Under the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009⁸ various mitigation programmes are now being implemented.

Synergies with international commitments

Cooling is directly linked with the Montreal Protocol through the refrigerants used in RAC equipment. The HCFC phase-out management plan (HPMP) is currently being implemented. In stage 1 of the HPMP for Bangladesh, the target was a 30 percent reduction of HCFC from the baseline by 2018,

³ Ibid

⁶ Bangladesh National Building Code, Housing and Building Research Institute, Government of the People's Republic of Bangladesh

⁷ Energy Efficiency Standards and Labeling, EE&C Rule 2016, SREDA, Government of the People's Republic of Bangladesh, http://www.sreda.gov.bd/files/Standard%20and%20labeling%20regulation%20Draft%201_08_2018.pdf

⁸ Bangladesh Climate Change Strategy and Action Plan 2009, Government of the People's Republic of Bangladesh, <http://nda.erd.gov.bd/files/1/Publications/CC%20Policy%20Documents/BCCSAP2009.pdf>

resulting in the phasing out of 24.53 ODP tonnes of HCFC. In the HPMP Stage 11 period, from 2019 to 2025,⁹ the focal areas for action have been identified as follows:

- the conversion of five AC manufacturing enterprises and one chiller manufacturing enterprise to phase out HCFC-22;
- a technical assistance programme for the servicing sector; regulatory actions and monitoring of the implementation of the HPMP; and
- action to promote the use of alternative technologies and limit the demand for HCFCs, including changes in public procurement and building standards, setting of standards, and increasing the awareness of stakeholders and the public.

The Kigali Amendment to the Montreal Protocol has brought in HFCs as a controlled substance under the Protocol. The HFC phase-down schedule for parties operating under Article 5 of the Montreal Protocol is depicted in Figure 1. Here, Bangladesh is under Article 5 in group 1.

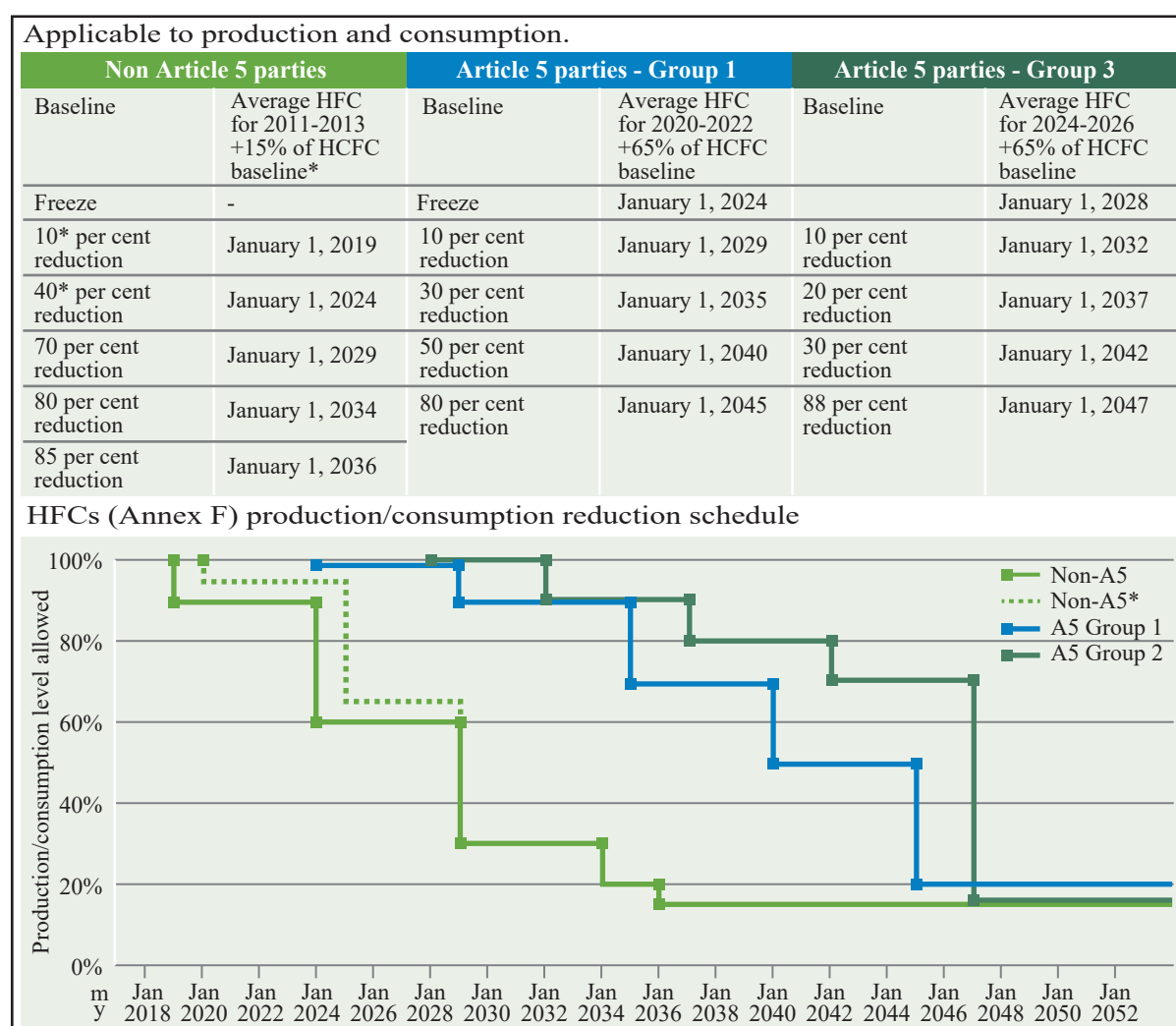


Figure 1: HFC phase-down schedule for parties operating under Article 5 of the Montreal Protocol¹⁰

⁹ HCFC phase-out management plan (stage II, first tranche) for Bangladesh, 2018, UNEP, United Nations, <http://www.multilateralfund.org/81/English/1/8123.pdf>

¹⁰ Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer, Fourteenth Edition (2020), Ozone Secretariat, UNEP, United Nations, <https://ozone.unep.org/sites/default/files/Handbooks/MP-Handbook-2020-English.pdf>

It has been recognized that sustainable cooling is at the intersection of three international multilateral agreements: the Kigali Amendment to the Montreal Protocol, the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC), and the Sustainable Development Goals (SDGs) of 2030. Essentially, providing thermal comfort for all is also part of SDG 3: Good health and well-being; 8: Decent work and economic growth; and 13: Climate action. ¹¹It is an opportune time for international actions to be synergized to secure environmental and societal benefits.

1.4.5 Outline of suggested interventions

Policies and programmes for building and habitat design, the testing of new technology and the promotion of RAC appliances, utilization of low-GWP refrigerants, have been developed without compromising on energy efficiency. Interventions have further included low-energy cooling technologies and the development of a collaborative research and development (R&D) platform to support a robust eco-system to promote sustainable and smart cooling strategies, while implementing the Kigali Amendment to the Montreal Protocol for phasing down use of HFCs, and so on.

The Technology and Economic Assessment Panel (TEAP) report on energy efficiency while phasing down HFCs recommends the following measures for efficiency improvements:

- ensuring minimization of cooling loads;
- selection of the appropriate refrigerants;
- the use of high-efficiency components and system design;
- ensuring optimized control and operation under all common operating conditions; and
- designing features that will support servicing and maintenance.

When framing recommendations for interventions the TEAP suggestions were taken into consideration, as well as existing knowledge and international best practice.

1.5 Limitations of the study

Ideally, there should have been six thematic working groups to prepare their respective sectoral reports and then a team of consultants comprising an economist, a planner and technical personnel to compile the final report. Instead there was a single consultant.

As so many inputs are required from a wide range of professionals and experts it is challenging for one person to do the subject full justice. Moreover, there were insufficient resources to carry out essential field studies, modelling exercises and to hiring relevant experts. The expert contributions have all been on a voluntary basis.

⁹ Sustainable Development Goals: Bangladesh First Progress Report 2018, Government of the People's Republic of Bangladesh, [https://www.undp.org/content/dam/bangladesh/docs/Publications/Pub-2019/SDGs-Bangladesh_Progress_Report%202018%20\(1\).pdf](https://www.undp.org/content/dam/bangladesh/docs/Publications/Pub-2019/SDGs-Bangladesh_Progress_Report%202018%20(1).pdf)

Section B
Situation Analysis And Assessment
of Cooling Demand

2. Space cooling in buildings

2.1 Overview

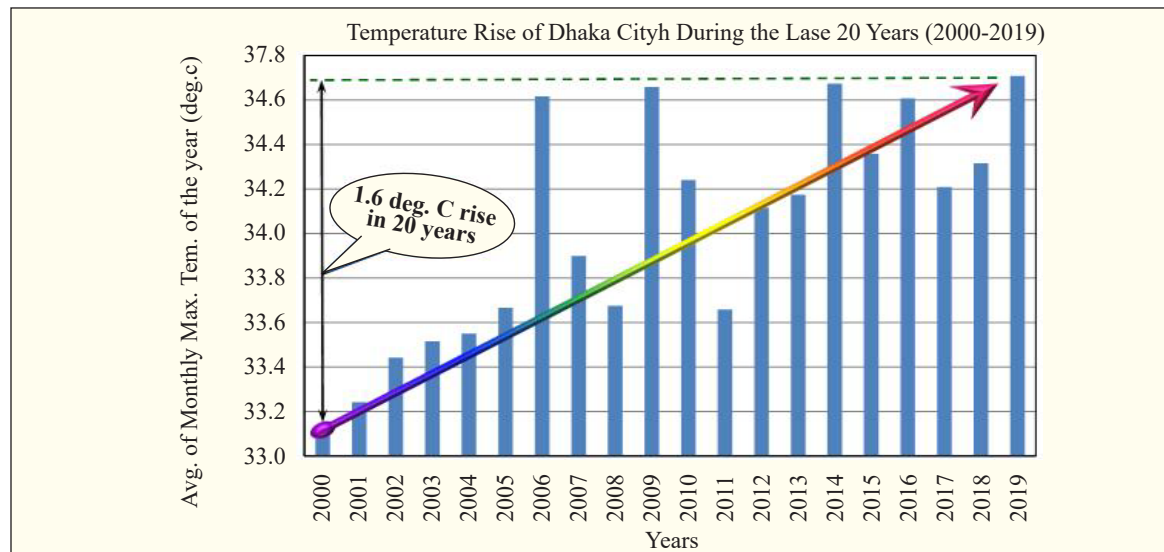
Space cooling constitutes the principal component of the total cooling requirement in the country. Indoor thermal comfort, essential for physiological and psychological well-being, can typically be provided by active heating or cooling, or a combination of both. This is contingent mainly on the local weather and seasonal variations.

Bangladesh has a subtropical monsoon climate characterized by wide seasonal variations in rainfall, high temperature and humidity. Due to its tropical location, dense urban morphology and higher-than-average population density, buildings in Dhaka and other major cities are likely to be adversely affected by the projected changes in climate, in particular by the increases in temperature.

There are three distinct seasons in Bangladesh: a hot humid summer from March to June; a rainy monsoon season from June to October; and a cool dry winter from October to March. Various studies indicate that, as a result of climate change, heating degree days are likely to decrease while cooling degree days will increase. The average monthly maximum temperature in Dhaka city has increased by about 1.6°C in the last 20 years, as shown in Figure 2.

Cold chain and refrigeration is another major emerging sector. The preservation of perishable foods like fruits, vegetables, dairy products, fish and meat is expanding rapidly, while the cold chain plays a crucial role in maintaining the efficacy of vaccines during transport and storage. There is scope to enhance the energy efficiency of the cold chain sector whilst selecting new refrigerants which are economically viable and environmentally sustainable. The challenge for the industry is to move towards energy-efficient and environmentally friendly technologies.

Increased occurrences of temperatures above the comfort threshold are likely to have significant



Source: Bangladesh Meteorological Department (BMD)

Figure 2: Temperature rise in Dhaka City during the last 20 years

consequences for human health and wellbeing, and more cooling degree days will result in a surge in demand for energy for comfort cooling. This will add further strain to Bangladesh’s already stressed energy infrastructure. The increase of temperature is also an indication that global warming has already taken place.

Thermal comfort will be achieved by space cooling in buildings, using either refrigerant-based air conditioning or non-refrigerant-based cooling (that is, fans and air coolers). Of these, room air conditioning is the most important segment as it meets the bulk of demand and consumes significant amounts of energy. Given their expected growth, a long-term roadmap is necessary for improving the efficiency of room air conditioners.

2.2 Cooling demand in the building sector

Demand for space cooling has been rising steadily over the last decade for several reasons. These are also likely to have a significant bearing on the sales of new comfort cooling equipment in the coming decades:

- growth in per capita income;
- aspiration needs;
- purchasing power of urban and as well as rural population; and
- rate of urbanization.

Bangladesh is in the midst of rapid growth in construction. The increase in building stock and the associated air-conditioned areas makes it increasingly important to incorporate from the outset interventions that will reduce the need for the active cooling of buildings. By incorporating energy efficient design in construction strategies, buildings can have inherently reduced energy consumption over their operating lifetime. High-performance buildings use substantially less energy than conventional buildings.

This section assesses the current stock of cooling equipment in the residential and commercial building sectors and its growth trajectory over the next decade. The approximate cooling demand numbers presented here provide a guide to trends and are based upon industry information, surveys and research conducted by various organizations.

2.2.1 Residential sector current stock and future projections

Room air conditioners: use of room air conditioners was very low in 2000. The subsequent rapid increase in demand led to the development of a significant number of manufacturing facilities. In 2008, there were only 1.51 million air conditioners (stationary, mobile and others) in Bangladesh, while there were 1.73 million refrigerators (domestic, commercial, industrial and transport), as shown in Table 1.

Table 1: Installed base of RAC equipment in Bangladesh in 2008

Sub-Sector	2008 Installed Base (Units)
Refrigeration - Domestic	1,720,000
Refrigeration - Commercial	4,500
Refrigeration - Industrial	25
Refrigeration - Transport	1,100
Stationary A/C	1,200,000
Mobile A/C	300,000
Other A/C	5,000
Solvent	B/A
Foams	1,720,000
Fire Protection	3,000

Source: HFC Emissions Report for Bangladesh²

The sales volume of refrigerators and air conditioners between 2010 and 2019 is presented in Figure 3. From this figure, an exponential increase in RAC demand can be seen during the last decade.

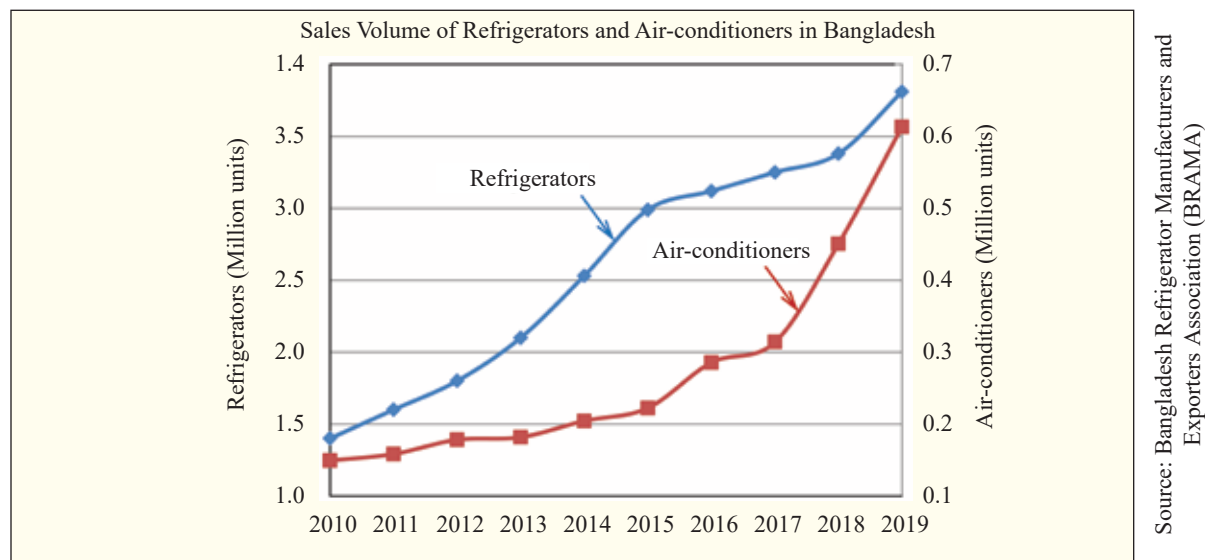


Figure 3: Refrigerator and air conditioner sales volume in Bangladesh from 2010 to 2019

Assuming a 15-year life span for the AC units that existed in 2008 (as set out in Table 1), and a 10 percent combined annual growth rate (CAGR), 32 percent of the historical stock may still have been in operation in 2019. Considering Figure 3 and the old air conditioners’ life span and CAGR, the stock of air conditioners in 2019 can be estimated as 3.5 million units.

Given the average capacity of room air conditioners in the Bangladeshi market, the total capacity in 2019 can be translated into 6.0 million tonnes of refrigeration (TR). As seen in Figure 3, the CAGR of room air conditioners was about 22 percent for 2014 to 2019, and about 17 percent for 2010 to 2019.

Experts in this sector believe that around 6-7 percent of Bangladeshi households now have access to room air conditioners (ACs). Around 50 to 60 percent of these are one AC families; the rest possess more than one AC. Demand for room ACs is growing with the rise in economic growth, which offers a tremendous opportunity for the industry to expand.

Projections of growth

It has been assumed that most households purchased their first room air conditioners between 2001 and 2015. However, based on expert analysis and intelligence from key stakeholders, it is likely that over the next 15 to 20 years, many households – especially in urban areas – will buy their second or third ACs.

The future room AC stock has been estimated using the baseline of historically installed units, the current sales trends, and the following underlying assumptions:

- room AC life is around 10 years (this is according to the literature, though some good quality machines can last up to 15 years if maintained);
- a good share of room ACs are still used in commercial spaces;
- manufacturers’ production and import data analysis reveals that the market for room ACs is doubling every four years;
- further global warming will further push sales.

¹² HFC Emissions Report for Bangladesh, 2020, Climate and Clean Air Coalition, UNDP, <http://ccacoalition.org/en/file/2747/download?token=TJskvc-m>

Based on the above scenario, experts predict that room AC sales are likely to grow at a CAGR of 10 to 12 percent in the next 10-15 years. The projection using a 10 percent CAGR is shown in Figure 4.

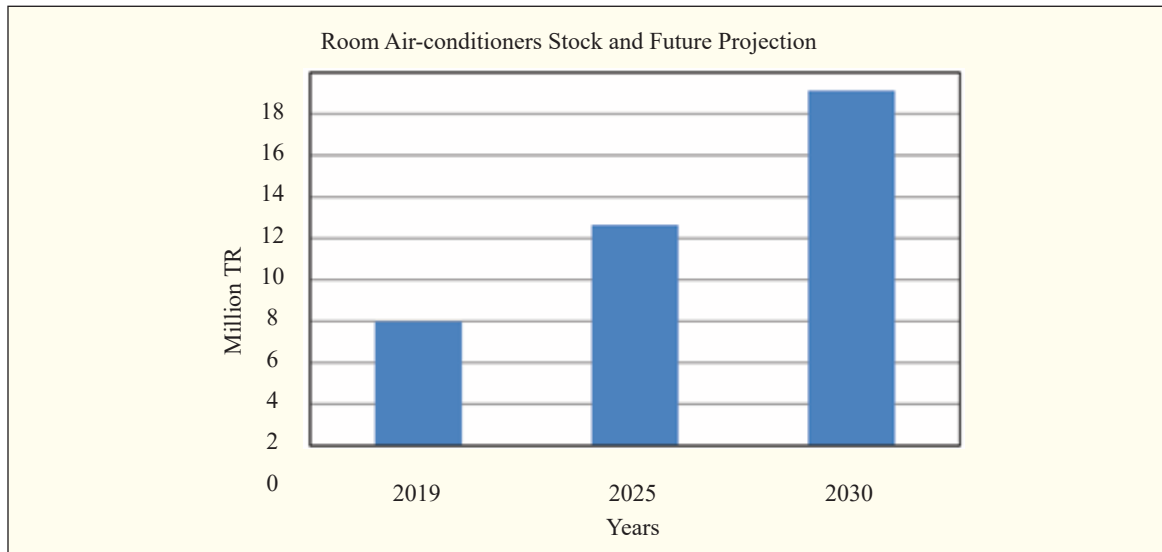


Figure 4: Projection scenario of room air conditioner demand from 2019 to 2030

It is also observed from the market that there has been a sharp rise in the adoption of inverter room air conditioners in recent years, alongside a significant decline in uptake of fixed speed room air conditioners. Given the trends in the uptake of inverter room ACs, it is anticipated that in the future the share of fixed-speed room ACs will decline. This is the most important air conditioner segment, both because it meets the bulk of thermal comfort demand and because of the significant amount of energy that it consumes.

2.2.2 Commercial building sector current stock and future projections

Chillers: the commercial building sector comprises eight major segments: hospitals; hotels and restaurants; retail; office buildings; educational institutions; assembly places; transit buildings; and warehouses. Various types of air conditioners –such as splits, screw compressor, reciprocal, and centrifugal – are used in commercial sector buildings. In general, capacity ranges from 200 tonnes and above for centrifugal; 50 to 200 tonnes for screw compressors; and 20 to 50 tonnes for scroll compressors.

