National Green Cooling Program

In-depth study and survey to develop the National Green Cooling Program

Final Report

March 2024

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ABBREVIATIONS

AC	Air Conditioning, Air Conditioner
BAT	Best Available Technology
BAU	Business as usual
COP	Conference of Parties
DCC	Department of Climate Change
EE	Energy Efficiency
ESCO	Energy Service Company
ETP	Southeast Asia Energy Transition Partnership
EV	Electric Vehicle
EVN	Viet Nam Electricity
GEF	Grid Emission Factor
GHG	Greenhouse Gas
GSO	General Statistics Office of Viet Nam
GWP	Global Warming Potential
HC	Hydrocarbon
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HFO	Hydrofluoroolefin
HPMP	HCFC Phase out Management Plan
IPCC	InterGovernmental Panel on Climate Change
ITMO	Internationally Transferred Mitigation Outcome
JETP	Just Energy Transition Partnership
MAC	Mobile Air Conditioning
MEPS	Minimum Energy Performance Standards
MOIT	Ministry of Industry and Trade
MOLISA	Ministry of Labour - Invalids and Social Affairs
MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
NDC	Nationally Determined Contribution
NGCP	National Green Cooling Program
NGCAP	National Green Cooling Action Plan
NZT	Net Zero Target
O&M	Operation and Maintenance
ODS	Ozone Depleting Substance
PDP8	Viet Nam's Eighth National Electricity Development Plan
RAC	Refrigeration and Air Conditioning
RE	Renewable Energy
RTOC	Refrigeration, Air Conditioning and Heat Pumps Assessment Report
TA	Technical Assistance
TCVN	Viet Nam Technical Standards
UNEP	United Nations Environment Programme
UNOPS	United Nations Office for Project Services

VNEEP	National Energy Efficiency Programme
VRF/VRF	Variable Refrigerant Flow/Variable Refrigerant Volume

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EXECUTIVE SUMMARY

Surging cooling demand and the contribution to meet the national commitment to reduce GHG emissions

Viet Nam aims at an annual GDP growth of 7% during the 2021-2030 period and aspires to become an upper-middle income country by 2030 with GDP per capita reaching 7,500 USD. Beyond that date, the vision for 2050 is to become a developed high income country with a per capita GDP around 30,000 USD. In that context, Viet Nam is currently rapidly shifting from a rural-agrarian society to an urban-industrial and services-based economy, with urbanisation reaching 38.1% in 2022 which will result in increasing high demands for new buildings, infrastructure and vehicles.

Viet Nam is a country with high temperatures and humidity, covering both subtropical and tropical zones. In rural areas in Viet Nam, lack of access to cooling infrastructure leads to a loss of productivity and exacerbates health risks, particularly in heatwave conditions that are likely to become more severe with climate change. 80% of Viet Nam's population currently are at risk from being unable to access cooling technology and inadequate cooling services which is particularly lacking for low-income households, vulnerable groups, such as the elderly and infants. Predictions suggest that heat-related deaths could triple by 2050.

Tackling this surging cooling demand sustainably is extremely important to fulfil Viet Nam's Nationally Determined Contribution (NDC) climate change mitigation targets. First of all, it is crucial to assess comprehensively the growing cooling demand in the country and mitigate related greenhouse gas (GHG) emissions through solutions such as passive building designs, energy efficient active cooling using best available technology, phasing out of high global warming potential (GWP) refrigerants, use of green refrigerants, and recycling and safe disposal of refrigerants among others. To tackle this challenge, the Southeast Asia Energy Transition Partnership (ETP) has taken a significant step forward in supporting the Technical Assistance (TA) initiative titled "National Green Cooling Program In-depth study and survey to develop the National Green Cooling Program" undertaken in collaboration with Department of Climate Change (DCC), and the Ministry of Natural Resources and Environment (MONRE). The primary objective of this TA is to formulate a National Green Cooling Program (NGCP) for Viet Nam. Throughout the implementation of the TA, regular consultations with the DCC, MONRE and other key relevant stakeholders from other line ministries, Governmental agencies, associations, research institutes and cooling industries were undertaken in order to seek the feedback, recommendations as well as to ensure the outcomes, findings and deliverables under the TA are consistent with the existing and planning policies and practices. This TA implemented by the consulting consortium of Energy and Environment Consultancy Joint Stock Company (VNEEC), EPRO Consulting Joint Stock Company (EPRO), and Perspectives Climate Group GmbH (PCG).

This TA proposes a NGCP that focuses on activities, policies, and measures to improve equipment energy efficiency and transition to low to "0" GWP refrigerants (active cooling measures).