Air-cooled and water-cooled chiller systems are used in supermarkets. Many old supermarkets have a split AC system. Newly built supermarkets have variable refrigerant flow (VRF) central AC systems. Larger chillers are charged with refrigerant R-22. However, refrigerant HFC-134a is also used.

Every segment of commercial buildings has experienced a decade-long growth. Unfortunately, no data are available on the current stock of commercial space and/or how much of the space has cooling access. The consultant has therefore used data on historically installed units with the current sales data for chiller and VRF systems and their respective capacities, as supplied by importers of this equipment.

Current stock of chillers

As the chiller systems are 100 percent imported, the existing stock information has been arrived at by gathering two key pieces of information: chiller sales data for 2018 and an estimate of the historically installed base. Chiller sales data, sourced from importers and various market intelligence reports, have been aggregated. The data on estimated market size of different types of chillers in 2018 were also gathered from the above-mentioned sources. The stock of chillers in 2018, including the historically installed base, is estimated to be around 0.65 to 0.70 million TR.

According to ASHRAE, commercial buildings consume approximately 80 percent of all chillers sold in the country, while the remaining 20 percent goes into industrial AC applications. It is also observed that roughly one-sixth of the total annual chiller sales are to replace existing chillers.

Future growth projections

ASHRAE estimates that future growth in the chiller industry will be driven by growth in retail, hospitality and infrastructure projects, with a projected CAGR of around 10 percent for centrifugal, 5 percent for scroll and 15 percent for screw chillers over the next 10 to 15 years. The scroll chiller market is expected to decline and be gradually replaced by screw type chillers in the near future, owing to the latter’s easier maintenance and higher efficiency. Industry experts suggest that the chiller market will grow at an average CAGR of around 10 percent in the next decade, as presented in Figure 5.

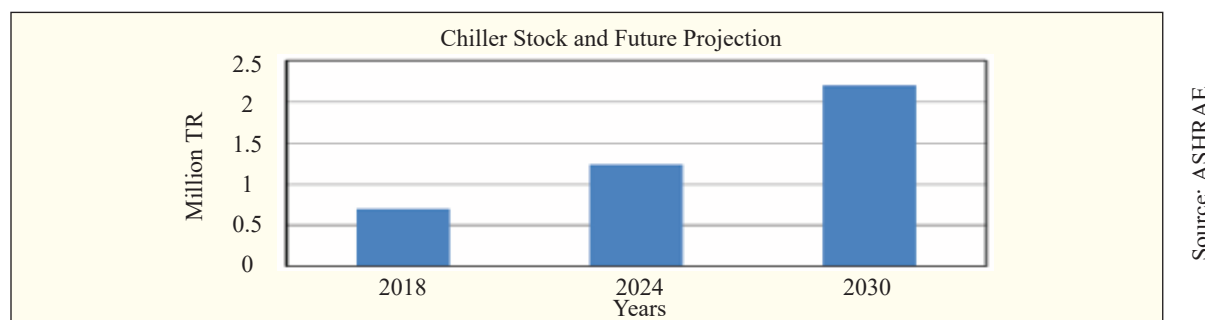


Figure 5: Projection scenario of chiller demand from 2018 to 2030

Current stock of variable refrigerant flow (VRF) systems

According to ASHRAE, the market size of VRF systems in 2017/18, with the historically installed base, is around 0.40 to 0.45 million TR, and these systems are getting more popular.

Industry experts suggest that the VRF market will grow at a CAGR of at least 10 to 15 percent over the next decade. A VRF growth projection using 15 percent CAGR is shown in Figure 5.

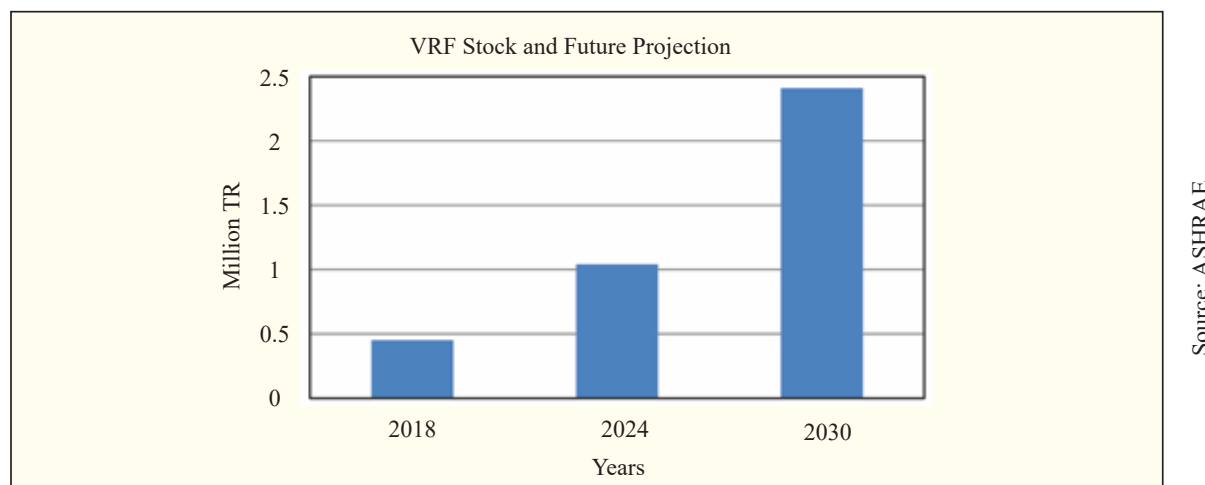


Figure 6: Projection scenario of variable refrigerant flow (VRF) system demand from 2018 to 2030

Other systems

There are also packaged direct expansion (DX) air conditioning systems in the market. The demand is still low, and they occupy around 2-3 percent of the total market.

2.3 Non-refrigerant cooling

2.3.1 Fans

The use of electric fans alone accounts for around 30 percent of energy demand in the residential sector, almost equal to the current energy demand from RAC combined. It is therefore very important to make electric fans energy efficient. Energy-efficient ceiling fans of around 50W, as compared to ordinary fans of around 70W, should become the norm, making possible an energy saving of 10-15 percent. Thereafter, mainstreaming of super-efficient 35W fans, which are already available in the market, can bring even greater savings.

2.3.2 Air coolers

Air coolers are not yet popular in the country, though during extreme summer weather, units are imported from India and China.

It is estimated that 10-20 percent energy savings are possible in the next decade, with more air coolers being fitted with energy-efficient fans and pumps. Additionally, low water-consuming air coolers can be designed in response to concerns about the excessive use of water.

2.4 Passive cooling using energy-efficient building envelopes

The design and construction of buildings can enhance comfort levels considerably if done in a climate-sensitive manner. The Bangladesh National Building Code (BNBC)¹³ and various green building rating systems put an emphasis on sustainable construction by integrating climate-responsive design elements which are low cost and energy efficient.

The BNBC covers designing an energy-efficient envelope that helps in reducing heat transfer, thus enhancing thermal and visual comfort. In addition, the regulatory and policy actions in the adoption of energy-efficient building practices – engendering regulatory compliance by mainstreaming the passive building design focused on occupants’ comfort – can significantly reduce the cooling requirement.

The Energy Efficiency & Conservation (EE&C) Master Plan¹⁴ prepared by the Ministry of Energy & Mineral Resources has set specific EE&C programmes to achieve energy saving in the building sector.

The intensity of demand for AC and corresponding electricity consumption in the commercial building sector is significantly higher than the residential sector, although overall national electricity consumption is still higher in the residential sector. However, there is tremendous potential for a reduction in energy consumption in commercial buildings. This includes:

- stricter compliance with the Bangladesh National Building Code (BNBC), in which one chapter has been dedicated to air conditioning to encourage minimum energy performance in commercial buildings, and which instituted a Standards and Labelling Programme to set minimum energy performance standards (MEPS) for room air conditioners, along with other consumer appliances; and
- combining strategies so that the positive impact is greater than the sum of the parts. For example, one of the ways to address space cooling requirements is a sequential approach that first reduces heat gain by passively cooling buildings, followed by the installation of energy-efficient HVAC appliances / systems, coupled with smart controls to efficiently meet the reduced cooling needs, and finally the deployment of green / natural refrigerants and renewable energy to meet cooling demand.

¹³ Bangladesh National Building Code, Housing and Building Research Institute, Government of the People’s Republic of Bangladesh

¹⁴ Energy Efficiency and Conservation Master Plan up to 2030, 2016, SREDA, Government of the People’s Republic of Bangladesh, http://www.sreda.gov.bd/d3pbs_uploads/files/policy_2_energy_efficiency_and_conservation_master_plan_up_to_2030.pdf

3. Refrigeration and Cold Chain

3.1 Overview

Refrigeration can be classified into three main categories: domestic, commercial and industrial refrigeration.

3.1.1 Domestic refrigeration

Domestic refrigerators are commonly used in households – as well as commercial setups like retail outlets, offices, hotels and hospitals – for the storage of perishable food, medicines, vaccines, and so on. These are two types: frost-free and direct-cool. Around 90 percent of the domestic refrigerator demand is met by local manufacturers and assemblers. R-134a is the preferred refrigerant.

3.1.2 Commercial refrigeration

Commercial refrigeration, in general, is applied through three different systems: centralized systems installed in supermarkets; condensing units installed mainly in small shops and restaurants; and self-contained or stand-alone units.

These types of refrigeration equipment are manufactured and/or assembled in Bangladesh. Essential parts – such as indoor and outdoor body covers, evaporator and condenser coils, plastic cabinets, copper tubes, binding belts and electric boxes – are imported. R-22 is still used in condensing units. HCFC-22 continues to represent a large refrigerant bank in commercial refrigeration.

3.1.3 Industrial refrigeration

Industrial refrigeration equipment is used for milk, meat and fish processing and storage; fruit and vegetable processing and storage; ice-cream manufacturing and storage; pharmaceuticals including vaccines, chemical manufacturing and storage, and other purposes. Large industrial systems, such as cold storage, fish freezers, textiles, pharmaceuticals, and so on, mainly use ammonia (R-717), which is accepted as the preferred refrigerant. For pre-cooling systems, only R-22 is used in small cold storage and fish freezing.

3.2 Domestic refrigerators: current stock and future projections

Based on the population census of 2011, the Bangladesh Bureau of Statistics (BBS) reported that 12.42 percent of households had fridges.¹⁵At that time, there were 32.1 million households, and therefore there were an estimated 3.98 million domestic refrigerators in 2011.

In section 2.2.1 above, it was reported that:

- there were 1.73 million refrigerator units (domestic, commercial, industrial and transport) in 2008;

¹⁵House Amenities and Assets, Population Monograph of Bangladesh, Vol-8, 2015
<http://www.bbs.gov.bd/site/page/47856ad0-7e1c-4aab-bd78-892733bc06eb/Population-and-Housing-Census>

- it was likely that around a third of the historical stock might continue in operation up to 2019; and
- there was a Combined Annual Growth Rate (CAGR) of refrigerator sales between 2010 and 2019 of about 12 percent, as presented in Figure 3 above.

Given this information, the stock of refrigerators in 2019 can be estimated at 28.5 million units.

Three factors accounted for a steady increase in the sale of refrigerators since 2010:

- steady economic growth, and thus growth in per capita income;
- the growing penetration of electricity in rural areas; and
- the availability of refrigerators at an affordable and competitive price from local manufacturers. It may further be noted that local manufacturing and assembling companies can now cater for 90 percent of demand.

Market experts believe that domestic refrigerator sales witnessed a steady CAGR of around 15 percent over these years. It is expected that this trend will continue for another five to six years, and they may reach saturation point in 2024-25, from where they will start to decline. Walton Hi-Tech Industries Ltd (the leading manufacturer in the country) and other companies have already started exploring the overseas market. If they can pick up the export market, manufacturing growth could continue. Based on a 15 percent CAGR, the projected stock of refrigerators is shown in Figure 7.

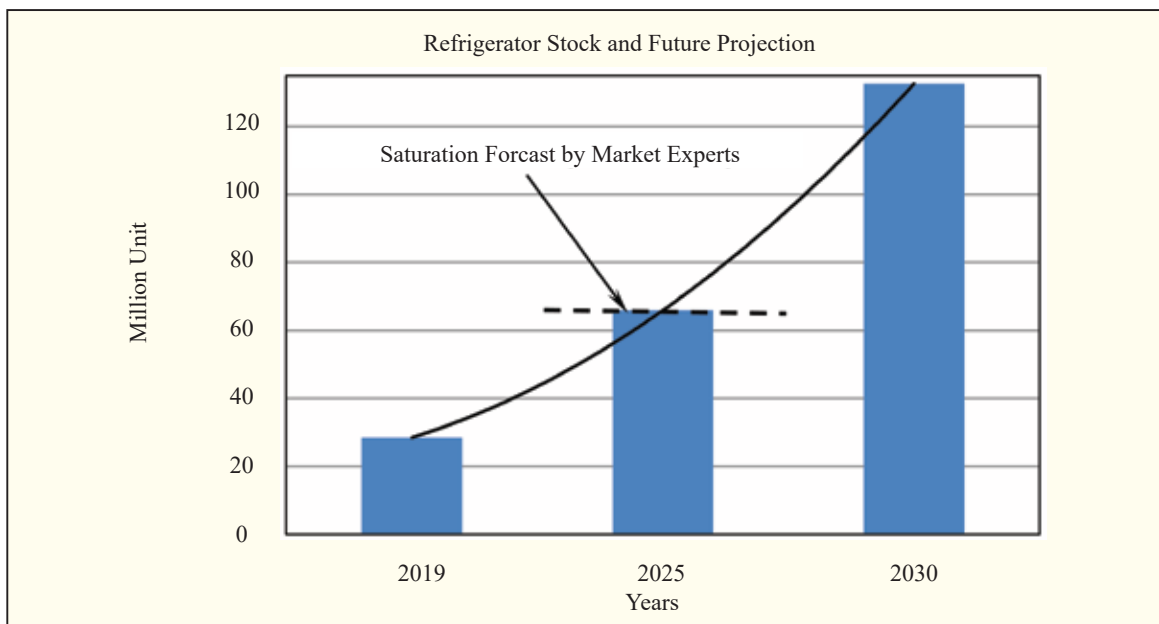


Figure 7: Projection scenario of domestic refrigerator demand from 2019 to 2030

To improve energy efficiency in this sector, inverter technology has been introduced by local manufacturers. Energy efficiency and conservation (EE&C) labelling is also progressively moving towards higher energy efficiency.

3.3 Commercial refrigeration systems: current stock and future projections

Commercial refrigeration equipment covers equipment of different capacities: deep freezers (glass top or hard top) (<1 kW); visi-coolers (<1 kW); remote condensing units (1-20 kW); water coolers (>2 kW); supermarkets (60-100 kW); and hypermarkets (100-200 kW). Polar, Igloo, Lovello, Kwaliti, Zaan Zee and Golden Harvest ice cream distribution chains make up a good proportion of the market.

It should be noted that remote condenser units can either be display type, used by large retail shops, or non-display for the storage of additional refrigerated goods. Non-display units have racks of condensing units placed in a small machine room away from the display area. Centralized systems as used in supermarkets and hypermarkets (in which compressor racks are installed in a machine room and which involve lengthy piping), are not very prevalent, but increasing.

Around 80 percent of the current market demand is met from local assemblers, who are largely SMEs. Many enterprises in the informal sector are also engaged in this trade. A technical assistance programme would upgrade their skills.

According to ASHRAE, using information from importers and market intelligence reports, the market size of commercial refrigeration – combining deep freezers, visi-coolers, remote condensing units and water coolers in the base year 2018, including the historically installed base – is estimated to be around 0.8 to 1.0 million TR. Market experts believe that various kinds of commercial refrigeration units will see a steady growth of around 10 percent CAGR increase over the next 10 to 15 years, as outlined in Figure 8. The main factors for growth in the commercial refrigeration sector will be commercial space growth, cold chain, GDP growth and the lowering of prices.

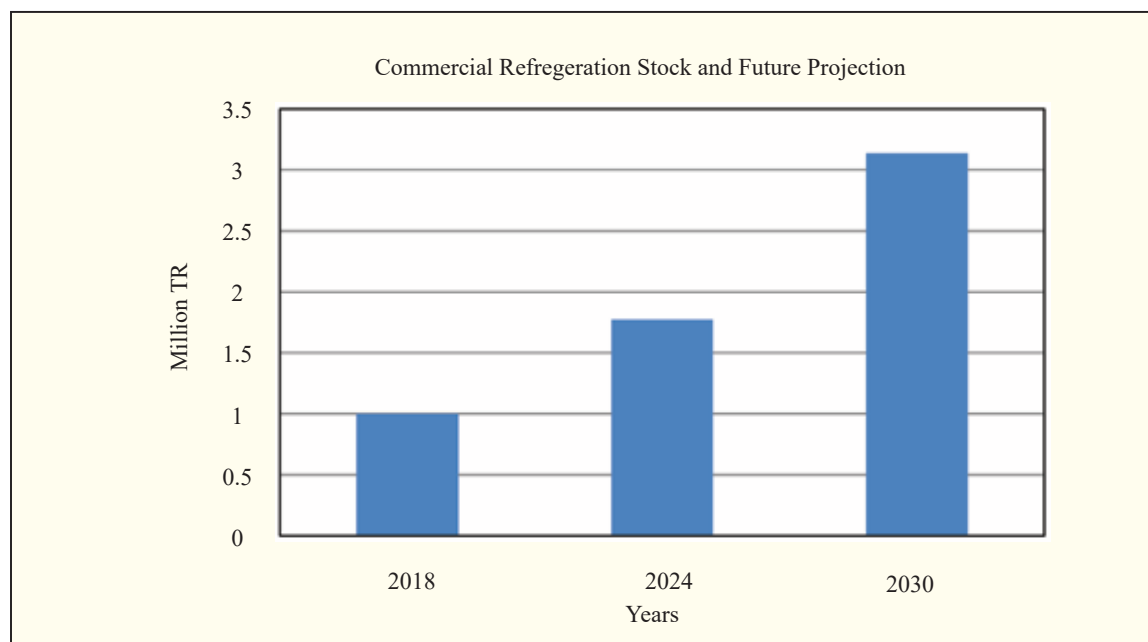


Figure 8: Projection scenario of commercial refrigeration demand, 2018 to 2030

3.4 Cold chain (industrial refrigeration)

The cold chain is a logistical chain of activities involving the packaging, storage and distribution of perishable food and non-food products (such as fruit and vegetables, milk, meat and poultry, flowers and vaccines) from the point of production to the point of consumption, where the inventory is maintained in predetermined environmental parameters.

Typically, a cold chain is made up of four links: pack-house or source point; reefer transport; cold storages; and ripening chambers or retail. Refrigeration forms an important and significant part of the food and beverage retail market. It ensures optimal preservation of perishable food. Domestic refrigeration and commercial/industrial refrigeration are also important elements of the cold chain.

Cold chain infrastructure in Bangladesh predominantly comprises a large quantity of refrigerated warehousing space. This capacity is primarily designed for bulk long-term warehousing of certain crops, mainly potatoes and red chillies. Most cold storages are single temperature units, except for a small percentage which are used as distribution hubs at the front end of the supply chain. Other requirements from source to market include modern pack-houses, refrigerated transport, ripening chambers and transport connectivity to retail outlets. Modern pack-houses and ripening chambers are yet to be developed in Bangladesh.

The cold chain for frozen products, being primarily industry-driven, originates post-production at manufacturing/processing factories and it captures most of the refrigerated transport and storage capacities for market linkage. However, the bulk of the infrastructure for the handling of fresh produce (fruit and vegetables) is yet to come. Hence, the cold chain sector offers tremendous opportunity for growth. Additionally, the sector has tremendous potential to reduce cooling, refrigerant requirements and energy consumption through improved design, including proper insulation and the use of energy-efficient cooling equipment.

The use of reefer transport as one of the components of the cold chain is on the rise. This transport refrigeration also comprises the delivery of frozen products by trucks, trailers, vans, inter-modal containers and boxes. It also includes the use of refrigeration and air conditioning on merchant, naval and fishing vessels above 100 gross tonnes (over about 24 metres in length). Almost all transport refrigeration systems continue to utilize HFCs, with a prevalence of HFC-134a, R-404A and low GWP refrigerants; but HCFCs are mainly used in ship refrigeration systems, including ship breaking and building, marine and inland fishing vessels. They play an important part in the cold chain for frozen products in the market linkage, being primarily industry driven, originating post-production at manufacturing / processing factories.

The fish freezing sector has also come of age. There are 280 to 300 fish freezers now in operation, according to the Bangladesh Fish Freezers Association. All of these are medium-sized and have a capacity of refrigerant range from 0.75 to 1.0 TR. Ammonia (R-717) is used as the refrigerant. For pre-cooling, R-22 is used in the fish freezing sector.

Within the cold chain, the most important aspect is the cold storage facility, comprising highly insulated and refrigerated warehouses designed to store perishable products to maintain the temperature and humidity parameters. This sector is described in more detail below.