Simultaneously, the United Nations Environment Program (UNEP) is implementing a TA to develop passive cooling measures including solutions that use natural elements to cool spaces. ETP and UNEP have agreed to synthesise the results of the two components to propose a "National Green Cooling Action Plan (NGCAP)" to provide a comprehensive plan for both active and passive cooling, addressing challenges in the cooling sector, moving towards comprehensive sustainable cooling methods. Thereby, NGCAP will propose measures and solutions to promote the application of the most advanced sustainable cooling

methods in Viet Nam to directly contribute to Viet Nam's NDC goal and its commitment to achieve Viet Nam's Net Zero Target (NZT) by 2050.

Viet Nam's international commitments to mitigate climate change

The Government of Viet Nam has demonstrated a proactive engagement in the international treaties addressing climate change and the destruction of the ozone layer. Viet Nam ratified the Montreal Protocol and its Amendments with a commitment to freeze consumption of hydrochlorofluorocarbons (HCFCs) in 2013 and will reduce HCFC consumption, except for servicing, by 100% by 2030. Accordingly, Viet Nam has set targets to gradually reduce and cease the import of HCFCs entirely by the year 2040. In 2019 it ratified the Kigali Amendment to phase down hydrofluorocarbon (HFC) refrigerants. Over the period 2024-2029, Viet Nam will freeze the production and consumption of HFCs and then reduce them progressively to 20% of this value by 2045. At the 26th Conference of Parties to the UN Framework Convention on Climate Change (UNFCCC) (COP26), Viet Nam pledged to achieve net-zero greenhouse gas (GHG) emissions by 2050. Currently, the emission reduction targets under self-implementation (unconditional contributions) and with international support (conditional contributions) in NDC 2022 are 15.8% and 43.5%, respectively compared to a baseline by 2030. At COP28 in 2023, Viet Nam signed a Global Cooling Pledge, along with other 63 nations which commit to a 68% reduction in cooling related GHG emissions by 2050.

Currently, the emission reduction targets under self-implementation (unconditional contributions) and with international support (conditional contributions) in NDC 2022 are 15.8% and 43.5%, respectively compared to a baseline by 2030.

The Ministry of Natural Resources and Environment (MONRE) is the national focal point for implementation of these international commitments. Viet Nam has developed a legal and institutional framework and strategies for phasing out ODS and reduction of GHG emissions, most recently through the 2020 Law on Environmental Protection and Government's Decree 06/2022/ND-CP on mitigation of GHG emissions and protection of ozone layer. The National Climate Change Strategy and NDC, updated in 2022, underscore Viet Nam's dedication to reducing ODSs and HFCs. The Just Energy Transition Partnership (JETP) signed between the Government of Viet Nam and International Partners Group in 2022 aims to mobilise significant funding over the next three to five years, to enable accelerated closure of coal power plants through an increase of energy efficiency (EE) and promote renewable energy generation. In parallel, Viet Nam has implemented several policies to enhance EE in the cooling sector, through the implementation of policies such as the Law on Economical and Efficient Use of Energy, Viet Nam's National EE Programme (VNEEP) and public procurement regulations that promote the economical and efficient use of energy generally and in the cooling sector particularly, challenges persist, including gaps in enforcement and outdated standards as well as a lack of comprehensive disposal and recycling systems.

Establishing the energy and emissions baseline scenarios for Viet Nam's cooling sector in 2030 and 2050