3.4.1 Cold Storage

Bangladesh has limited post-harvest storage infrastructure, with current cold storage capacity of 5.5 million tonnes in 427 cold storages all over the country.¹⁶ The cooling capacity of cold storages varies between 500 and 30,000 tonnes.¹⁷ In traditional business culture, cold storage is assumed to be large if it has a capacity of 2,000-5,000 tonnes. Given the huge investments and high electricity bills needed to run such facilities, the irregular supply of grid electricity is a major problem.

¹⁶ Statistical Year Book Bangladesh 2019, Published May 2020, Bangladesh Bureau Of Statistics, Government Of The People's Republic Of Bangladesh, www.bbs.gov.bd

¹⁷ Bangladesh Cold Storage Association figure.

These units are basically single crop (potato) storage. The existing capacity could also be expected to service a larger volume of goods if operations were modernized to optimize the rotation of goods within the same space. Cold storage cooling requirements are largely met by vapor absorption units using ammonia and reciprocating and / or screw type compressors using R22.

Unfortunately, due to the inadequacy of post-harvest cold storage facilities for other crops or fruits, farmers can suffer big losses and damage to perishable produce, and can be exploited by middlemen and local wholesalers. Primary producers and retailers suffer loss and damage of up to 60 percent of their seasonal fruits, vegetables, fish, milk and meat items, worth Tk. 34,420 million.¹⁸ According to a 2017 feasibility study by Palli Karma-Sahayak Foundation (PKSF), demand for cold storage for perishable produce is growing among farmers, fisheries and rural small businesses for the short term preservation of perishable agro-products near wholesale rural markets, but there is hardly any development of the necessary small scale cold storage.

The Bangladesh Cold Storage Association has reported that around 20 cold storages operate now for multi-purpose cold storage. The capacity of the multipurpose cold storage is still in the range of 15,000-20,000 tonnes. There are big opportunities for multi-purpose cold storage facilities, including for pack-house and ripening facilities.

Most of the existing cold storage capacity could be converted to multi-purpose cold storage by balancing, modernization and renovation. Both existing and future cold storage owners may actively consider mini-solar cold storage for perishable produce (of an average 8-10 tonnes capacity) as the best alternative source of dependable, sustainable, cost-effective and environmentally friendly storage. Solar-powered mini cold storage could become a viable alternative. Furthermore, there is significant potential to improve energy efficiency through the renovation of storage facilities, which were not properly designed as industrial buildings.

The Government of Bangladesh (GoB) encourages the spread of mini cold storage with solar and other alternative power sources through SREDA (Power Division). PKSF has granted finance for a few pilot plants (6-8 tonnes capacity). Successful operation of pilot solar mini cold storages will encourage hundreds of new investors to invest in this sector. Financial incentives and the availability of refrigerants for different sizes of cold storage facilities can increase the preservation capacity of agricultural crops in Bangladesh.

¹⁸ IHouse Amenities and Assets, Population Monograph of Bangladesh, Vol-8, 2015
<http://www.bbs.gov.bd/site/page/47856ad0-7e1c-4aab-bd78-892733bc06eb/Population-and-Housing-Census>

4. Transport air-conditioning and refrigeration

4.1 Introduction

This sector includes transport / mobile air-conditioning (MAC) systems used to cool the driver and passengers in land transport, including cars, vans, lorries, buses, agricultural vehicles and trains. Historically, all-car air conditioning used the CFC-12 refrigerant. This was completely phased-out during the 1990s in industrialized countries, and around a decade later in developing countries, as the global car market switched to HFC-134a, a refrigerant with a GWP of 1430. Larger vehicles such as buses and trains use other HFC refrigerants such as R-407C (GWP 1774) and R-410A (GWP 2088).

Passenger cars and other small vehicles, such as vans and lorry cabs, almost all use a very similar design of AC system. This utilizes a compressor powered via a belt drive from the main engine, connected to an evaporator in the ventilation air inlet duct and a condenser located at the front of the car near the radiator. The main components are connected by flexible hoses. The system is assembled and charged on the main vehicle production line. Some recent MAC designs use electrically driven compressors: these are a new requirement to ensure the function can continue when the main engine is off (such as in hybrid vehicles) and for fully electric vehicles.

Car MAC systems contain between 0.4 kg and 0.8 kg of refrigerant. The annual demand for refrigerant in the MAC sector is split between refrigerant used in new cars and refrigerant used in the service sector to top up systems that have leaked. Historically, car MAC systems have suffered from high levels of leakage: it was common to recharge the system with refrigerant on an annual basis. During the last 10 years, there have been major design improvements, especially to the compressor shaft seal and to the materials used for flexible hoses. Modern MAC systems experience relatively low levels of leakage in normal use, although they may suffer total refrigerant loss following a major car accident.

4.2 An overview of transport modes in Bangladesh

The transport and communication system is vital infrastructure for the socio economic development of a country. According to the Bangladesh Bureau of Statistics (BBS), the transport and communication sector contributed 11.26 percent to GDP and the rate of growth was 6.76 percent during 2016/17.¹⁹ The Roads and Highways Department (RHD) and the Local Government Engineering Department (LGED) play an important role in the construction and maintenance of roads in the country.

Under the management of the Roads and Highways Department (RHD) there are 21,596 km of highways of various types. Of this highway network, 18 percent is National Highway, 20 percent is Regional Highway and remaining 62 percent are Zilla (secondary) roads. In addition, the RHD has 4,404 bridges and 14,814 culverts under its control, and it operates 96 ferry boats in 42 ferry ghats (berths) and 118 pontoons on its road network.²⁰

¹⁹ National Accounts Statistics, Bangladesh Bureau of Statistics, 2018, http://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/057b0f3b_a9e8_4fde_b3a6_6daec3853586/National%20Accounts_Book_2017-18.pdf

²⁰ Roads and Highways Department, Ministry of Road, Transport and Bridges, 2019, Government of the People's Republic of Bangladesh, https://mof.portal.gov.bd/sites/default/files/files/mof.portal.gov.bd/page/f2d8fabb_29c1_423a_9d37_cdb500260002/Ch-11%20%20%28English-2019%29.pdf

A masterplan has been prepared for 2005-2025 by the Local Government Engineering Department (LGED), for the development of rural infrastructure and other programmes with the aim of balance across the country. From its inception until February 2019, LGED had constructed, reconstructed or rehabilitated 1,17,877 km of roads at upazila, union and village level, as well as constructing, reconstructing or rehabilitating bridges and culverts. Additionally, LGED has developed 4,333 growth centres / village markets, grown trees alongside 25,136 km of roads and built 3,272 union parishad complex bhaban, 210 upazila complex bhaban and 9,220 cyclone centres.²¹

Bangabandhu Bridge: To ensure an integrated communication system, the 4.8 km long Bangabandhu Bridge was built in 1998 over the Jamuna River at the cost of Tk.37.456 million. The bridge, which connects two regions divided by the Jamuna River, has helped to accelerate the country's overall political, social, economic, administrative and cultural development. A direct railway has been built between the capital Dhaka and Rajshahi, Lalmonirhat, Dinajpur and Khulna alongside the Bangabandhu Bridge, enabling very fast communication between the north-west region and Dhaka. Apart from the road and railway, other facilities like electricity, gas and a fibroptic telephone line have been established through this bridge. The construction of the Bangabandhu Bridge has facilitated a significant increase in agriculture production in the northern region, and farmers are now getting a fair price for their products. Industry has also flourished in the region.²²

Following the success of Bangabandhu Bridge, the government has undertaken to build the longest bridge in the country, over the River Padma.

Padma Bridge: The present government has given the highest priority to the construction of the Padma Multipurpose Bridge at Mawa-Janjira point (6.15 km long). This will establish an integrated communication network across all regions of the country. The cost of this largest ever, self-funded project in Bangladesh is Tk 301.933,800, and by July 2020, the work was 81 percent complete.

The Padma Bridge will connect 19 districts of the south-western region with the eastern part and the capital Dhaka. The bridge will also bring revolutionary changes in the communication system across South Asia due to its alignment to the Asian Highway (AH-1). As well as contributing to the communication network, the bridge will also encourage economic development by increasing production, employment and incomes, therefore helping alleviate poverty. It is estimated that the bridge will increase GDP by 1.2 percent and reduce poverty by 0.84 percent.

Road transport: the number of cars, buses and trucks has grown rapidly over the last decade. Table 2 shows the annual registration totals for various types of vehicles in the decade up to 2020, according to the Bangladesh Road Transport Authority (BRTA).

Other transport modes include railway and shipping. In recent years, the government has allocated more resources for the development of railway communication and internal and international water infrastructure to increase safety.

While the road transport sector has experienced an overall CAGR (including passenger-kilometre and tonne-kilometre) of over 12 percent in the last 10 years, rail transport has not expanded much. Current road transport growth is expected to continue to meet the needs arising from the expected rapid pace of urbanization, coupled with population and economic growth. The shipping sector is also expected to see substantial growth as the volume of trade continues to increase.

Given these anticipated trends in the transport sector, it is surmised that the biggest demand for refrigerant shall continue to come from road transport, followed by shipping.

²¹ Ibid.

²² Ibid.

Table 2: Number of registered motor vehicles in Bangladesh, 2020

Number of registered motor vehicles in Bangladesh (Yearwise)

Sl No	Type of Vehicles	Upto-2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Upto-June 2020	Grand Total
1	Ambulance	2793	219	181	243	333	480	378	486	564	667	311	6669
2	Auto Rickshaw	128763	20423	23545	15897	19897	20000	11173	9168	21628	30967	10217	309438
3	Auto Tempo	14266	175	626	395	500	1095	1322	1592	609	228	42	20850
4	Bus	27778	1761	1439	1107	1482	2391	3833	3760	2755	3808	1501	51419
5	Cargo Van	3522	489	282	687	602	399	1017	1413	1280	4	1	9702
6	Covered Van	5658	2354	1421	2271	2869	2354	3340	5175	5729	3042	792	35006
7	Delivery Van	17083	1004	774	894	1178	1719	2181	2410	2100	1531	515	31367
8	Human Hauler	6520	1152	715	385	225	1142	3487	3393	1423	510	91	19071
9	Jeep (Hard/Soft)	32288	2134	1589	1314	1870	3801	4892	5425	5555	5830	1943	66219
10	Microbus	66379	4051	3044	2537	4312	5224	5804	5575	4137	3683	1149	105896
11	Minibus	25644	276	249	148	256	323	472	492	438	837	285	29418
12	Motor Cycle	759257	114616	101588	85808	90686	240358	332057	326550	395603	406897	138193	2991612
13	Pick Up (Double/Single Cabin)	32240	10460	7625	6553	9554	9554	11371	13512	13097	11952	4372	130993
14	Private Passenger Car	219830	12950	9224	10472	14899	21062	20304	21959	18227	16783	5009	370529
15	Special Purpose Vehicle	6371	396	226	227	172	296	620	993	1336	1182	330	12152
16	Tanker	2706	317	195	228	362	324	394	319	529	419	166	5957
17	Taxicab	44380	75	172	51	374	88	44	15	161	11	6	45377
18	Tractor	20000	5200	3194	1895	1522	1899	2576	2777	3553	2561	856	46723
19	Truck	82871	7327	4335	5129	8135	6330	7275	10353	12663	8328	2229	154974
20	Other's	1317	7	1	1080	1595	2072	3870	5021	5976	5294	2007	28241
	Total	1498244	185386	160705	137109	160639	321215	416410	420398	497374	504130	170015	4471625

Source: BRTA, 2020²³

4.3 Current stock of refrigerants in transport air conditioning and shipping refrigeration

Bangladesh's changing climate means that the growing transport sector will have increased cooling requirements. Almost all imported cars and minibuses are air conditioned. Demand for mobile air conditioning (MAC) is growing rapidly and now forms a significant proportion of the country's total cooling needs. It should be noted that future cooling requirements in this sector will differ, depending on whether public transport is emphasized over private transport. The various modes of transport – such as road, rail, air, and shipping – need to be considered separately to predict future refrigerant demand. For example, the aviation sector does not use refrigerant gases for cooling purposes – it uses air as the refrigerant for AC and refrigeration. On the other hand, the shipping sector does use refrigerants for its refrigeration systems.

The data show that refrigerant demand for MAC and refrigeration grew exponentially over the last decade, but that the rate of growth has eased recently. Most demand is for servicing. Older vehicles with CFC-based ACs are now being serviced with HCFC-R-22, as CFC was phased out some time ago. MACs fitted in new imported vehicles are mostly R-134a based. As a result, demand for R-134a in the servicing of MACs has also begun to increase in recent years.

4.4 Projection of refrigerant demand

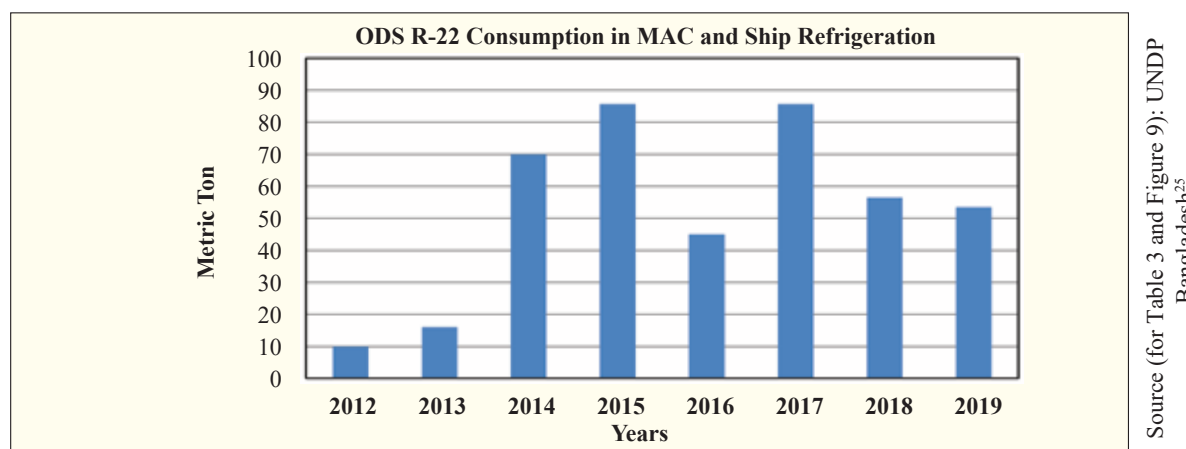
A survey of ozone depleting substances (ODS) and ODS alternatives was conducted in 2019 by UNDP Bangladesh to assess trends in demand for refrigerants, mainly in the HCFC and HFC categories.²⁴ The refrigerant-related trends, projections and relevant parameters included in this report are mainly extracted from this survey.

²³ Bangladesh Road Transport Authority (BRTA), 2020, Government of the People's Republic of Bangladesh, https://brta.portal.gov.bd/sites/default/files/files/brta.portal.gov.bd/monthly_report/d4d56177_644f_44f8_99c4_3417b3d7b0f4/MV_statistic_s-bangladesh-march-18.pdf

The R-22 consumption data of the MAC sector are set out in Table 3 and presented in Figure 9. Refrigerant demand for R-22 in the MAC sector grew exponentially for most of the last decade, but began to fall after 2017 due to R-22 becoming a controlled substance, in line with Article 5 of the Montreal Protocol. The contribution of other ODS in this sector is not significant.

Table 3: Consumption of ODS R-22 in the MAC sector, including ship refrigeration

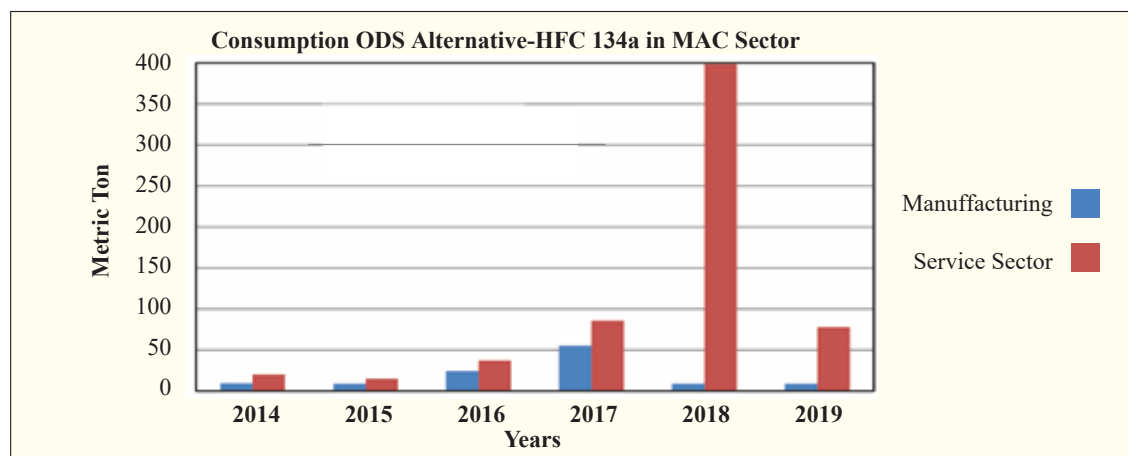
Year	2012	2013	2014	2015	2016	2017	2018	2019
MT	10	16	70	85.7	45	85.7	56.47	53.47



Source (for Table 3 and Figure 9): UNDP Bangladesh²⁵

Figure 9: Consumption of ODS R-22 in the MAC sector, including ship refrigeration

The combined consumption of ODS alternative R-134a in the MAC and MAC service sector increased exponentially from 2014 to 2018, though a decrease in 2019, as shown in Figure 10, goes against the trend. MAC servicing always consumes more than manufacturing. The increasing trend of consumption of this ODS alternative is in line with Article 5 of the Montreal Protocol. The contribution of other ODS alternatives in this sector is still not significant.



Source: UNDP Bangladesh²⁶

Figure 10: Consumption of ODS alternative HFC 134a in the MAC sector

²⁴ ODS and ODS Alternatives Survey, 2019, UNDP, Dhaka, Bangladesh.

²⁵ Ibid.

²⁶ Ibid.

5. Refrigeration and air-conditioning service sector

5.1 Introduction

In Bangladesh, there were around 18,000 RAC servicing workshops in 2019, distributed across the divisions as follows: 724 in Mymensingh, 6,278 in Dhaka, 1,578 in Sylhet, 4,011 in Chittagong, 690 in Barisal, 1,835 in Khulna, 2,110 in Rajshahi and 996 in Rangpur.²⁷

Service sector enterprises are now spread throughout the country, and – given that the penetration of air conditioners, refrigerators and cars is growing fast – their number is also rising. These service centres are not controlled by any government agencies, but instead start their businesses by obtaining a trade licence. There are three other channels through which room air conditioners or fridge servicing is offered in Bangladesh, as set out below.

5.1.1 Manufacturing companies

Manufacturing companies have a formal servicing setup and a pool of trained service personnel. These companies largely operate through a franchised service network – third-party sales and service dealers or authorized service providers – although they may have a few engineers / technicians on their payroll, at supervisory / managerial level. The company routes requests for both installation and repairs to these franchisees. Actual service delivery is completed by the franchisees using their service technicians.

Most of the products in the category of air-conditioners are guaranteed for one year. During the warranty period, apart from assuring satisfactory performance of the product, a few proactive services are provided by almost all original equipment manufacturers (OEMs) on site. It is also common practice for installations to be carried out by a technician employed by the sales distributor / dealer of the OEM.

These technicians have been trained only in installation and a few routine product checks to commission the unit after installation at a customer's premises. They do not have a thorough diagnostic knowledge of the product. This meets the customers' demand for speedy installation after the AC has been purchased. After the warranty period has expired, customers generally resort to non-authorized service enterprises or freelance technicians, due to the relative expense of authorized servicing.

5.1.2 Third-party servicing companies

The second channel consists of third-party servicing companies. These could be either formally registered or unregistered, but they do not have any franchisee relationship with the OEM. In the MAC sector, many such enterprises offer specialized services and may even be preferred by customers.

²⁷ Ibid.

5.1.3 Non-authorized service shops and freelance technicians

The third channel is services from non-authorized service shops or freelance technicians. Servicing air-conditioners is a growing opportunity, especially in urban Bangladesh. Technicians who are already familiar with the servicing of AC systems or fridges hire staff to train on the job.

Given the informal nature of this set up, it is difficult to estimate the number of technicians operating in this way and their level of training. Moreover, many people who service electronic appliances enter air conditioning servicing during the peak season, with employed technicians freelancing in their spare time. This sector is popular and large in numbers.

5.2 Concerns in the RAC servicing sector

5.2.1 Refrigerant emissions

An important concern in the service sector is refrigerant emissions caused by leaks, and the consequent ozone and/or climate impacts. Refrigerant gases leak out of AC systems and so chillers must be refilled by trained service technicians for optimal performance of the system. Refrigerant gases are also used to flush the system, leading to further usage of the gases during servicing. Finally, at the end of the life of an air conditioner, chiller or car, the residual refrigerants in the system are typically not recovered before the system is salvaged for its parts. The consumption of refrigerants is much higher than it should be, due to inconsistent leak testing, practices like ‘refrigerant top-up’, and weather conditions that cause corrosion of tubes.

The wider adoption of good practice by RAC service technicians would lead to a reduction in the consumption of refrigerants during the servicing of AC equipment.