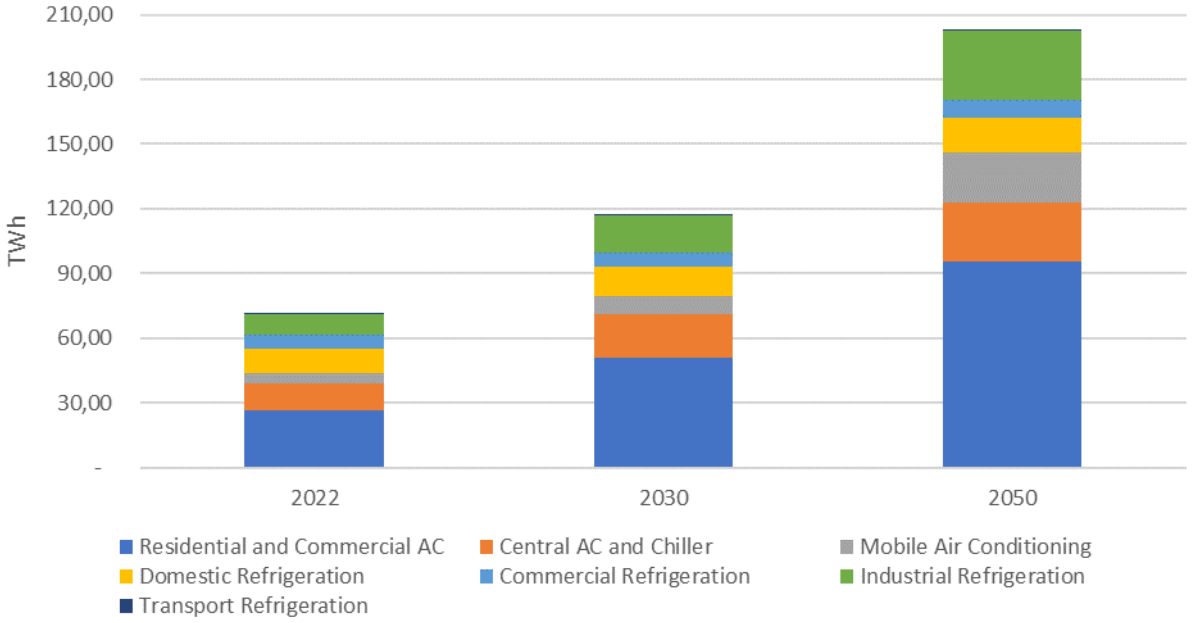
Within the framework of the TA funded by ETP, the most up-to-date database on the cooling sector for the period 2018-2022 has been built based on diverse data sources and extensive analyses collected through national survey activities. This database includes seven sub-sectors: residential and commercial air conditioning (AC), central AC and chillers, mobile AC (MAC), domestic refrigeration, commercial refrigeration, industrial refrigeration, and transport refrigeration. Through this database, a baseline

scenario and growth forecast for energy consumption and emissions from cooling equipment in Viet Nam was established for the period 2022-2050.

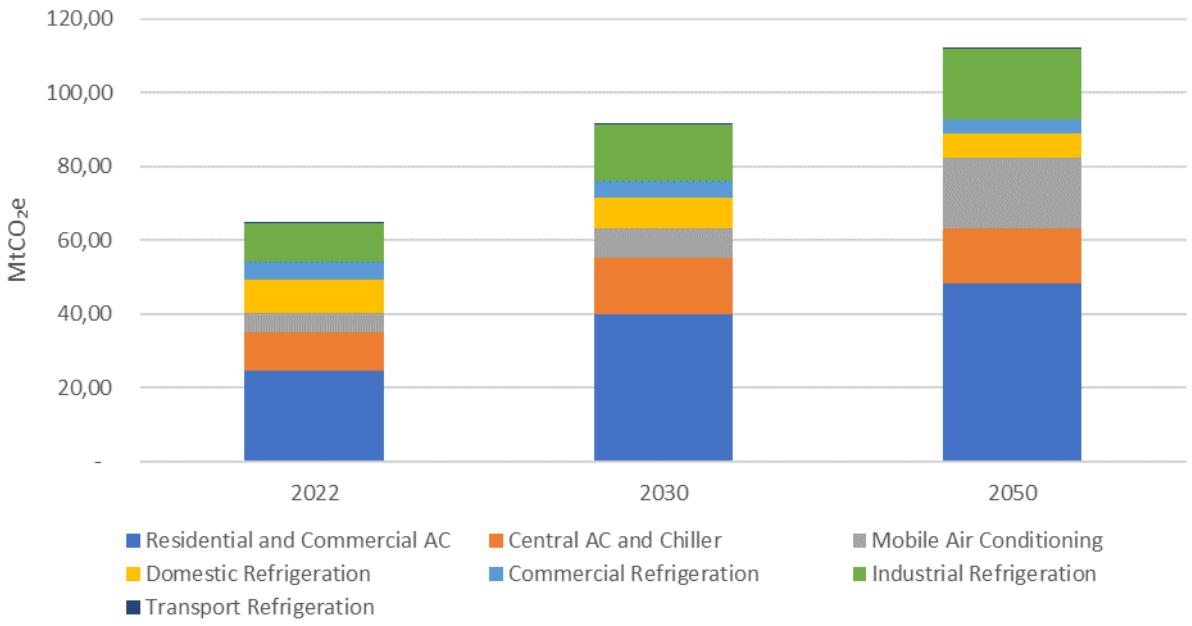
In 2022, the cooling sector was responsible for 25.2% of total electricity (generated and imported) of Viet Nam and 64.7 $MtCO_2e$ emissions. Direct emissions were responsible for 15.7%, indirect emissions for 84.3% of the total in 2022. The high level of the latter is due to Viet Nam's high grid emission factor (0.7221 tCO_2/MWh in 2021). Total emissions are projected to rise to 91.7 $MtCO_2e$ in 2030 (accounting for 9.9% of total national emissions) as per the NDC business-as-usual (BAU) scenario.