5.2.2 Impact of poor servicing on energy efficiency of air-conditioning equipment

Poor servicing can also reduce the energy efficiency of AC equipment. Even if an appliance with high efficiency potential is installed, it will not be able to realize that potential if it is not installed, maintained and serviced properly; instead it will use more electricity than required.

A Technology and Economic Assessment Panel (TEAP) report from 2018 observed that some energy efficiency degradation over the lifetime of equipment is inevitable. However, there are ways to limit the degradation through improved servicing, at installation and with ongoing maintenance.

The impact of proper installation, maintenance and servicing on the energy efficiency of equipment is considerable over the working lifetime of AC equipment, while the impact on cost is minimal. Proper maintenance and servicing can prevent up to 50 percent of the reduction in performance and maintain rated performance over its lifetime. Currently, no policies focus on the servicing sector for energy efficiency gains.

5.2.3 Servicing practices

Given the importance of good service practices for the reduction of refrigerant consumption and the maintenance of energy efficiency, it is important to understand the current level of adherence to good servicing, and what factors can improve it. More widespread use is required of techniques such as testing for leaks, calibrated charging, flushing without refrigerants and the recovery of refrigerants. However, no study is available on these issues.

5.3 Training needs in the servicing sector

Around 50,000 technicians work in the servicing sector, but most have no technical academic qualifications. Experts working in this sector say there are acute shortages of trained service technicians in the commercial and industrial chiller sector.²⁸

Research for the HCFC Phase-out Management Plan (HPMP) reveals that the refrigeration and AC servicing sub-sectors are responsible for around 55-60 percent of HCFC-22 consumption in Bangladesh. There is a wide variation in failure rates, depending on the knowledge and skill levels of individual technicians. The ageing of products also has a direct impact on HCFC consumption. The servicing needed for larger and more complex systems is significant.

Skilled personnel are needed for installation and servicing of RAC equipment: thus, the training of RAC service technicians is very important. The new alternative refrigerants used while phasing out HCFCs are either mildly flammable or flammable. The technicians need to be trained in their safe handling. Additionally, most service technicians are in the informal sector rather than the formal one. Technician training for the servicing sector has primarily been organized by the National Ozone Unit (NOU) of DoE and focuses on reaching technicians who generally are not covered under formal training systems. There are technical training institutes and vocational training centres, public and private, spread across the country that provide formal training.

5.3.1 Current status of training for servicing technicians

Training imparted by NOU

Given the context, training needs to be practical, not just theoretical. The experience of the NOU from previous servicing sector projects funded by the Multilateral Fund (MLF) to implement the Montreal Protocol reveals that technicians who have undergone training significantly improve servicing practices.

The NOU has trained around 10,000 technicians, from both the formal and informal sectors, under the Good Services Practices Project in RAC, while about 2,000 technicians were trained in refrigerator retrofit and 800 RAC service shop owners were provided with the retrofit kits and essential tools.

The continuous programme of the NOU, funded by the MLF, provides a certificate to all participants completing the course. The training curriculum includes:

- environmental impact and human health Impacts of ODS refrigerants;
- alternatives to HCFCs and their characteristics;
- handling of HFC refrigerants;
- servicing of HCFC and HFC based air conditioners;
- tools and equipment for servicing;
- dos and don'ts in refrigeration and air-conditioning servicing;
- handling and safety issues of hydrocarbon refrigerants;
- servicing of hydrocarbon-based air-conditioners;
- installation procedure of split air conditioners;
- refrigerant recovery, recycling and reclamation;
- economics of refrigerant reclamation and best service;
- contaminated refrigerants and refrigerant identifier;

²⁸ Ibid.

- selection and safe usage of cleaning solvents;
- maximizing climate benefits through the servicing sector;
- recovery machine maintenance; and
- single stage vs. double stage regulator.

The trainers come from a pool registered with the NOU from government polytechnic institutes, as well as qualified trainers generated from training of trainers programmes.

Courses offered under government polytechnic colleges and technical training (vocational) institutes

There are several polytechnic college and technical training institutes under the Directorate of Technical Education. Polytechnic colleges offer a four-year course on RAC, leading to a diploma. The graduates from these colleges enter government jobs as 2nd class officers, or industry as assistant engineers. These jobs are largely supervisory, responsible for assistants who carry out the work.

Technical institutes offer a two-year course with hands-on training. The course enables trainees to go directly into work using good practice in refrigeration.

The RAC curricula of both the polytechnic colleges and the technical training institutes would benefit from a review and update.

5.4 Livelihoods and social security of the technicians

Stable and secure livelihoods and long-term social security are important from the perspective of social welfare. In large unorganized sectors in developing economies, livelihoods are vulnerable to unexpected shocks. This is also true for service technicians in the RAC industry. For example, a prolonged illness could have a significant effect on the income and savings of a technician, perhaps pushing them towards work in the unorganized sector.

As the country's economy grows, it is imperative that the service sector, which includes the air conditioning and refrigeration servicing sector, strengthens its quality of delivery. This in turn implies that the average performance of technicians ought to improve to deliver that higher quality. An understanding of the current status of technicians is therefore useful to help plan for the future.

Firstly, there is a disparity in the earnings of service technicians between the room AC, commercial AC and mobile air conditioning (MAC) sectors. There is also a distinct seasonal pattern to this work, with the busy season lasting for six to nine months, depending on the location. During the off-season, many technicians provide servicing for other electronic equipment or do installation work.

Secondly, there are marked differences between the average earnings for technicians working for authorized / specialized service centres and those of technicians working with other enterprises or freelancing, with the former earning more than their counterparts.

Thirdly, access to social security schemes is not prevalent in this sector. This is mainly because most technicians are either self-employed or informally/casually employed by authorized service centres / registered enterprises. Only a small percentage of technicians employed at managerial/supervisory level have access to the benefits associated with formal employment.

6. Transition of Refrigerants from CFC to HCFC and ODS

6.1 Phasing out of CFCs

Bangladesh has been very successful in its efforts related to global action towards the protection of the ozone layer. After accession to the Montreal Protocol on Substances that Deplete the Ozone Layer, Bangladesh has ratified its amendments, including the London, Montreal, Copenhagen and Beijing amendments.

The country has established a comprehensive legal framework for the control of ozone depleting substances (ODS), including an enforceable national licensing and quota system for imports and exports of CFCs, HCFCs, and so on. In 2014, the ODS (Control) Rules from 2004 were amended and aligned with the HCFC phase-out schedule.

The Ozone Cell of Bangladesh is the National Ozone Unit (NOU), which is housed in the Department of Environment (DoE) under the Ministry of Environment and Forests, and has been operational since 1995. The Director-General of the DoE is the chairman of the Ozone Cell. The Director-General is responsible for the issue of import licences and export permits after importers and exporters fulfil the stipulated conditions in a satisfactory manner. Importers apply for their quota to the DoE, and are also required to report the utilization of their licences by the end of the calendar year.

Bangladesh phased out CFCs from the RAC sector in 2009 in accordance with the Montreal Protocol schedule, with the exception of pharmaceuticals in the metered dose inhaler (MDI) sector. With support from the Multilateral Fund, HCFCs from the pharmaceutical sector were phased out in 2012. After the phasing out of CFCs, the market has been occupied by HCFCs, HFCs and non ODS refrigerants.

6.2 Current stock of HCFCs and the transition to low-ODP refrigerants

6.2.1 Current consumption of HCFCs

Consumption of ozone-depleting HCFCs has been regulated in Bangladesh for some years. Most demand for ODS comes from the servicing of existing equipment. Table 4 shows consumption of ODS in Bangladesh from 2014 to 2019, with the information displayed in Figure 11. The demand for ODS has been falling since 2017, in line with the Montreal Protocol.

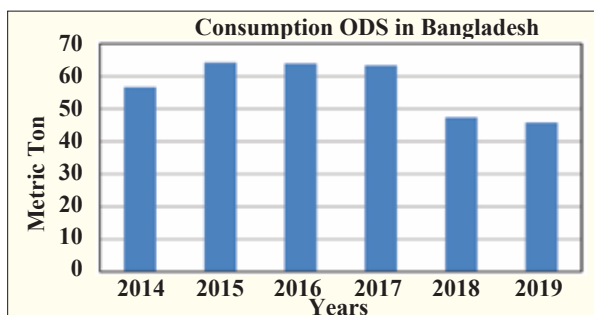
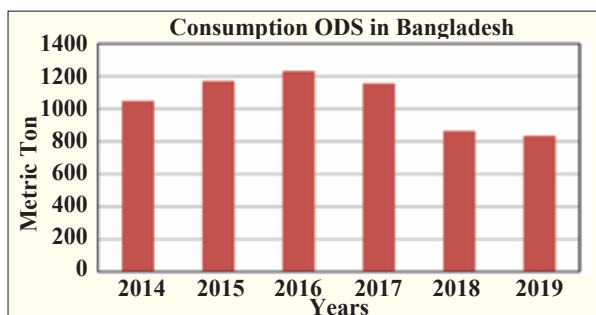
Table 4: Consumption of HCFCs (ODS) from 2014 to 2019

Name of ODS	2014	2015	2016	2017	2018	2019
R-22	1,020.00	1,148.75	1,141.81	1,132.88	852.90	808.123
R-123	3.00	7.00	11.00	7.00	3.01	2.50
R-406a	25.75	15.64	15.64	15.64	7.75	23.86
Total	1048.75	1,170.79	1,232.63	1,155.52	863.66	831.483
Total ODS (Tons)	56.626	64.18	63.34	63.34	47.41	45.822

Source: UNDP Bangladesh³⁰

²⁹ HCFC phase-out management plan (stage II, first tranche) for Bangladesh, 2018, UNEP, United Nations, <http://www.multilateralfund.org/81/English/1/8123.pdf>

³⁰ ODS and ODS Alternatives Survey, 2019, UNDP, Dhaka, Bangladesh.



Source: UNDP, Bangladesh³¹.

Figure 11: Total ODS consumption (tonnes and ODP tonnes) in Bangladesh from 2014 to 2019

Mixed Polyol containing R-141b has not been used in Bangladesh since 2013, in accordance with the Montreal Protocol. In addition, Bangladesh implemented a project to convert HCFC-141b to Cyclopentane and phased out 20.20 Ozone Depleting Potential (ODP) tonnes of HCFC-141b from the total established baseline consumption of 21.23 ODP tonnes.³²

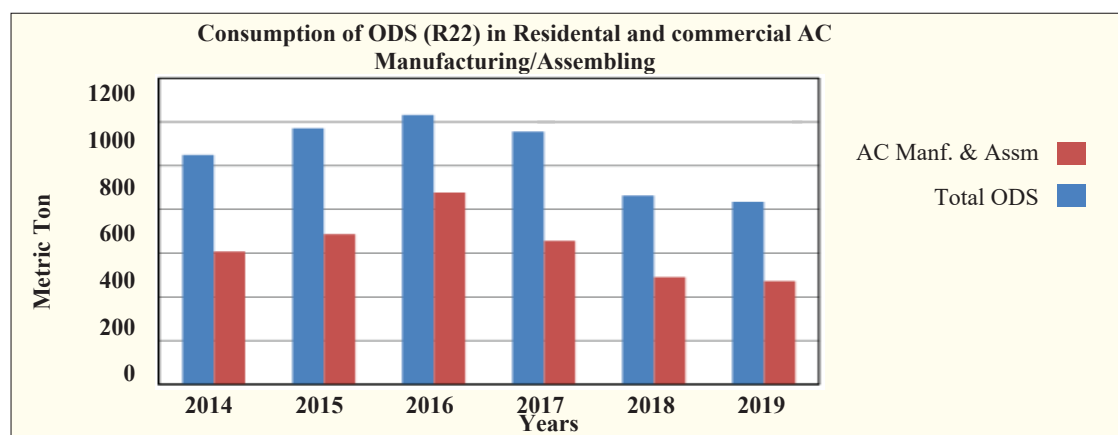
Air-conditioning manufacturing sector

Bangladesh has a relevant national industry that produces window units, splits (medium to large sized) and chillers for domestic use only. Six companies have the largest share of HCFC-22 consumption, while a few other medium to small-sized companies consume negligible quantities of HCFC-22.

R22 consumption in residential and commercial AC manufacturing / assembling is shown in Table 5, and this is compared to total ODS consumption in Bangladesh in Figure 12.

Table 5: R22 Consumption in residential and commercial AC manufacturing / assembling

Years	R-22 (MT)
2017	381.187
2015	399.711
2016	474.524
2017	512.452
2018	510.887
2019	505.440



Source (for Table 5 and Figure 12): UNDP, Bangladesh³³

Figure 12: Comparison of ODS (R-22) consumption in residential and commercial AC manufacturing / assembling to the national total

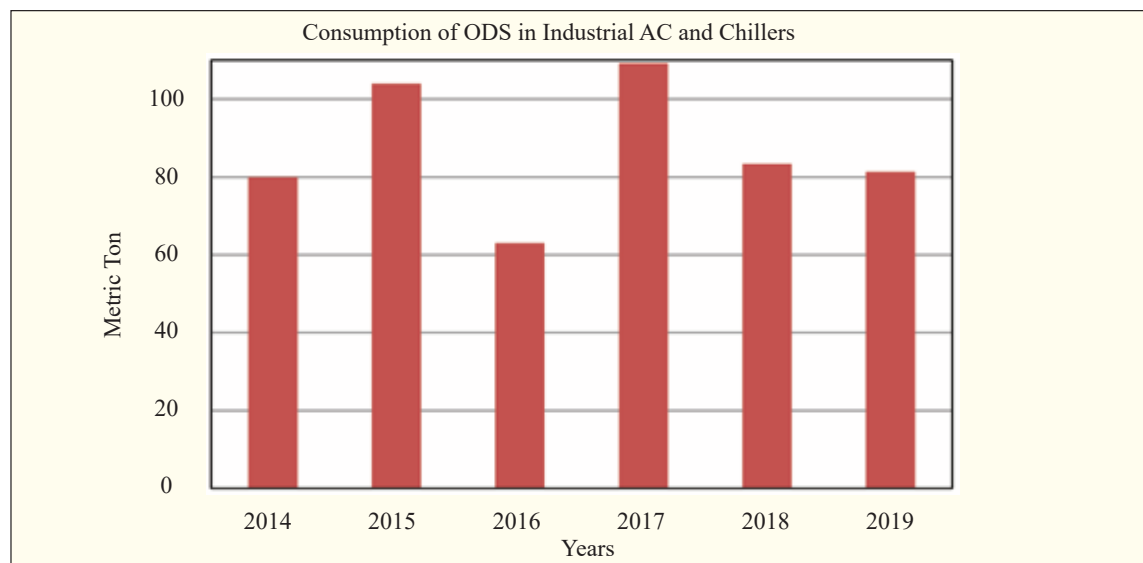
³¹ ODS and ODS Alternatives Survey, 2019, UNDP, Dhaka, Bangladesh.

³² Ibid.

³³ Ibid.

The average consumption of R-22 in the residential and commercial AC manufacturing / assembling sector was close to 40 percent of total national ODS consumption in 2014, but this proportion is now more than 50 percent because since 2016 industry demand has not fallen as quickly as consumption in other sectors.

Consumption of R-22 in industrial AC, including chillers, has also decreased recently, as shown in Figure 13.

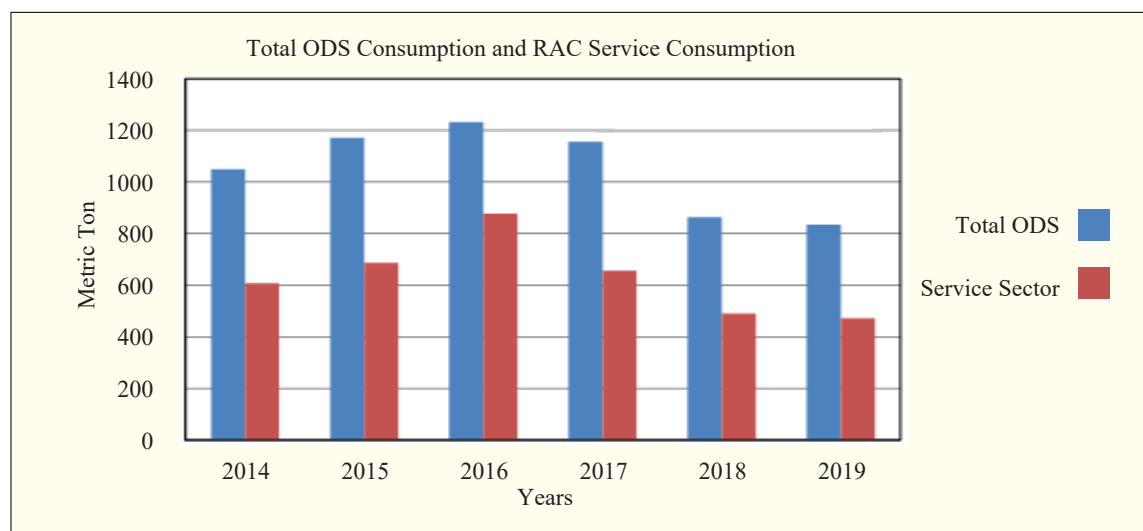


Source: UNDP, Bangladesh³⁴

Figure 13: ODS R-22 consumption in industrial air-conditioning including chillers

Refrigeration and air conditioning servicing sector

The annual average consumption of ODS R-22 by the RAC servicing sector in Bangladesh is close to 60 percent of total ODS consumption, as shown in Figure 14.



Source: UNDP, Bangladesh³⁵

Figure 14: Comparison of R-22 consumption in RAC service sector with respect to total R-22 consumption

³⁴ Ibid.

³⁵ Ibid.

Overall, therefore, nearly all ODS R-22 consumption in Bangladesh comes from these two sectors: RAC servicing and residential and commercial AC manufacturing / assembling. After the servicing sector, the next highest consumption of ODS R-22 is by RAC manufacturing / assembling and then industrial air conditioning, including chillers, though this is not a significant proportion.

There is little ODS consumption in Bangladesh other than R-22 refrigerants.

There is a wide variation in equipment failure rates depending on the knowledge and skill levels of technicians, who are primarily from the informal sector without proper access to technology and training. The ageing of products also has a direct impact on HCFC consumption. The servicing needed for larger and more complex systems is significant. Room ACs and commercial refrigerators are responsible for the biggest share of servicing-related ODS consumption in Bangladesh.

6.2.2 Transition from HCFC to low-ODP refrigerants

Transition to low-ODP Refrigerants under HPMP Phase 1

The challenge for Bangladesh is to phase out hydrochlorofluorocarbons (HCFCs), and to utilize more comparatively low ozone-depleting potential refrigerators. In 2011, the government, with support from the Multilateral Fund (MLF), prepared the HCFC Phase-out Management Plan (Stage-I) (the HPMP), including a foam conversion project for Walton Hi-tech Industries Ltd.³⁶

Stage I of the HPMP for Bangladesh was approved to meet the 30 percent reduction from the baseline by 2018, resulting in the phase-out of 24.53 ODP tonnes of HCFCs, comprising 20.2 ODP tonnes of HCFC-141b, 3.48 ODP tonnes of HCFC-22, 0.57 ODP tonnes of HCFC-142b, 0.21 ODP tonnes of HCFC-123, and 0.07 ODP tonnes of HCFC-124. Walton Hi-tech Industries shifted to using Cyclopentane as a propellant, which has zero effect on the ozone layer and has very low global warming potential. The propellant is also energy efficient, saving on the carbon footprint in the long run. A project for the phasing out of HCFCs was completed in 2014 and 183.7 tonnes (20.20 ODP tonnes) of HCFC-141b were phased out every year from the manufacturing of refrigerator insulation foam as a blowing agent.³⁷

Transition to low-ODP refrigerants under HPMP Phase 2

With the success of conversion projects under Phase 1, the government, with support from UNDP, prepared the HCFC Phase-out Management Plan (Stage II) in 2018. Stage II of the HPMP includes the conversion of five AC manufacturing enterprises and one chiller enterprise from HCFC-22 to R-290 / HFC-32 technology. Equipment with capacity of up to 1.5 TR would convert to R-290, and those with capacity of greater than 1.5 TR would convert to HFC-32. All enterprises are 100 percent locally owned.

Implementation of stage II of the HPMP will result in 35.27 ODP tonnes of HCFCs being phased out. This is made up of 23.22 ODP tonnes of HCFC-22 (17.09 ODP tonnes used in manufacturing domestic and commercial ACs and 6.13 ODP tonnes from RAC servicing), and 12.05 ODP tonnes of HCFC-141b in imported pre-blended polyols used in polyurethane (PU) foam manufacturing. The proposed activities of stage II of the HPMP will enable the country to achieve a 67.5 percent reduction in HCFC baseline consumption by 2025. Stage II of the HPMP is expected to phase out all HCFC-22 used in the RAC manufacturing sector³⁸.

³⁶ HCFC phase-out management plan (stage II, first tranche) for Bangladesh, 2018, UNEP, United Nations, <http://www.multilateralfund.org/81/English/1/8123.pdf>

³⁷ Ibid.

³⁸ Ibid.

HC-290 is zero ODS, low GWP and also energy efficient. The proposed project will be implemented as a public-private partnership. The project will result in the sustainable reduction of 35.27 ODP tones of HCFC consumption. The replacement of HCFC-22 by R-290 and HFC-32 in the AC sector will result in avoiding the emissions of 1,730,798 tonnes CO₂-eq. (i.e. a reduction from the baseline of 2,587,635 tonnes CO₂-eq. emissions to 856,837 tonnes CO₂-eq.).³⁹

These projects have introduced improved and climate-friendly technologies and production processes using best practice from companies in industrialized countries.