Figure ES-1 below projects Viet Nam's energy consumption for the cooling sector which is expected to triple in 2050. It is evident that the residential and commercial AC sub-sector will be the most energy intensive sub-sector in 2050.

Figure ES-1: Energy consumption and GHG emissions from cooling in Viet Nam by sub-sectors



Energy consumption



GHG emissions

Source: Compiled from the database of the survey

Viet Nam's total cooling sector emissions are estimated to double from 2022 to 2050, peaking in 2045, considering the current trend of electricity grid emission factor reduction as well as the effect of policies that will be applied on refrigerants.

Key highlights of the NGCP analysis and the roadmap

The NGCP has been developed focusing on the following four pillars: 1) the strengthening, expansion and enforcement of Minimum Energy Performance Standards (MEPS) in line with the targets set out under the NDC and the Kigali Amendment, 2) harnessing of domestic and international financing sources for the improvement of cooling equipment production and use while minimising foreign debt burden, 3) capacity building of key actors to ensure proper handling, usage, O&M of cooling equipment with high efficiency and low GHG refrigerant, and 4) awareness raising on climate-friendly cooling equipment.

To achieve the NDC and NZT, it is imperative to implement indirect emissions reduction measures by upgrading EE levels for residential and commercial AC, domestic refrigeration, and the adoption of MEPS in sub-sectors such as industrial refrigeration, MAC, commercial refrigeration and transport refrigeration. Direct emissions are addressed by control measures and the acceleration of transition towards natural refrigerants with zero GWP. Setting up waste recycling centres, disposal emissions can be minimised through recycling of the refrigerants, and safe disposal of refrigerants and e-waste. There is a strong need for awareness raising of users and market participants through organised and targeted capacity building, and certification of the technicians.

The utilisation of HCFCs such as R-22 and R-123, primarily in industrial refrigeration, is on track for complete phase out by 2040, with the increased use of HFCs and natural refrigerants. Natural alternatives of HC (Hydrocarbon) like R-600a (Isobutane) and R-290 (Propane) would be used in domestic and commercial refrigeration, while R-717 (NH_3) finds application in large-scale industrial refrigeration systems. As for MAC, the HFO (Hydrofluoroolefin) of R-1234yf is penetrating the market of automobiles.

Viet Nam needs bold measures and strategies to achieve both its NDC target and the overarching NZT. This includes supplement/amend EE standards for RAC products, harnessing climate finance judiciously, capitalising on the carbon market, and deploying robust policy incentives to facilitate the seamless transition toward low-GWP refrigerants and efficient RACs. A resolute commitment to rigorous recovery of refrigerants, recycling of e-waste, and disposal systems underpins realising the national green cooling aspirations. This is not merely a call to action; it is developing consensus on a sustainable and efficient cooling paradigm that befits the aspirations of a progressive Viet Nam.

National Green Cooling Program: Targets, actions and recommendations

The NGCP should primarily focus on seven sub-sectors residential and commercial AC, central AC and chillers and MAC as well as domestic, commercial, industrial and transport refrigeration. Under NGCP, regulations and standards related to MEPS as well as energy labelling need to be established and regularly updated. EE improvements and low GWP refrigerant adoption is to be incentivised in order to achieve NDC targets and progress towards the NZT. Furthermore, policies should target the disparities in cooling access between urban/high-income and rural/low-income groups. This can be achieved by implementing measures that remove financial constraints for low-income groups by introducing affordable, and simple procedure to avail financing. Expanding guarantee programs for commercial loans provided by domestic banks and concessional loan programs for private companies, which have shown moderate success in the past, is also essential.

With regard to international cooperation, revenues from the sale of Internationally transferred mitigation outcomes (ITMOs) through international carbon markets under Article 6 of the Paris Agreement could lead to a rapid upscaling of EE and low GWP refrigerant replacement which would otherwise not be financially feasible. Internationally, several Governments have already engaged with MONRE to acquire ITMOs under Article 6.2, while the Government of Viet Nam has to set up its specific institutional and legal frameworks for such cooperation. Revenues from ITMO sales could help overcome the challenge related to the Government of Viet Nam being very reluctant to accept international concessional loans in order not to increase international debt beyond a manageable threshold. In other countries, Article 6.2 cooling sector projects are already moving ahead, inter alia in Ghana and Morocco. Viet Nam can take advantage and learn from experiences of these countries while enhancing capacity building to exploit the opportunities of the international carbon market.