6.3 Towards ratification of the Kigali Amendment

The country is now undertaking all necessary measures to ratify the Kigali Amendment,⁴⁰ a legally binding climate agreement to phase down the manufacture and use of hydrofluorocarbons (HFCs) by 80-85 percent by 2045. This phase down is expected to arrest the rise in the global average temperature by up to 0.5 degrees Celsius by 2100, a useful contribution to the target set in the Paris Agreement⁴¹.

The ratification will help Bangladesh to promote:

- energy efficiency, at 30-40 percent beyond the current level in the RAC sector;
- a more climate-friendly cooling system;
- enhanced access to global climate funds; and
- the opportunity to jump-start the transition to the lowest global warming potential cooling technology.

UNDP is supporting the Government of Bangladesh to ratify the Kigali Agreement, as well as encouraging both the government and the private sector to adopt climate-friendly technology to foster greener growth and to achieve the climate targets set in the historic Paris Climate Agreement. It is believed that Bangladesh will be the first and the leading developing country in the successful reduction of HFCs.

6.4 Annual imports of ODS and ODS alternatives

6.4.1 ODS imported and consumed from 2014 to 2019

The consumption of imported ODS from 2014 to 2019 is set out in Table 6. The trend has been downward since 2015, in line with the Montreal Protocol.

Table 6: Consumption of imported ODS from 2014 to 2019 (tonnes)

Name of ODS	2014	2015	2016	2017	2018	2019
R-22	1,020.00	1,148.75	1,141.81	1,132.88	852.90	808.123
R-123	3.00	7.00	11.00	7.00	3.01	2.50
R-406a	25.75	15.64	15.64	15.64	7.75	23.86
Total	1048.75	1,170.79	1,232.63	1,155.52	863.66	831.483
Total ODS (Tons)	56.626	64.18	63.34	63.34	47.41	45.822

Source: UNDP, Bangladesh⁴²

³⁹ Ibid.

⁴⁰ Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, Kigali, October 2016, <https://treaties.un.org/doc/Publication/CN/2016/CN.872.2016-Eng.pdf>

⁴¹ Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer, Fourteenth Edition (2020), Ozone Secretariat, UNEP, United Nations, <https://ozone.unep.org/sites/default/files/Handbooks/MP-Handbook-2020-English.pdf>

⁴² Energy Efficiency and Conservation Master Plan up to 2030, 2016, SREDA, Government of the People's Republic of Bangladesh, http://www.sreda.gov.bd/d3pbs_uploads/files/policy_2_energy_efficiency_and_conservation_master_plan_up_to_2030.pdf

Note: ODP of R-22 = 0.055, R-142b = 0.065, R-123 = 0.020; the composition of R-406a consists of 55% R-22, 41% R142b and 4% R-600a]. Mixed polyol containing R-141b was not consumed after 2013 in accordance with Montreal Protocol.

6.4.2 Imports of ODS alternatives from 2014 to 2019

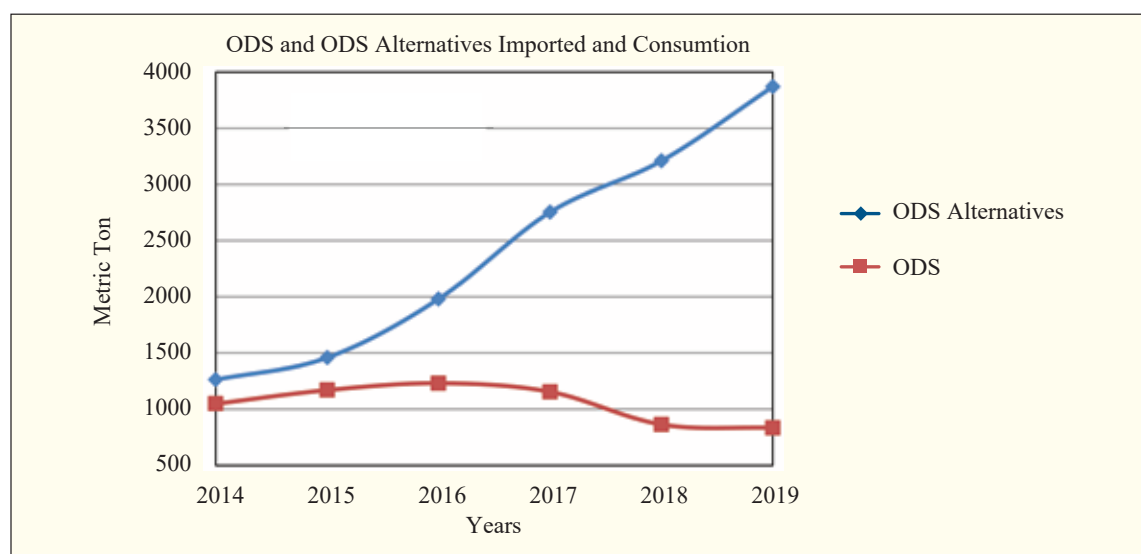
Table 7 shows that demand for ODS alternatives is increasing sharply, with a combined annual growth rate (CAGR) of 25 percent between 2014 and 2019, also in line with the Montreal Protocol. The total figures for imports of both ODS and ODS alternatives are also shown in Figure 15. The demand for ODS is decreasing at a CAGR of 12 percent over the last four years.

Table 7: ODS Alternatives imported and consumed from 2014 to 2019 (tonnes)

Refrigerent	2014	2015	2016	2017	2018	2019
R-134a	638.8	766.5	1012.1	1497.6	1677	1755.542
R-32	1.5	1.9	0.8	0.550	1.75	2.54
R-227ea	1.2	2.5	2.8	3	3.1	3.56
R-404A	14.7	16.5	16.9	12.3	12	27.213
R-410A	20	21.3	100.6	221.3	307.1	822.542
R-407C	2.8	3.9	27.3	32.2	44.3	21.3523
HC-600a	34.6	43.8	118.8	201.8	280.3	285.23
HC-290	0	2	1.5	0	0	0
Cyclopentane	550	600	100.2	786.584	885.2	953.543
Total	1263.6	1458.4	1981	2754.78	3210.75	3871.52

Source: UNDP, Bangladesh⁴⁴

Note: R-404A (44% HFC-125, 52% HFC-143a, 4% HFC-134); R-407C (25% HFC-125, 52% HFC-134a, 23% HFC-31); R-410A (50% HFC-125 & 50% HFC-32); HC-600a (iso-butane); HC-blend (C-30): 50% HC-600a & 50% HC-290; Cyclopentane: HC blowing agent.



Source: UNDP Bangladesh⁴⁵

Figure 15: ODS and ODS alternatives imported and consumed from 2014 to 2019 (tonnes)

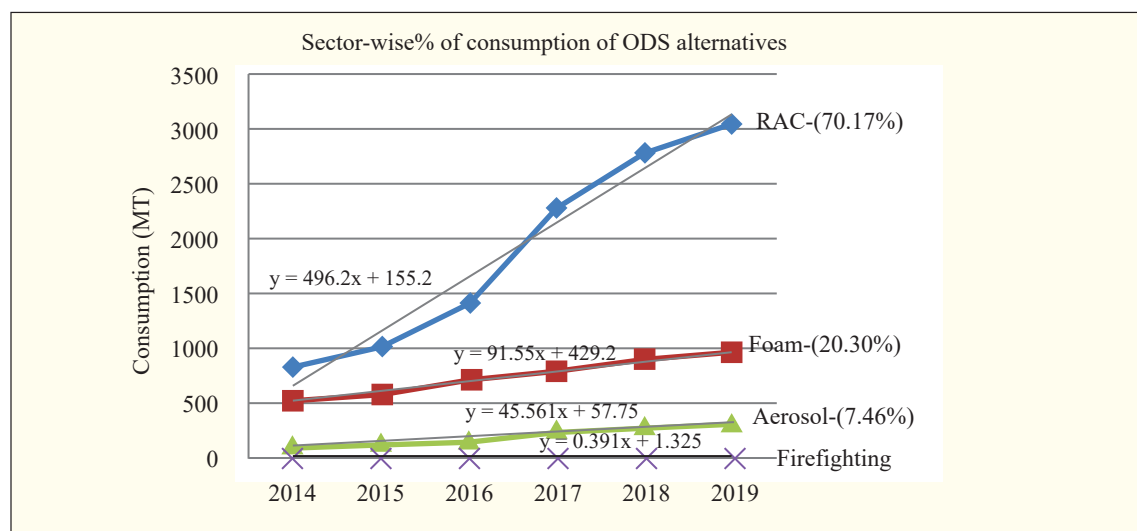
⁴³ODS and ODS Alternatives Survey, 2019, UNDP, Dhaka, Bangladesh

⁴⁴ODS and ODS Alternatives Survey, 2019, UNDP, Dhaka, Bangladesh

⁴⁵ ODS and ODS Alternatives Survey, 2019, UNDP, Dhaka, Bangladesh

Sectoral consumption of ODS alternatives

Sectoral consumption of ODS alternatives from 2014 to 2019 is shown in Figure 16. The RAC sector accounted for most demand (70.17 percent) in 2019, while the foam sector made up 22.29 percent, the aerosol sector 7.46 percent, and the fire extinguisher sector just 0.08 percent.



Source: UNDP Bangladesh⁴⁶

Figure 16: Sectoral ODS alternatives consumption (tonnes) from 2014 to 2019

6.5 Analysis of consumption of ODS and ODS alternatives in 2019

Analysis of the data reveals that R-22 was by far the biggest refrigerant in use in Bangladesh in 2019, with consumption of 818 tonnes, as shown in Table 8. A prime user of R-22 is the AC sector, comprising domestic, commercial and industrial air conditioning, including chillers. MAC also had a good share of total demand. However, the largest share remained with the servicing sector, which accounted for close to 60 percent of total consumption.

Table 8: Consumption of ODS in various sectors in 2019 (tonnes)

Sector and Subsector	R-22	R-142b	R-123
Residential air conditioning	102.92		
Commercial air conditioning	66.27		
Industrial air conditioning, including chillers	81.34		0.50
Mobile air conditioning, including ship refrigeration systems	53.47		
Commercial refrigeration	33.3		
Industrial refrigeration	7.823		
Fire extinguisher servicing			1.00
Service sector	473	9.55	1.00
Grand total	818.123	9.55	2.50

Source: UNDP Bangladesh 47

In terms of the consumption of ODS alternatives, R-134a accounts for the largest share of demand, with consumption of over 1,700 tonnes in 2019, as set out in Table 9. A major user of R-134a is the refrigeration sector, especially domestic refrigeration. However, the aerosol and servicing sectors make up the largest share of demand. We also find that domestic refrigeration has had a limited transition to R-600a.

⁴⁶ ODS and ODS Alternatives Survey, 2019, UNDP, Dhaka, Bangladesh

⁴⁷ ODS and ODS Alternatives Survey, 2019, UNDP, Dhaka, Bangladesh

Table 9: Sector and sub-sector consumption of ODS alternatives in 2019 (tonnes)

Sector and sub-sector	R-134a	R-404A	R-410A	R-407C	R-227ea	R-32	HC-600a	R-717	Cyclopentane
RAC Manufacturing									
Domestic Refrigerator	191.00	-	-	-	-	-	71.34	-	-
Commercial Refrigerator	149.12	1.62	-	-	-	-	33.64	-	-
Industrial Refrigerator	-	-	16.50	-	-	-	-	61.45	-
Transport Refrigeration	2.61	-	18.50	-	-	-	-	-	-
Residential AC	1.10	-	144.15	-	-	2.24	-	-	-
Commercial AC	-	-	162.00	-	-	-	-	-	-
Industrial AC with chiller	-	-	98.00	0.071	0.51	-	-	-	-
MAC manufacturing	9.00	-	-	-	-	-	-	-	-
Aerosol sector	324.30	-	-	-	-	-	-	-	-
Foam sector	19.17	-	-	-	-	-	-	-	499.93
Servicing									
Fire Extinguisher	-	-	-	-	3.56	-	-	-	-
Other servicing	1026.72	25.56	412.32	21.19	-	9.17	15385	126.30	450.20
Total	1723.02	27.17	822.47	21.26	3.56	11.40	258.83	191.75	950.13

Source: UNDP Bangladesh⁴⁸

6.6 Projections of refrigerant demand and its pathways

The RAC sector is the largest user of ODS and ODS alternatives in the country. The main use of refrigerants is in stationary AC, followed by commercial refrigeration and MAC. It is worth noting that cooling demand in all sectors has been observed to be increasing many fold.

Table 6 shows that imports of R-22 are gradually decreasing. This is because, under the compliance regime of the Montreal Protocol, Bangladesh is obliged to achieve 35 percent, 67.5 percent and 97.5 percent reductions from its base year (average of 2009 and 2010) consumption by 2020, 2025 and 2030 respectively.⁴⁹

In order to fulfill these commitments, imports of HCFCs are restricted under a licensing system and transition to low GWP refrigerants is encouraged. The government prepared the HCFC Phase-out Management Plan (Stage-II) in 2018 with support from UNDP, under which five AC manufacturing companies will convert from HCFC-22 to HC-290. This will further reduce consumption of R-22 and help meet the reduction target by 2025.

Under the Montreal Protocol, baseline consumption of ODS in Bangladesh was 72.65 ODP tonnes (1,120.58 tonnes), the average consumption of 2009 and 2010. As an Article 5 party, Bangladesh was to have no controls on consumption during 2011 to 2012, and a freeze in 2013, followed by a 10 percent reduction in 2015, on the way to the further targets of a 35 percent reduction by 2020, 67.5 percent by 2025, and 97.5 percent by 2030. The remaining 2.5 percent (for service purposes) has to be eliminated by 2040. The schedule is shown in Figure 17.

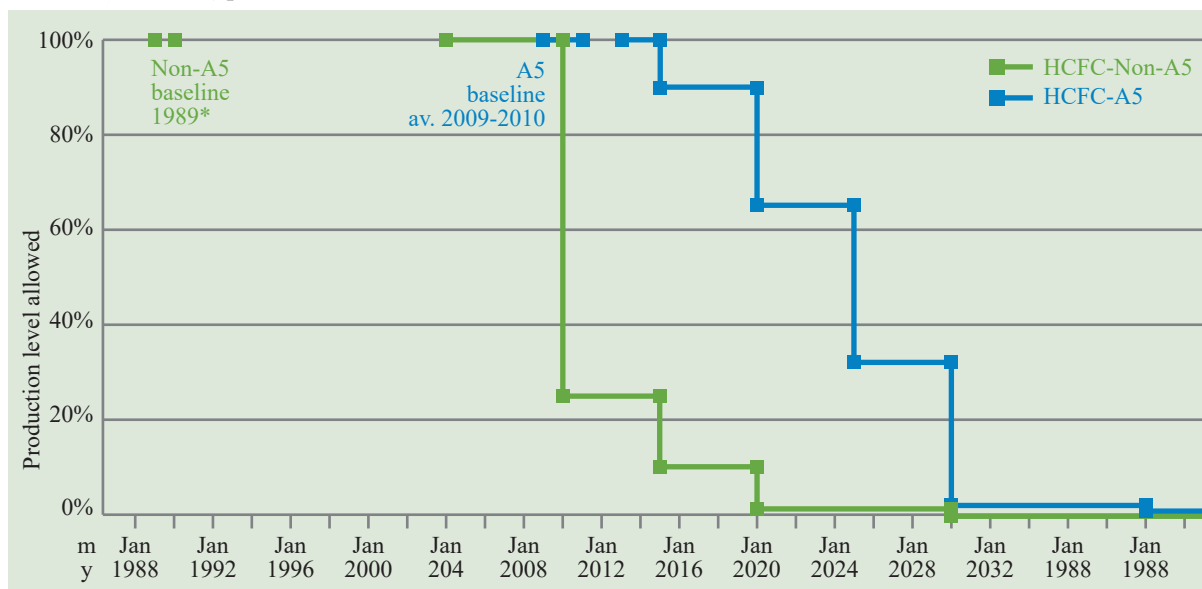
⁴⁸ ODS and ODS Alternatives Survey, 2019, UNDP, Dhaka, Bangladesh

⁴⁹ Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer, Fourteenth Edition (2020), Ozone Secretariat, UNEP, United Nations, <https://ozone.unep.org/sites/default/files/Handbooks/MP-Handbook-2020-English.pdf>

Non-Article 5 parties		Article 5 parties	
Baseline	Average of 1989 HCFC production + 2.8 percent of 1989 CFC* production and 1989 HCFC consumption + 2.8 percent of 1989 CFC* Consumption	Baseline	Average 2009-2010
Freeze	January 1, 2004, at the baseline for production	Freeze	January 1, 2013
		10 percent reduction	January 1, 2015
75 percent reduction	January 1, 2010	35 percent reduction	January 1, 2020
90 percent reduction	January 1, 2015	67.5 percent reduction	January 1, 2025
100 percent reduction	January 1, 2020, and thereafter <ul style="list-style-type: none"> - allowance of 0.5 percent of baseline production baseline production unit January 1, 2030 for the uses defined in Article 2F paragraph 6(b) and - possible essential use exemptions 	100 percent reduction	January 1, 2030, and thereafter <ul style="list-style-type: none"> - allowance of 2.5 percent of baseline production when averaged over ten years 2030-2040 until January 1, 2040 for the uses defined in Article 5 paragraph 8 <i>ter</i> (e) (ii) and - possible essential use exemptions

* Annex A Group 1

HCFCs (Annex C/I) production reduction schedule



Source: HPMP for Bangladesh⁵⁰

* Baseline calculated as average of 1989 HCFC production + 2.8 percent of 1989 CFC production and 1989 HCFC consumption + 2.8 percent of 1989 CFC consumption

Figure 17: HCFC phase-out schedule for parties operating under Article 5 of the Montreal Protocol

⁵⁰ HCFC phase-out management plan (stage II, first tranche) for Bangladesh, 2018, UNEP, United Nations, <http://www.multilateralfund.org/81/English/1/8123.pdf>

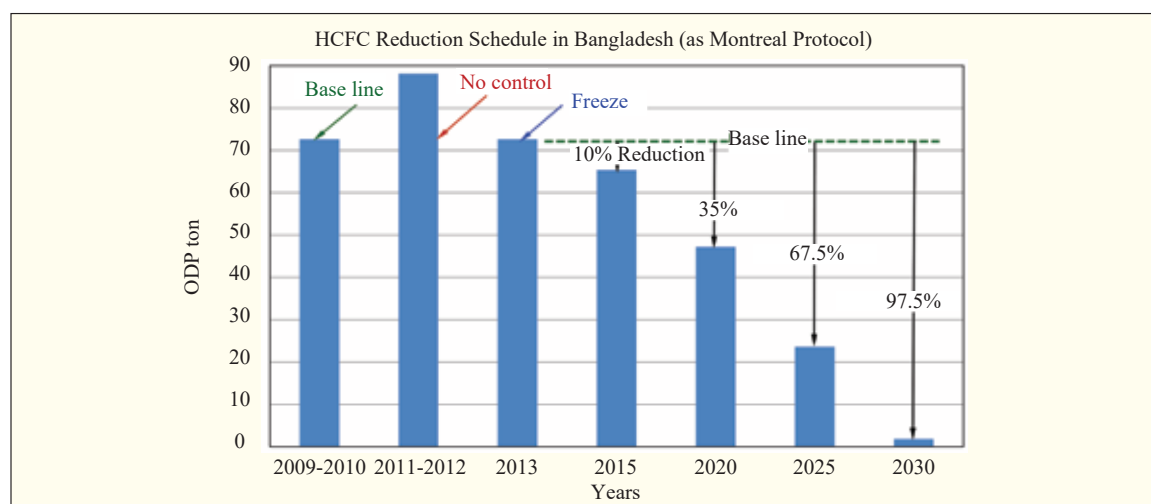
The schedule corresponding to Bangladesh in ODS tonnes and ODP tonnes is outlined in Table 10 and is graphically presented in Figure 18.

Table 10: HCFC baseline, freeze, 10%, 35%, 67.5% and 97.5% reduction schedule

HCFC	Baseline	No control	Freeze in	10% reduction	35% reduction	67.5% reduction	97.5% reduction
Year	Average of 2009 – 2010	2011-12	2013	2015	2020	2025	2030
ODS tonnes	1120.58	1355.9*	1120.58	1008.5	728.4	364.2	28.0
ODP tonnes	72.65	88.14	72.65	65.39	47.22	23.61	1.82

* assuming 10% CAGR from 2010 to 2012

Source: HPMP for Bangladesh⁵¹



Source: HPMP for Bangladesh⁵²

Figure 18: HCFC baseline, freeze, 10%, 35%, 67.5% and 97.5% reduction schedule

The situation is different with ODS Alternatives (HFCs). Imports of HFCs are rapidly increasing to meet the increasing cooling demand in various sectors owing to the restrictions imposed on HCFCs. As shown in Figure 15 above, the consumption of alternatives, such as HFC-134a and HC-600a, increased more than 25 percent each year between 2014 and 2019. HFCs are used in the domestic, commercial and transport refrigeration and other sectors. At present, the new refrigeration manufacturing companies largely use HC-600a. HFC-134A and R-404A are being used in commercial and industrial chillers. However, there is no conversion project for HFCs yet.

The United Nations Environment Programme (UNEP) indicates that under a business-as-usual-scenario, demand for HFC-134a in the RAC sector would quadruple between 2015 and 2030; demand for R-404A and R-407C would grow by a factor of four to five; and demand for low-GWP refrigerants would grow by a factor of three, mainly because these refrigerants are assumed to be used only in certain subsectors (e.g., MAC and stationary AC). Between 2015 and 2030, total demand for refrigerants will increase by about 200 percent.⁵³

⁵¹ Ibid.

⁵² Ibid.

⁵³ United Nations Environment Programme (UNEP), Format for preparation of the surveys of ODS alternatives and presentation of the resulting data (decision 74/53(g)), 2015 <http://www.multilateralfund.org/75/English/1/7577r1.pdf>

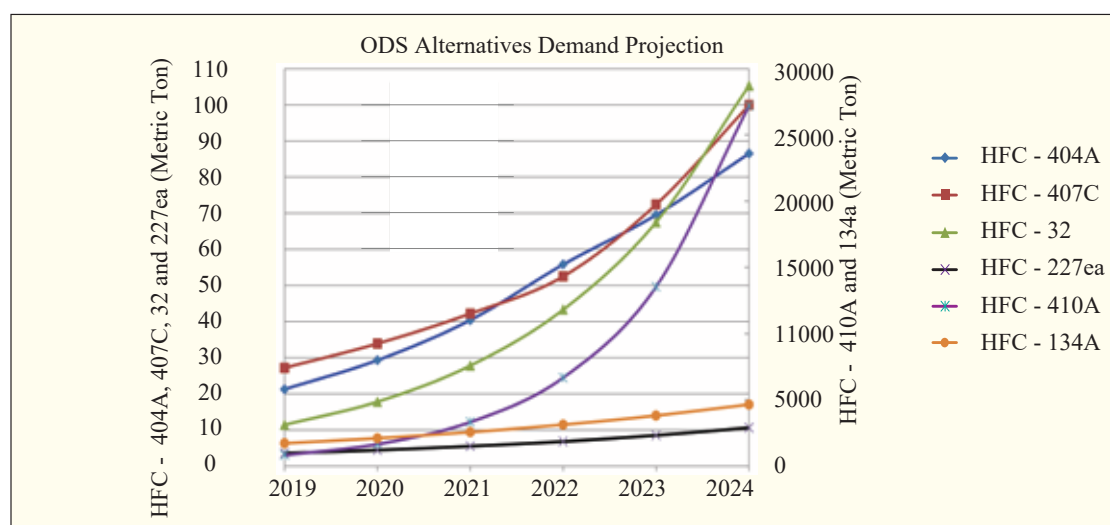
6.6.1 Projection of HFC consumption for the next five years

In response to the Montreal Protocol compliance regime between 2016 and 2030, demand for HFC-134a will decrease after 2025. Table 11 shows the projections for non-ODS refrigerant demand from 2019 to 2024, with the same information presented graphically in Figure 19.

These estimates of HFC consumption are based on the CAGR values of fresh survey data between 2014 and 2019, followed by a business-as-usual scenario during 2020 to 2024. The projections are calculated assuming the historical growth rate of R-134a was 22 percent. In the AC sector, the biggest refrigerant, R-410A, showed an annual compound growth rate of 100.94 percent, followed by R-32 at 55.97 percent.

Table 11: Business-as-usual projections of ODS alternatives demand (tonnes) from 2019 to 2024

Year / Refrigerant	2019	CAGR %	2020	2021	2022	2023	2024
HFC-134a	1723.02	21.95%	2,101.2	2,562.4	3,124.9	3,810.8	4,647.3
HFC-410A	822.48	100.94%	1,652.7	3,321.0	6,673.3	13,535.5	27,198.2
HFC-404A	21.26	24.55%	29.3	40.4	55.8	69.5	86.5
HFC-407C	27.18	37.93%	33.9	42.2	52.5	72.4	99.9
HFC-32	11.41	55.97%	17.8	27.8	43.3	67.5	105.3
HFC-227ea	3.56	24.30%	4.4	5.5	6.8	8.5	10.6



Source (for Table 11 and Figure 19):
UNDP, Bangladesh⁵⁴

Figure 19: Business-as-usual projections of ODS alternatives demand (tonnes) from 2019 to 2024

The major causes behind the increasing demand of HFC are⁵⁵:

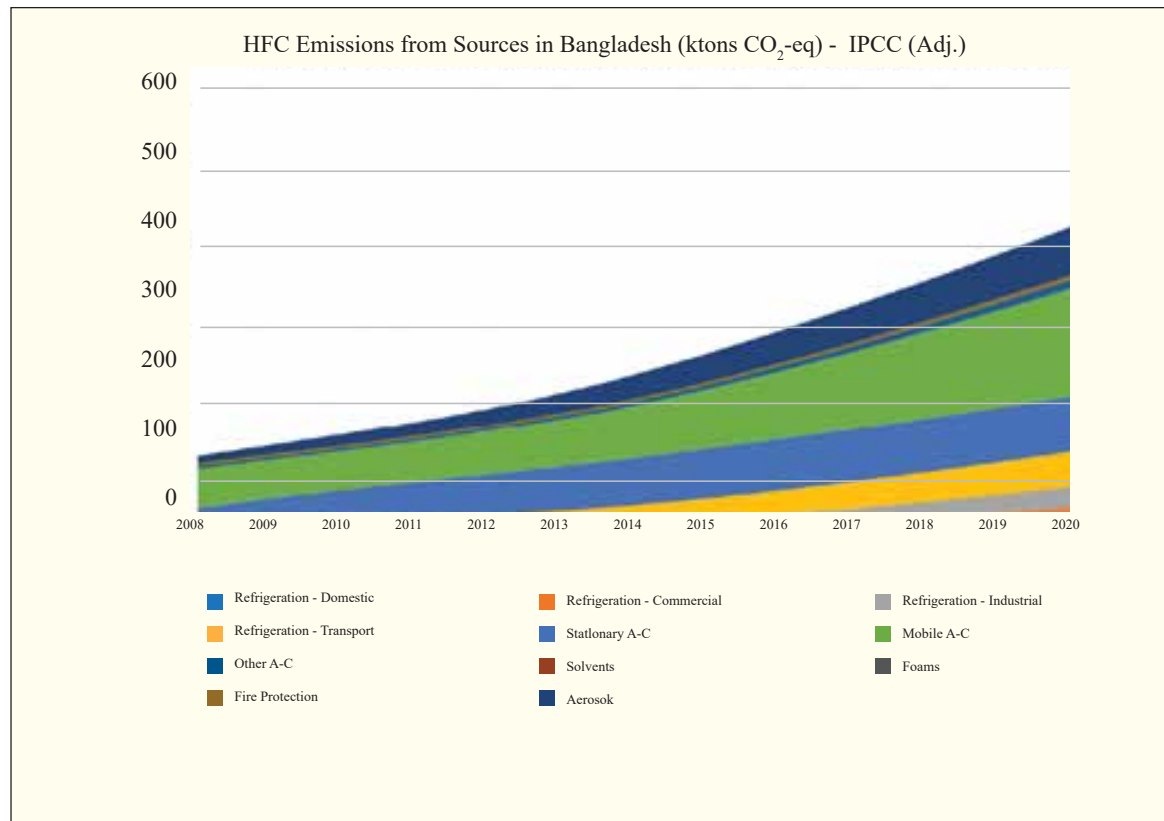
- the RAC sector grew with an average annual compound growth of around 48 percent;
- the growth of the use of RAC equipment is on a steady increase, so their repair and maintenance needs are on the rise, leading to a steady growth in service sector consumption;
- the accelerated phase-out schedule of HCFCs in the foam sector and the foam industries has led to a switch to HFCs and other HC based alternatives;

⁵⁴ ODS and ODS Alternatives Survey, 2019, UNDP, Dhaka, Bangladesh.

⁵⁵ Ibid.

- the aerosol sector experienced a steady growth in the production and export of metered dose inhalers (MDI). This growth rate is expected to increase in future;
- in the firefighting sector, the growth of HFC-227ea is likely to increase;
- all these factors will have a cumulative effect on the rise of imports and the consumption of HFCs.

The growth in HFC emissions (in terms of CO₂ equivalent) in Bangladesh by sector from 2008 to 2020, based on 20 percent MDI use ‘in country’, is shown in Figure 20.



Source: UNDP56; IPCC: Intergovernmental Panel on Climate Change.

Figure 20: Historical and present growth in HFC emissions in Bangladesh by sector

6.6.2 ODS alternatives reduction schedule as per the Kigali Amendment

The growth trend assumes that the RAC industry will, in most cases, continue with a business-as-usual approach and the continued evolution of the market across Bangladesh. Projections of growth trend by substance are based on consultations with stakeholders and RAC industry drivers.

Baseline data: in accordance with the Kigali Amendment schedule, baseline consumption will be an average of HFC consumption from 2020 to 2022, with a freeze in consumption from 2024 to 2028, as shown in Figure 1. The reduction steps from the baseline are due to start from 2029. Tables 12a and 12b show what the Kigali Amendment schedule will mean for the phasing down of ODS Alternatives in Bangladesh.

⁵⁶ HFC Emissions Report for Bangladesh, 2020, Climate and Clean Air Coalition, UNDP, [http://ccacoalition.org/en/file/2747/download?token=TJskvc-m](http://ccacoalition.org/en/file/2747/download?token=TJskvc-m;);

Table 12a: ODS alternatives (HFC) base line for phase-down schedule

Substances	2019 (tonnes)	CAGR (%)	2020 (tonnes)	2021 (tonnes)	2022 (tonnes)	Baseline(Avg. of 2020-2022)(tonnes)	Freeze in 2024 (tonnes)
HFC-134a	1723.02	21.95	2101.2	2562.4	3124.9	2596.2	2596.2
R-410A	822.48	100.94	1652.7	3320.9	6673.1	3882.2	3882.2
R-404A	27.18	24.55	33.9	42.2	52.5	42.9	42.9
R-407C	21.26	37.93	29.3	40.4	55.8	41.8	41.8
HFC-227ea	3.56	24.30	4.4	5.5	6.8	5.6	5.6
R-32	11.41	55.97	17.8	27.8	43.3	29.6	29.6

Table 12b: ODS Alternatives (HFC) Reduction Schedule for Phase Down

Reduction (tonnes)	Freeze in 2024	10% reduction	30% reduction	50% reduction	80% reduction
Substances/Year	Average of 2020-2022	2029	2035	2040	2045
HFC-134a	2596.2	2336.6	1817.3	1298.1	519.2
R-410A	3882.2	3494.0	2717.5	1941.1	776.4
R-404A	42.9	38.6	30.0	21.5	8.6
R-407C	41.8	37.6	29.3	20.9	8.4
HFC-227ea	5.6	5.0	3.9	2.8	1.1
R-32	29.6	26.6	20.7	14.8	5.9

Up to 2025, R-134a will be the key alternative for RAC equipment. Thereafter, R-290 and other hydrocarbons are likely to be introduced in some of the RAC applications. As such, the long term pathway must include: ammonia (R-717); carbon dioxide (R-744); hydrocarbons (HC-600a, HC-290 and others); HFCs (medium and high GWP); and HFCs (low GWP). Given the latest RAC technology, hydrocarbons (HC) are the best option for environmentally friendly refrigerants, though their usage will demand some new safety precautions.

6.6.3 Concerns for Bangladesh

In the context of the phasing-down programme for the preparation of HPMP Stage II, Bangladesh is concerned about the alternative technology choices that would be needed to meet its Stage II compliance targets (2019-2024) for HCFC phase out in: (1) AC assembling/ manufacturing, (2) commercial, (3) industrial refrigeration and (4) servicing, where flammable refrigerants could possibly be introduced as alternatives to HCFC/HFCs.

6.6.4 Proposed activities in stage II of the HPMP

The activities to be implemented during stage II of the HPMP include:

- the conversion of five AC manufacturing enterprises (Walton Hi-Tech Industries Ltd., Unitech Products (BD) Ltd., Supreme Air-conditioning Co., Elite Hitech, and AC Bazar Industries Ltd.) and one chiller manufacturing enterprise (Cooling Point Engineering) to phase out HCFC-22;
- the conversion of one PU foam manufacturing enterprise to phase out HCFC-141b contained in imported pre-blended polyols;
- a technical assistance programme for the servicing sector;
- regulatory actions; and
- monitoring the implementation of the HPMP.

6.6.5 Regulatory actions

During stage II, actions will be undertaken to promote the use of alternative technologies and limit demand for HCFCs, including changes in public procurement and building standards, setting of standards, and increasing awareness among stakeholders and the public.

The adoption of alternative technologies is a crucial factor applying to both manufacturing industries and servicing sectors. In various sectors, R-134a, R-410A, R-404A, R-407C, R-125, R-227 R-717 are being used as alternatives to HCFCs. For conversion projects, HC-290 – an environmentally-friendly, non-flammable and low-GWP technology that is not presently available in the market – would be the best choice for AC manufacturing alternatives to HCFC-22. Other alternatives include: an increased proportion of low-GWP refrigerants; the use of natural refrigerants like R-290 (propane), R-717 (ammonia) and R-744 (CO₂) where possible; and reduced usage of R-404A, R-407C and R-410A as the alternatives are developed.

6.6.6 Refrigerant reduction potential

Climate-appropriate building envelopes driven by faster adoption of the Bangladesh National Building Code (BNBC) in future commercial buildings would reduce refrigerant demand. And, most importantly, the use of good servicing practices and proper installation of room ACs has the potential to reduce refrigerant demand in Bangladesh by around 30 percent.

7. An Overview of The Energy Sector in Bangladesh and Energy Efficiency Targets

The national vision is for electricity for all by 2021. The total installed electricity generation capacity of Bangladesh (including captive and renewable energy) was 23,548 Megawatts (MW) as of August 2020, with 97 percent of the population having access to electricity. The largest energy-consuming sectors are industry and the residential sector, followed by the commercial and agricultural sectors. Bangladesh will need an estimated generation capacity around 40,000 MW of power by 2030 to meet the real demand of around 34,000 to 36,000 MW, in order to sustain economic growth at over 7 percent a year.^{57 58}

7.1 Energy supply

Bangladesh has been able to exploit its natural gas reserves, which currently supply around a quarter of its energy. It is believed, however, that gas supply reached its peak in 2018 and will gradually decrease thereafter. The country cannot build another gas-fired power plant, but will instead resort to other resources for power generation, such as oil, liquefied natural gas (LNG) and coal.

The government plans to develop the Matarbari island area to build ports and facilities to allow the import of coal and LNG from 2021 and 2022 respectively. The development of nuclear power generation, in collaboration with Russia, is also in progress.

7.2 Energy demand

Bangladesh is a densely populated country with around 180 million people living in 147,570 km² of land. A growing and reliable energy supply is required to maintain sustainable annual GDP growth of 7 percent. Primary energy consumption has been increasing steadily at around 8 percent per year. Seventy percent of total consumption is still dependent on domestic gas, excluding biomass. A forecast for the composition of primary energy consumption by sector is presented in Figure 21.

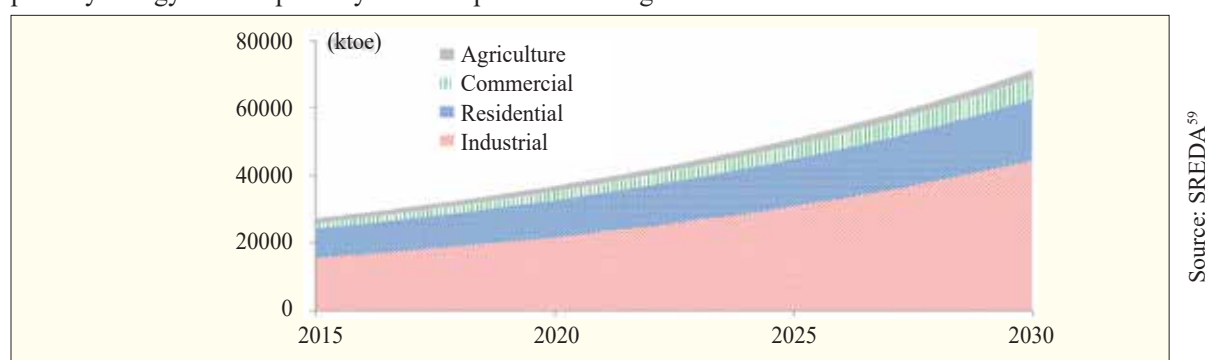


Figure 21: Forecast of primary energy consumption from 2015 to 2030 (business-as-usual case, excluding transportation and biomass)

⁵⁷ Power sector progress report (draft), September 2020 (<https://www.bpdb.gov.bd>), Bangladesh Power Development Board, Government of the People's Republic of Bangladesh

⁵⁸ Power System Master Plan, 2016, Ministry of Power, Energy and Mineral Resources, Government of the People's Republic of Bangladesh, [https://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/4f81bf4d_1180_4c53_b27c_8fa0eb11e2c1/\(E\)_FR_PSMP2016_Summary_revised.pdf](https://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/4f81bf4d_1180_4c53_b27c_8fa0eb11e2c1/(E)_FR_PSMP2016_Summary_revised.pdf)

⁵⁹ Energy Efficiency and Conservation Master Plan up to 2030, 2016, SREDA, Government of the People's Republic of Bangladesh, http://www.sreda.gov.bd/d3pbs_uploads/files/policy_2_energy_efficiency_and_conservation_master_plan_up_to_2030.pdf

The government established the Sustainable and Renewable Energy Development Authority (SREDA) in May 2014 under the Sustainable and Renewable Energy Development Authority Act (2012) to promote, facilitate and disseminate sustainable energy, i.e. covering both renewable energy and energy efficiency to ensure the energy security of the country.

SREDA is now working under the Power Division of the Ministry of Power, Energy and Mineral Resources (MPEMR) as a coordination body for the development of renewable energy. It has been entrusted with demand-side energy management and for attaining energy efficiency and conservation.

A rapidly growing country like Bangladesh needs a huge amount of energy to meet the demands of growth. In 2030, the country’s total primary energy consumption, excluding transportation and biomass, is estimated to reach over 72 Mtoe, three times that of 2013.

Energy consumption by sectors in Bangladesh

The industrial sector share of energy consumption is about 33 percent, while that of the domestic sector is about 53 percent, with much smaller proportions accounted for by the commercial, agricultural and other sectors, as presented in Figure 22.

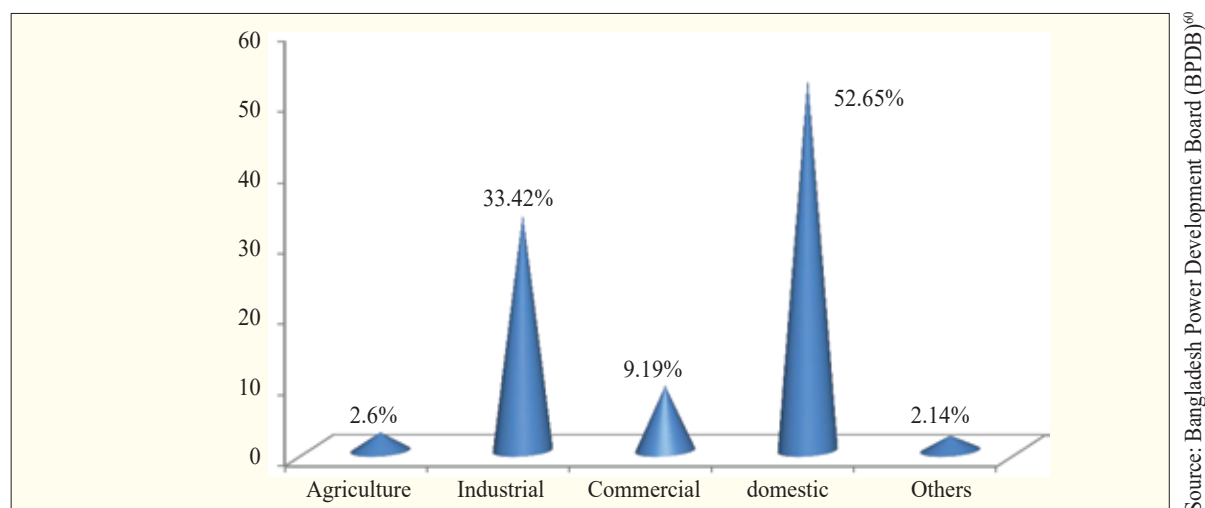


Figure 22: Sectoral power consumption pattern, 2017/18

7.3 Targets for energy efficiency and conservation

SREDA was tasked to undertake an appropriate study to develop an Energy Efficiency and Conservation Master Plan (EE&CMP), taking into the account that the country’s natural gas reserves had started to decrease and that imports of coal and LNG had started to increase. Additionally, the country’s industrial structure is changing from labor intensive to energy intensive. Since 2016 the EE&CMP has been implemented.⁶¹The targets for energy efficiency under the EE&CMP are presented in Figure 23.

⁶⁰ Energy Scenario Bangladesh, 2017-18, Hydrocarbon Unit, Energy and Mineral Resources Division Ministry of Power, Energy and Mineral Resources, 2019, Government Of the People's Republic of Bangladesh, http://hcu.portal.gov.bd/sites/default/files/files/hcu.portal.gov.bd/publications/b84e0d36_2355_4581_a4b3_b8d5abbf9fdd/25102018%20Energy%20Scenario%202017-18_Final.pdf

⁶¹ Energy Efficiency and Conservation Master Plan up to 2030, 2016, SREDA, Government of the People’s Republic of Bangladesh, http://www.sreda.gov.bd/d3pbs_uploads/files/policy_2_energy_efficiency_and_conservation_master_plan_up_to_2030.pdf

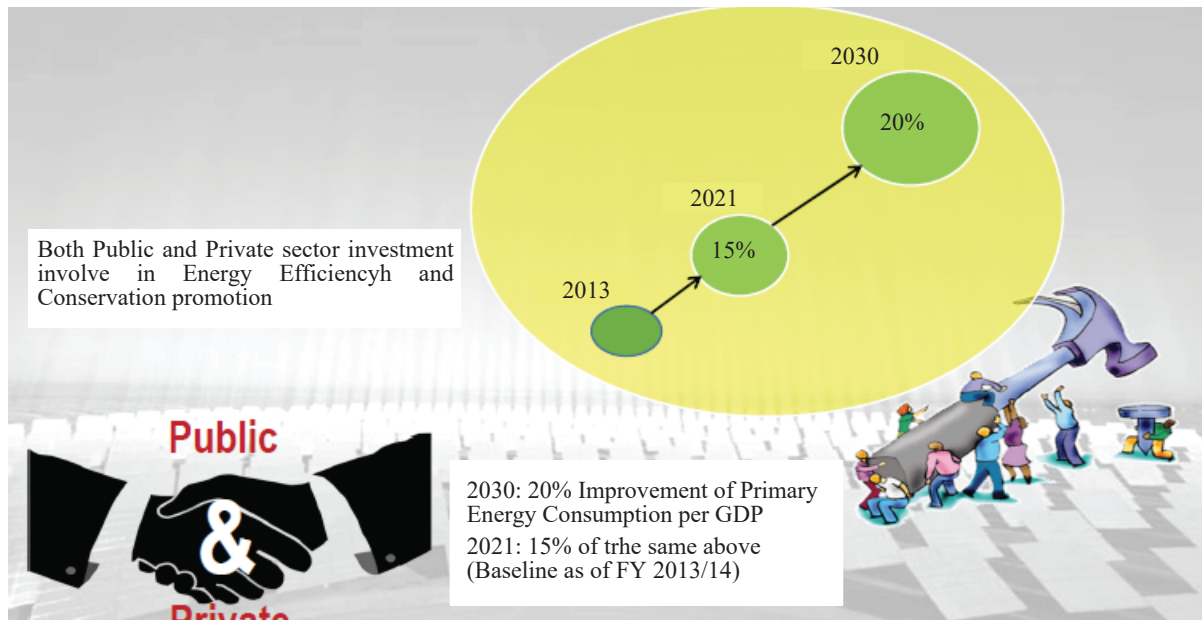


Figure 23: Targets for energy efficiency in Bangladesh up to 2030

The concept of energy intensity can be used to capture the energy efficiency of production in factories, buildings and economic activities. It is defined as energy consumption per unit of production, or per floor area or per unit of GDP respectively. Energy efficiency and conservation (EE&C) potential can be calculated by comparing the actual energy intensity of a product, building or economy with the best-case energy intensity in the most advanced factory in Bangladesh, or other countries.

Under the EE&CMP, three EE&C programmes have been promoted and targeted at large energy-consuming entities and equipment in the industrial, residential and commercial sectors: the Energy Management Programme; the Energy Efficiency Labelling Programme; and the Energy Efficiency Buildings Programme. These programmes cover all prospects for achieving energy efficiency in the RAC sector.

The direct economic benefit of EE&C implementation will be achieved by reducing energy consumption. Without implementation of EE&C programmes, the country's total energy consumption may expand three-fold, from 25 million toe (Mtoe) in 2013 to 72 Mtoe by 2030. To meet the economy's growing demand for energy, the government must minimize energy waste and maximize the use of available energy.

According to the EE&C target of EE&CMP, the government aims to improve energy intensity (national primary energy consumption per unit of GDP) by 15 percent by 2020 and by 20 percent in 2030, compared to the 2013 level. This goal is considered attainable based on an estimation that the industrial, commercial and residential sectors currently have the potential to save by 21 percent, 10 percent and 28.8 percent of their energy use respectively.

Set out below are two scenarios for the calculation of the economic benefits of energy savings expected to be generated through EE&C implementation, from 2015 and 2030. In the Target Scenario (moderate case), the energy saving potential realization rate in 2030 will be 80 percent (i.e. 80 percent of expected energy savings by 2030 will be accomplished), whereas in the Stretch Scenario (ambitious case), the potential realization rate will be 100 percent (that is, expected energy savings by 2030 will be fully accomplished).

⁶² Ibid.

Target Scenario

By achieving the target of 20 percent improvement of primary energy consumption per unit of GDP, a total of approximately 66 Mtoe (or 78 billion m³ of gas equivalent) is expected to be saved within 15 years, from 2016 to 2030. The total energy savings in monetary terms will amount to approximately BDT 530 billion in the period, or an annual average of BDT 35 billion, based on a time weighted average natural gas price. Energy intensity in 2030 would be improved by 20 percent compared to the 2013 level, and total energy consumption in 2030 would be reduced by 17 percent (or by 12 Mtoe) compared with the business-as-usual case⁶³.

Stretch Scenario

Under the Stretch Scenario, a total of approximately 100 Mtoe (or 118 billion m³ of gas equivalent) would be saved in the period to 2030. The total energy savings in monetary terms would be around Tk 580 billion (or an annual average of Tk 39 billion). The energy intensity in 2030 would be improved by 24.6 percent compared to the 2013 level, while energy consumption would be reduced by 22 percent compared with the business-as-usual case. The energy saving potential of both the Target Scenario and the Stretch Scenario is outlined in Figure 24.

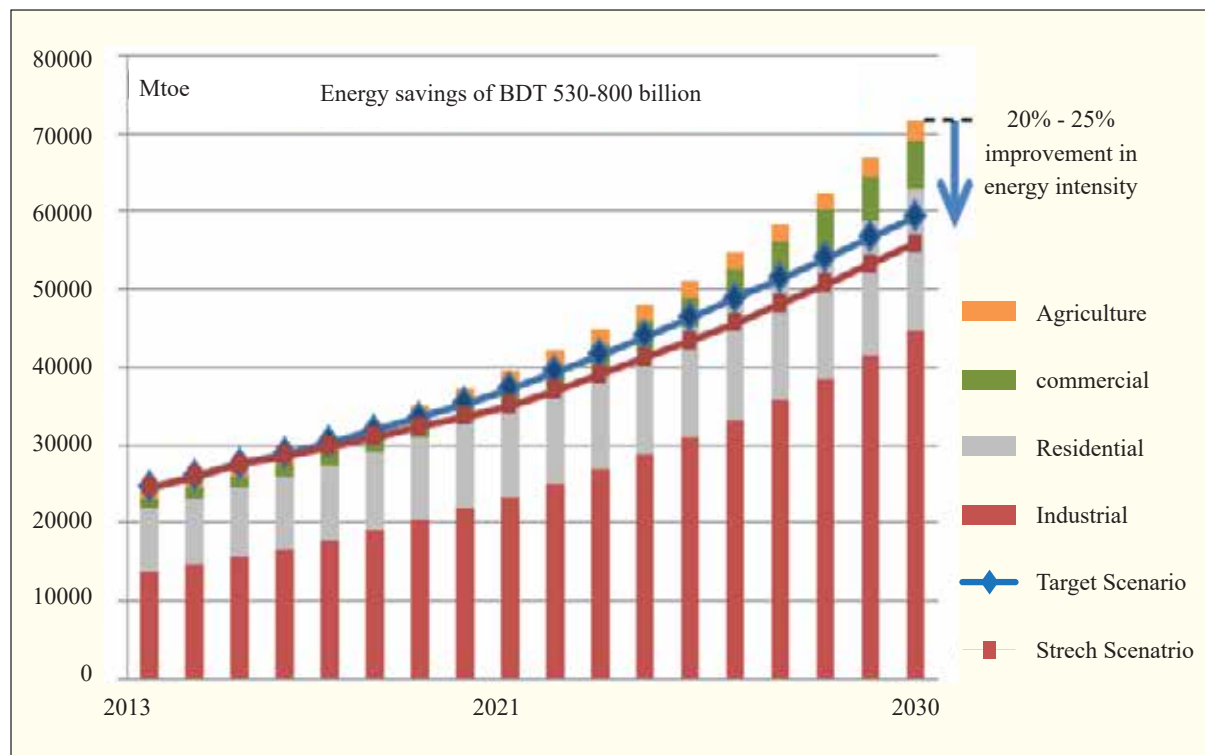


Figure 24: Realization of energy saving potential

⁶³ Ibid.

⁶⁴ Ibid.

7.4 Analysis of RAC sector EE&C potential

Residential Sector

In 2018/19, demand for electricity in the peak hours of the summer months was around 12,000 to 13,000 MW.⁶⁶ The share of the residential sector was around 53 percent, or 6,500 to 7,000 MW. If all existing home appliances were replaced by the highest efficiency products currently available, it is calculated that a maximum potential saving of 28.8 percent could be made (as shown in Figure 25): an 1,800 to 2,000 MW reduction in energy consumption.

RAC devices, including electric fans for cooling, consume about 60 percent of total residential energy.⁶⁷ It would therefore be possible to reduce demand by around 1,100 to 1,200 MW from RAC and electric fans. For example, today's technology, using high efficiency motors offers a 25 percent energy saving potential, while refrigerators / freezers could save 55 percent by using variable speed compressor / inverter technology and high-performance heat insulation. The electricity consumption of ACs could fall by 50 percent with the use of high-performance large heat exchanging coil and variable speed compressor / inverter technology).⁶⁸ It may be noted that electricity consumption is much higher in summer months than in winter months, and the difference comes from lower consumption by room ACs.

Table 13 shows the energy efficiency rate and EE&C potential of home appliances in terms of GWh/year (i.e. in terms of electricity consumption / cost).

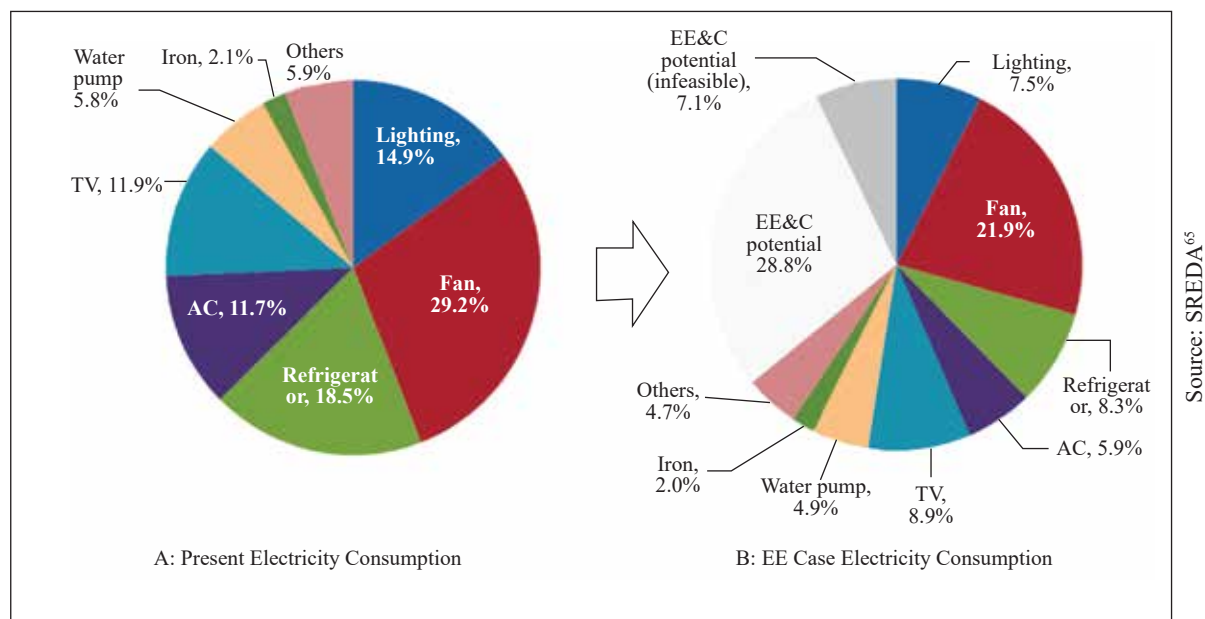


Figure 25: EE&C potential of home appliances

⁶⁵ Ibid.

⁶⁶ Power sector progress report (draft), September, 2020 (<https://www.bpdb.gov.bd>), Bangladesh Power Development Board, Government of the People's Republic of Bangladesh.

⁶⁷ Energy Efficiency and Conservation Master Plan up to 2030, 2016, SREDA, Government of the People's Republic of Bangladesh, http://www.sreda.gov.bd/d3pbs_uploads/files/policy_2_energy_efficiency_and_conservation_master_plan_up_to_2030.pdf

⁶⁸ Ibid.

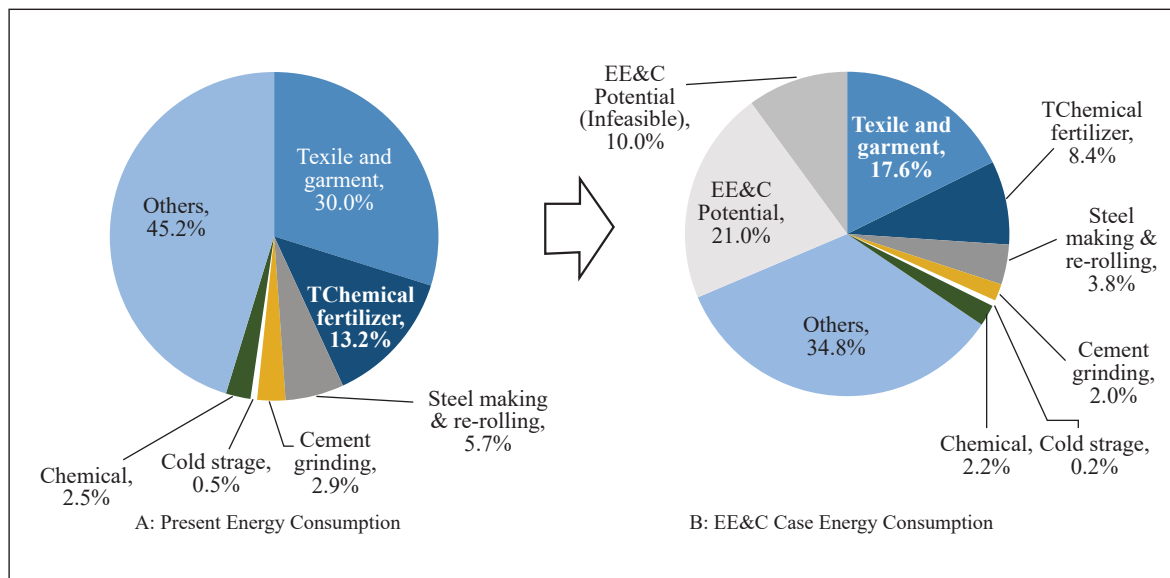
Table 13: Energy efficiency rate and EE&C potential of home appliances

Appliance	EE Technology	Current Energy Consumption (GWh/year)	EE Rate	EE&C Potential (GWh/year)
Fan	High efficiency motor	6,181	-25%	1,545
Refrigerators / Freezers	Variable speed compressor, high performance heat insulation	2,299	-55%	1,264
ACs	High COP with large heat exchanging coil and variable speed compressor	2,237	-50%	1,119

Source: SREDA⁶⁹

Industrial sector

Manufacturing industries in Bangladesh are not efficient in their energy use due to old and poorly maintained machines and poor energy management. The EE&C potential is estimated to be around 21 percent of the entire sector’s consumption, as shown in Figure 26. Given that about half of the country’s primary energy is consumed by industry, these EE&C measures could reduce the economy’s demand by almost 10 percent.



Source: SREDA⁷⁰

Figure 26: EE&C potential of industrial sector

Commercial sector (buildings)

Electricity consumption in the commercial sector has been 1,100 to 1,200 MW in the peak hours of the summer months. As in the residential sector, room ACs account for much of the increase in electricity consumption in summer.

⁶⁹ Ibid.

⁷⁰ Ibid.

Electricity is the main source of energy consumed within buildings. Around 50 percent of total energy is consumed by air conditioning and from 10 to 30 percent is consumed by lighting. The expected energy-saving potential of these two categories is as follows:

- air conditioning: 50 percent by applying high efficiency ACs with inverter technology;
- lighting: 50 percent by applying high efficiency systems, such as LED lamps, or T5 fluorescent lamps with electronic ballast, or utilizing sun light.

It is expected that simple replacement of ACs and lighting systems with high energy efficiency ones can save about 50 percent (550 to 600 MW) of total electricity consumption in the commercial sector. However, it is not easy to introduce EE&C measures for all buildings. Thus, as a realistic value, EE&C potential for buildings is estimated at about 10 percent.

7.5 Energy efficiency and conservation programmes

An efficient policy / programme mix is required to achieve the EE&C target, as shown in Table 14. These policies and programmes have been introduced in industrialized and neighboring countries.

Table 14: Energy efficiency & conservation programmes

Policy/Programme	Target	Methodology
Energy management by energy consumers	Large energy consumers	<p>Energy Management Programme includes:</p> <ul style="list-style-type: none"> • designation of large energy consumers • certification of energy managers, certified energy auditors and accredited energy auditors, including their qualification and examinations • mandatory/voluntary energy audits • energy consumption reporting (mandatory) • benchmarking <p>The programme will be administrated by the government.</p>
Penetration of high efficiency home appliances / equipment in the market	Residences and commercial sector	<p>EE Labelling Programme includes:</p> <ul style="list-style-type: none"> • label certification system and laboratory accreditation system • standardization of energy efficiency (EE) measurement method and star rating/labelling criteria • unification and standardization of the EE labels • mandatory/voluntary participation of manufacturers, importers and retail shops in the programme • issuance of MEPS (Minimum Energy Performance Standard) <p>The programme will be administrated by the government in cooperation with testing institutes, etc. Along with other suitable standards, the standards set by SREDA (see end of table) can be considered for EE and safety standard purposes.</p>
Penetration of EE buildings	Buildings	<p>Enforcement of Bangladesh National Building Code (BNBC) as revised and introduction of Building Energy & Environment Rating (BEER) which includes:</p> <ul style="list-style-type: none"> • promotion of energy efficiency and conservation in buildings • application to all new constructed buildings, including residential buildings <p>The programme will be administrated by the government.</p>

Policy/Programme	Target	Methodology
EE&C financing to the private sectors	Private sector EE&C investments	Provision of financial incentives for EE&C investments, such as: <ul style="list-style-type: none"> • low interest loans for EE&C investment • preferential taxation on EE&C investments including the purchase of high efficiency equipment/appliances • subsidy for EE&C investments • other incentive mechanisms The programme will be carried out by the government jointly with private financial institutions.
Awareness raising	General public	The following methods will be introduced: <ul style="list-style-type: none"> • EE&C awareness content for TV, publications, internet, etc. • manufacturing companies / importers / other organizations can include initiatives for the EE&C awareness programme as part of their social responsibilities • provision of EE&C tips and technologies • intensive education, maximizing motivation of educational institutions, and other administrative units etc.
	Students	<ul style="list-style-type: none"> • environmental education at schools
Government's own initiatives on EE&C implementation	Government	Central and local government will implement EE&C through their own initiatives. The following programmes will be developed: <ul style="list-style-type: none"> • a 'green purchase programme' which specifies eco-friendly products for governmental purchase • obtaining ISO14001, 50001 and/or other relevant certification by governmental organizations
Global warming countermeasure	All parties	<ul style="list-style-type: none"> • capacity development
Energy tariffs	Electricity companies and gas companies	Besides collecting the data on actual costs for energy supply, the following matters should be considered: <ul style="list-style-type: none"> • incentives and motivations for effective EE&C implementation • electricity supply peak load shift • financial resources for EE&C implementation

Source: SREDA^{71, 72}

SREDA EE standards: BDS 1860:2012, BDS 818, BDS IEC 62212:2015, IEC 62560, BDS 1853:2012, AS/NZS 4965.1:2008 or ISO 5151:2017, BDS 1850:2012, IEC 62552-1:2015

7.6 Review of implementation of EE&CMP

It appears that there is a lack of urgency among the public and industry to save energy in the current situation where the government subsidizes the fuel and electricity prices for households and businesses. However, people do understand the importance of saving energy once they discover the magnitude of economic benefits they can earn, even under current low energy prices. It is therefore important for the government to facilitate the development and delivery of EE&C programmes, as well as create the momentum to promote energy saving activities among the general public through EE awareness-raising activities.

⁷¹ Ibid.

⁷² Energy Efficiency Standards and Labeling, EE&C Rule 2016, SREDA, Government of the People's Republic of Bangladesh, http://www.sreda.gov.bd/files/Standard%20and%20labeling%20regulation%20Draft%201_08_2018.pdf

In addition, the government may consider it helpful to provide an energy efficiency finance programme to raise energy efficiency awareness among power users and boost their investments in energy efficiency products. Financial incentives such as loan interest, subsidies and preferential taxes could be provided to lessen the financial burden of purchasing high energy efficiency electrical appliances and industrial equipment.

7.7 Potential for greenhouse gas reduction in the energy sector

The Intended Nationally Determined Contributions (INDC) of Bangladesh consist of the following elements:⁷³

- an unconditional commitment in the power, transport and industrial sectors to reduce greenhouse gas (GHG) emissions by 5 percent (12 MtCO₂e) from the business-as-usual levels, by 2030, based on existing resources;
- a conditional 15 percent reduction (36 MtCO₂e) in GHG emissions from the business-as-usual levels by 2030 in the power, transport, and industry sectors, subject to appropriate international support in the form of finance, investment, technology development and transfer, and capacity building; and
- further mitigating actions in other sectors, subject to the provision of additional international resources.

The INDC of Bangladesh is presented in Figure 27. It should be noted that the RAC sector has not been accounted for in the INDC Bangladesh. The RAC sector is responsible for an increasingly significant share of emissions, which, at the same time can be mitigated effectively at a low cost, as has been demonstrated above. This makes the sector highly appealing for early mitigation within NDC implementation.

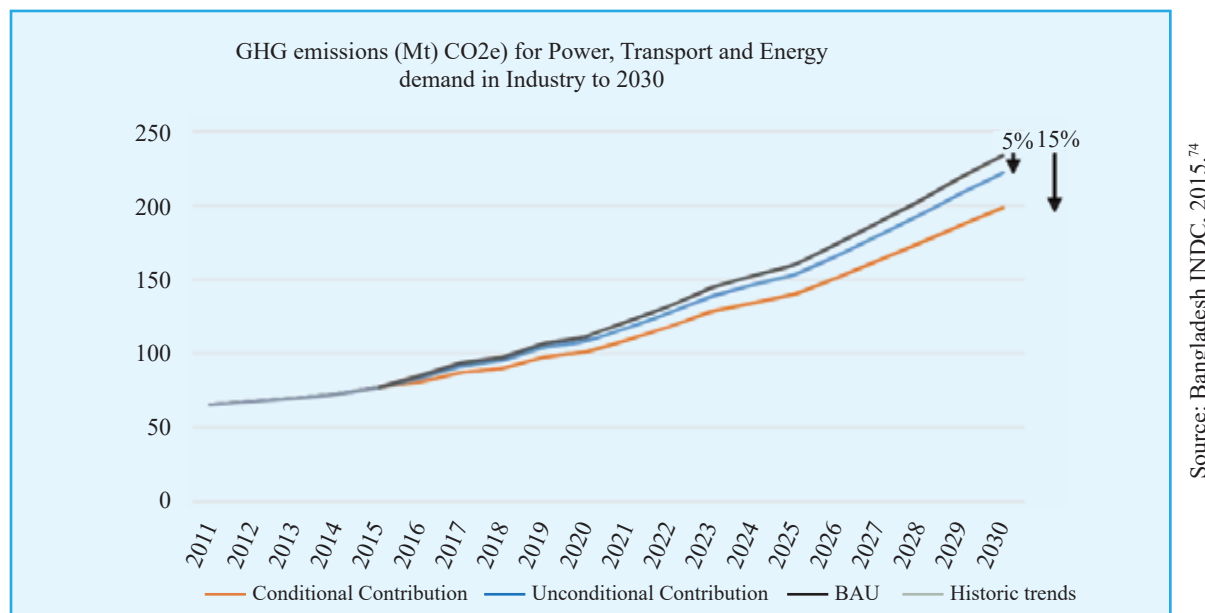


Figure 27: Projection of GHG emissions (MtCO₂e) in the power, transport and industry sectors from 2011 to 2030

⁷³ Intended Nationally Determined Contributions (INDC), 2015, MOEF, Government of the People's Republic of Bangladesh, https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Bangladesh%20First/INDC_2015_of_Bangladesh.pdf

⁷⁴ Ibid.

Section C

Towards a sustainable cooling

8. The Cooling Action Plan

8.1 Rationale

Cooling is a cross-cutting issue, so an integrated and long-term vision across sectors is a prerequisite to address cooling demand in a sustainable manner. The starting point is the current stock of cooling appliances used in air conditioning and refrigeration. The data on cooling demand from the various sectors available in the limited timeframe of this report provide trends rather than definitive estimates, since the information from different sources may have underlying assumptions. However, it has been possible to use the data to provide an outlook on how cooling demand in Bangladesh will evolve and grow.

The preceding chapters reveal that demand for cooling in the country is increasing rapidly. In 2000, the use of room air conditioners was very limited, with only 50,000 in the country. By 2008, Bangladesh had 1.51 million AC units, and by 2019, there were 3.5 million units. This translates into cooling stock of 6.0 million TR. By 2030, the cooling demand from room ACs is expected to be around 17 million TR.

The use of cooling appliances in the commercial building sector is also increasing. Different types of ACs such as splits, different types of chillers such as screw, reciprocal, and centrifugal, are used in commercial buildings. The Variable Refrigeration Flow system (VRF) has also been introduced into the market. Combining chillers and VRF, the cooling stock in 2018 stood at 1.15 million TR. The demand is projected to increase by around three or four times during the period from 2018 to 2030. It's a similar case with mobile air conditioners.

In the refrigeration sector, especially domestic refrigerators, cooling demand has been increasing even more rapidly. In 2008, the number of domestic refrigerators in Bangladesh was 17.2 million units. By 2019, the stock was around 28.5 million units, meaning that 41.4 percent of households now have domestic refrigeration facilities. By around 2024-25, numbers are expected to reach saturation level. Manufacturing companies involved in the production of domestic refrigerators are now exploring the international market for export opportunities, with some already exporting. In the commercial refrigeration and in the cold chain sector, the demand for cooling is forecast to increase threefold during the period from 2018 to 2030.

Against this background, several actions are required to implement the Montreal Protocol and move to sustainable cooling:

- a reduction in cooling load;
- passive cooling interventions for buildings;
- a move towards more energy efficient RAC equipment; and
- operational efficiency enhancements and the use of new and alternative technologies, including not-in-kind technologies.

The move to sustainable cooling should also be reinforced through appropriate rules and regulations, standards and a skilled RAC service technicians' work force.

A significant percentage of households will not be able to afford refrigerant-based cooling equipment. For these families, more thermally efficient residential spaces, that reduce heat load and have enhanced ventilation, are required. This should be coupled with a greater availability of efficient non-refrigerant based cooling equipment, such as fans and coolers.

Based upon this analysis and that set out in the preceding chapters, as well as suggestions received at the stakeholder discussions held as part of this research, the following ideas, policies, regulatory measures and other interventions have been put forward for implementation during the period up to 2030. Due consideration has also been given to their synergy with the ongoing policies and programmes of the government, including EE&CMP, BNBC and policies supporting low GWP and energy-efficient alternatives.

8.2 Ideas, policies, regulatory measures and other interventions

8.2.1 RAC (cross cutting)

1. Advancing Nationally Determined Contributions (NDCs) through climate friendly refrigeration and air conditioning.
2. Establishing and enforcing minimum energy performance standards (MEPS) & a labelling system.
3. Reducing the cooling load of RAC equipment with better insulation and use of energy-efficient accessories.
4. Establishing a mechanism for market monitoring, verification and enforcement in the RAC sector.

8.2.2 Space cooling sector

5. Space cooling sector – envelope improvement (building design)

- 5.1 Passive design and envelope improvements in all new construction to reduce the need for active space cooling. All new construction – both residential and commercial – should be 100% code compliant.
- 5.2 Institutionalizing a holistic and integrated approach for energy-efficient building designs of commercial buildings with a mandate to minimize cooling needs as a condition under environmental clearance policy.
- 5.3 Adopting an adaptive thermal comfort-based set-point for AC operation. The next revision of building codes should include guidelines specific to the Bangladesh climate.
- 5.4 Aggressively driving widespread adoption and stringent enforcement of the BNBC towards energy efficient building practices. All new construction – both residential and commercial – should be 100% code-compliant.
- 5.5 Integrating housing finance policies for the adoption of energy-efficient equipment for existing and new buildings

6 Space cooling sector- envelope improvement (market campaign)

- 6.1 Aggressive market awareness campaigns to sensitize both the construction community as well as users to the multiple benefits of efficient buildings – reduced operational costs, health and comfort, environmental and societal benefits.
- 6.2 Widespread adoption of 5-star labelled fans and room ACs in new and existing public buildings and campaigns to encourage the private sector and consumers to do the same to save money and the environment.
- 6.3 Support information and capacity-building efforts that encourage consumers to opt for energy-efficient products and services.

7. Chain cooling and the refrigeration sector

Envelope improvement:

- 7.1 Standardizing design, construction and associated specifications for small, medium and large cold chain infrastructure components.
- 7.2 Developing safety standards for flammable and toxic refrigerants for cold storage and other

segments of the cold chain

7.3 Driving greater proliferation of efficient refrigeration equipment by fostering user-awareness of purchase cost versus equipment life-cycle (operational) cost.

7.4 Ensuring all supermarket counters and cabinets have operable doors or proper curtains to avoid energy wastage.

7.5 Promoting renewable and alternative energy technologies for the cold chain sector.

8. Retrofitting old and inefficient cold chain systems, including cold storage, with low-GWP, low refrigerant charge, energy-efficient and appropriately-sized cold chain equipment.
9. Providing technical assistance to the SME and informal sector engaged in assembling refrigeration equipment to upgrade their skills and make their products risk-free for users and energy-efficient.

8.2.3 Servicing sector

10. Recovery, recycling and reclamation of refrigerants from servicing centres: the relevant authorities can provide assistance by providing training and equipment for this purpose.

11. Training and capacity building of RAC technicians:

- 11.1 Assessing industry and market demand and availability of trained RAC service technicians across the country as well as the quality and facilities of the training institutes.
- 11.2 Strengthening the capacity of the national vocational and other technical training systems and national certification bodies by reviewing the curricula of the training programmes for RAC technicians.
- 11.3 Addressing the current skill gaps on chillers and servicing through extensive capacity building and training for professionals, operators and technicians. The same applies to the commercial refrigeration and cold chain.
- 11.4 Making certification mandatory and strengthening the certification of RAC technicians under an appropriate regulation and customer awareness programme, reinforcing the need to hire only certified technicians.
- 11.5 As the use of flammable refrigerants (hydrocarbons) will increase in future, special training of RAC technicians regarding fire safety issues.

8.2.4 Transport air conditioning

12 Transport air conditioning – envelope development:

- 12.1 Policies to improve energy efficiency and adaptation of low-GWP refrigerants, especially in hybrid and electric vehicles.
- 12.2 Promoting the development of low-refrigerant charge and energy efficient MAC systems.
- 12.3 Skilling the MAC service technicians through training.

8.2.5 Policies and regulatory measures (cross cutting)

13. Transition to climate friendly refrigerant alternatives supported with appropriate policy, regulation and financial incentives:

- 13.1 Strengthening the introduction of relevant standards, codes and norms that facilitate the safe adoption, operation and servicing of low-GWP based technologies / refrigerants.
 - 13.2 Assessment of funding and financial mechanisms for market transformation.
 - 13.3 Assessment of RAC energy efficiency technologies available in the market and foster the introduction of new technologies.
 - 13.4 Prohibition of imports of equipment using lower than specified energy-efficiency standards.
- 14 Institutional strengthening of the enforcement of Energy Efficiency and Conservation Rules, 2016.

15 Development of an R&D platform and instituting an eco-labelling programme for cooling appliances and an awareness-raising programme:

- 15.1 Public and private collaboration in developing an R&D platform and awareness-raising programmes.
- 15.2 Promoting sustainable and smart cooling strategies while implementing the Kigali Amendment to the Montreal Protocol for the phase-down of HFCs.
- 15.3 Assessing the environmental footprint of cooling equipment in terms of GWP (or ODP) and GHG emissions, in combination with safety, performance and energy efficiency, all under a single eco / environmental label.

16. Development of appropriate fiscal policies to support the use of low-GWP and energy-efficient equipment:

- 16.1 Developing incentive programmes for utility companies to encourage the use of low-GWP and energy-efficient equipment.
- 16.2 Bulk procurement programmes (by government and other bodies) for energy-efficient equipment using low / zero GWP refrigerants.

8.3 Implementation and monitoring framework

Given the diverse range of recommendations proposed in the National Cooling Plan, an effective coordination, implementation and monitoring framework is needed. Active collaboration is also required among the relevant ministries, government departments, industry associations, civil society, the private sector, and other concerned stakeholders.

The following Implementation and Monitoring Framework is proposed for the implementation of the Cooling Plan. It should comprise two committees: a Steering Committee and a Coordination & Monitoring Committee. The Director General in the Department of Environment can take forward project ideas, policies and regulatory measures and other interventions.

The Steering Committee (SC) should be chaired by the Secretary of the MoEFCC, and act as the highest decision-making body to provide policy guidance for implementation of the Cooling Plan recommendations, including their allocation to respective ministries / agencies.

Other members should include:

- Representative of the Ministry of Power and Mineral Resources;
- Representative of the Ministry of Industry;
- Representative of the Ministry of Finance;
- Representative of the Ministry of Planning;
- Director General, Department of Environment;
- Member (Energy Efficiency), SREDA;
- Member, Customs, NBR (Energy Efficiency);
- Chairman, Bangladesh Standards & Testing institution (BSTI);
- Chairman, Mechanical Engineering Department, BUET;
- Chairman, Chemical Engineering Department, BUET;
- Director General, Department of Technical Education;
- Chairman, BRAMA;
- President, ASHRAE;
- Representative from the RAC Manufacturers Association;
- Representative from the RAC Importers Association;
- Representative from the Cold Storage Association; and
- Joint Secretary (Environment), MoEFCC to act as the Member Secretary of the Committee.

The Coordination & Monitoring Committee should be Chaired by Director General, Department of Environment.

Other members should include:

- Representative of the Ministry of Industry;
- Representative of SREDA;
- Representative of Customs, NBR;
- Chairman (or their) representative, Mechanical Engineering Department, BUET;
- Chairman (or their) representative, Chemical Engineering Department, BUET;
- Director General (or their) representative, Department of Technical Education;
- Representative of the Bangladesh Standards & Testing Institution (BSTI);
- Representative of the Bangladesh House Building Finance Corporation;
- Representative of BNBC Authority;
- Representative of BRAMA;
- Representative of ASHRAE;
- Representative of the RAC Manufacturers Association;
- Representative of the RAC Importers Association;
- Representative of the Cold Storage Association; and
- Project Director, Institutional Strengthening, National Ozone Unit, DoE who will act as Member Secretary of the Committee.

8.4 Financing the implementation

Developing countries often require additional financial assistance to initiate the transition to a more climate-friendly RAC market. GHG mitigation in the RAC sector is among the most cost-effective mitigation actions that can be undertaken. However, barriers such as lack of capital, lack of information and high risk perceptions prevent end-users from purchasing more climate-friendly and efficient RAC products.

An effective mitigation framework for the RAC sector must be based on an integrated approach, covering financing for mitigation of both direct and indirect emissions, within the NDC framework. This would ensure that both the climate and socio-economic benefits could be maximized.

8.4.1 Financing of HFC reductions under the Montreal Protocol

The financing of activities to reduce HFC emissions will be funded under the Montreal Protocol. Developing countries (under Article 5 of the Protocol) are supported through the Multilateral Fund (MLF) with finance for technology transfer to enable their compliance with the Protocol's control measures. The eligible funding is provided on the basis of the total baseline consumption and subsector-specific incremental cost guidelines.

Developing countries have agreed a baseline approach which sets the level of allowable HFCs for consumption and production. Under this approach, developing countries responsible for approximately 87 percent of HFC consumption (in developing countries) apply a baseline based on the years 2020 to 2022, while the remaining countries with specific difficulties take the years 2024 to 2026 as their baseline. In both cases, two years after the last baseline year, consumption will be capped at 100 percent of the baseline, the so-called 'freeze'. In the following years, consumption will be gradually reduced to a final plateau of 20 percent or 15 percent of the baseline respectively by the years 2045 or 2047.

During the phasing down of HFCs, Article 5 parties will have the flexibility to individually select HFC sectors and replacement technologies, and adapt their strategies to their needs and national circumstances.

Funding the phase-down of HFC may include incentives for energy-efficiency improvements when appropriate and cost-effective. Since the MLF has no capacity to control the impact of energy

efficiency measures, it is likely that funding for energy efficiency will depend on a supporting framework in the beneficiary country. In addition, it is expected that MLF support for capacity building in the servicing and repair sector will substantially improve the energy efficiency of installations and equipment. Funding may include the following elements:

- costs for setting up inventories, reporting and ratification processes;
- demonstration projects and regulative action;
- institutional strengthening; and
- incremental costs necessary to achieve the first control step (freeze) and the individual phase-down steps until the final plateau is achieved. Incremental costs are provided for the closure of HFC production capacities and for reducing consumption in the manufacturing sector, including costs for building capacity in the servicing sector. End-user funding is not obligatory under the MLF and only demonstration projects are financed in exceptional cases.

Energy efficiency incentives are evaluated in the context of incremental costs resulting from HFC conversions, giving consideration to limited upgrades of components and parts in alternative technologies where it is cost effective and represents only a small percentage of the total conversion costs.

8.4.2 Climate finance under the UNFCCC

The provision of financial support for mitigation activities in developing countries is a cornerstone of the international climate policy process and the Paris Agreement. Industrialized countries committed to jointly mobilize US\$100 billion per annum until 2020 to support climate action in developing countries⁷⁵. This commitment was reiterated in the Paris Agreement and extended through to 2025. Before 2025, a new collective finance goal is to be defined with the \$100 billion constituting the minimum. The HFC phase-down is expected to significantly contribute to global mitigation targets, with an expected reduction of 0.5°C by the year 2100. This figure does not include reductions that could be achieved through energy efficiency and a replacement of fossil energy by renewable energy.

In developing countries, the aggregated reductions until 2050 achieved by HFC reduction and the combined introduction of EE measures and renewable energy production are projected to be equally high. In the energy sector, absolute reductions will be difficult to achieve, given the rapid economic growth expected in developing countries. Because of the importance of cooling in developing countries, the massive replacement of fossil energy production with renewable energy in combination with highly energy-efficient cooling systems is the only option if they are to achieve the 2050 targets. Therefore, the major part of funding for energy related mitigation in the RAC sector will need to come from international climate finance sources.

8.4.3 Green Climate Fund

One of the main sources of support is the Green Climate Fund (GCF), which was adopted as the financial mechanism of the United Nations Framework Convention on Climate Change (UNFCCC) at the end of 2011. The initial resource mobilization raised over \$10 billion and is expected to increase substantially in future. The GCF aims to fund climate action equally across mitigation and adaptation, with at least half of its resources to be made available to the Least Developed Countries, Small Island Developing States, and African states.

The funding framework is continuously evolving and funding for several projects has already been agreed. A Private Sector Facility is also being established to allow the direct engagement of the private sector.

The GCF will operate a variety of financial instruments including grants, concessional loans, subordinate debt, equity and guarantees depending on specific project and funding needs. A higher risk-bearing capacity is expected to support innovative approaches and crowd-in finance from other, in particular private, sources.

Conclusions

Even before it signed the Kigali Amendment to the Montreal Protocol, Bangladesh was taking steps towards a reduction in cooling demand:

- it had prepared and started implementation of the Bangladesh National Building Code (BNBC) and the Energy Efficiency Conservation Master Plan (EECMP);
- it had also successfully implemented projects (CFC & HCFC phase out) towards transition to low ODP potential refrigerants.

The Bangladesh National Cooling Plan for implementation of the Montreal Protocol builds on these basic pillars. In line with the BNBC and EECMP, additional recommendations have been included in Chapter 8, setting out potential project ideas and/or policy and regulatory measures for the respective cooling sectors.

It is hoped that strict compliance to BNBC, proper and timely implementation of EE&CMP programmes, the introduction of innovative policy for the safe introduction of low GWP and energy efficient alternatives against HFC and the implementation of the additional interventions suggested in this National Cooling Plan will take the country in the right direction.

To monitor, verify and enforce the Cooling Plan and overall implementation of the Montreal Protocol, the establishment of an inter-ministerial implementation, monitoring and coordination committee has been suggested.

It should be noted that this Cooling Plan is a dynamic document that will evolve as new empirical evidence emerges to fill the data gaps identified. The establishment of the size of the current stock in different equipment categories and the projections of cooling demand in various sectors has been difficult because of the dearth of data, research publications etc. In particular, the historically installed bases of AC and refrigeration equipment have not been accounted for in any publication.

While climate modelling data and economic projections were available, often growth projections for commercial cooling spaces, future household cooling demand and so on were not available. The same is true for forecasts of the chain cooling and refrigeration sectors. Therefore, the estimates of the current stock of different cooling equipment and of future cooling demand in these sectors have been attempted using the best judgment of experts and marketing surveys of the industries concerned.

It is recommended that this Cooling Plan is used as a starting point, and that the necessary measures are taken to support further research in the future to make it as comprehensive as possible.



KIGALI
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