Impact of the NGCP on energy use and emissions in 2030 and 2050

The Best Available Technology (BAT) scenario projects energy savings of 10.57 TWh in 2030 and 62.09 TWh in 2050 compared to the BAU scenario, with the residential and commercial AC sub-sector achieving savings of 7.48 TWh in 2030 and 43.76 TWh in 2050. The somewhat less ambitious NZT by 2050 scenario, aiming for a 50% increase in AC efficiency by 2050, would achieve savings of 9.03 TWh in 2030 and 54.48 TWh in 2050.

The NGCP has the following objectives as shown in Table ES-1 below with a 50% increase in the average efficiency rating of new ACs by 2030 and an 80% increase by 2050, a 7%-30% increase in the efficiency of non-AC cooling equipment by 2030, and 10%-35% by 2050, with reference to 2022; and recovery of all refrigerants from cooling equipment at its end of life by 2050.

Table ES-1: Targets and actions of the NGCP

Cooling sub-sector	Target for EE improvement to achieve NDC/NZT scenario	Target for EE improvement to achieve BAT scenario	Action to achieve targets
Residential and commercial AC	**50%** higher EE compared to the current level in 2030. **80%** higher EE compared to the current level in 2050.	**60%** higher EE compared to the current level in 2030. **100%** compared to the current level in 2050.	Increase MEPS, rising star level, and incentive for buyers to buy highly efficient ACs. Market transformation through demand aggregation and targeted rollout in Government and private/retail sectors. Sustainable Public Procurement. Buyback of old and used cooling equipment and safe disposal/end of life.
Central AC and chiller	**15%** higher EE than the current level in 2030. **20%** higher EE compared to the current level in 2050.	• Chillers: **18%** higher EE than the current level in 2030. **25%** higher EE compared to the current level in 2050. • Central AC: **20%** higher EE compared to the current level in 2030. **30%** higher EE compared to the current level in 2050.	Including in the building EE policies (QCVN) which are not only limited to EE buildings (QCVN 09:2013/BXD). Implement a specific MEPS for VRV/VRF and other types of multi-split ACs. Develop new TCVN for chiller which included MEPS. Standards for chillers operation and maintenance (O&M) through recognised and accredited experts and a mechanism to monitor. An incentive to use higher efficiency types of equipment.
MAC	**30%** of cars in 2030 are Electric Vehicles (EVs). **100%** of cars in 2050 are EVs. **30%** increase in the EE for MAC in 2030. **35%** increase in the EE for MAC in 2050.	**30%** of cars in 2030 are EVs. **100%** of cars in 2050 are EVs. **30%** increase in the EE for MAC in 2030. **35%** increase in the EE for MAC in 2050.	Develop TCVN for MAC or vehicles with MAC which includes MEPS. (MEPS for MAC or control via fuel efficiency MEPS of vehicles with MAC) Restrict importing old MAC equipment. Training and capacity building of technicians for the O&M of vehicles with MACs. Incentive buying EVs.
Domestic and commercial refrigeration	**15%** higher EE compared to the current level in 2030. **30%** higher EE compared to the current level in 2050.	**20%** higher EE compared to the current level in 2030. **35%** higher EE compared to the current level in 2050.	Rising MEPS, rising star level. Support or incentive of buying high efficiency equipment, especially in rural areas. Energy labelling for commercial equipment. (specify the type of equipment and EE according to TCVN 10289:2014)
Industrial and transport refrigeration	**7%** higher EE compared to the current level in 2030. **10%** higher EE compared to the current level in 2050.	**10%** higher EE compared to the current level in 2030.	Develop TCVN and MEPS for equipment. Standards for O&M through recognised and accredited experts and a mechanism to monitor the performance of the industrial system.

Cooling sub-sector	Target for EE improvement to achieve NDC/NZT scenario	Target for EE improvement to achieve BAT scenario	Action to achieve targets
		15% higher EE compared to the current level in 2050.	

Source: Developed by consultant

Phasing out of HCFCs and HFCs is proposed as follows under the NGCP:

Table ES-2: HCFC and HFC reduction targets proposed under the NGCP

Refrigerant	Elimination Roadmap	Implementation period	Quota
HCFCs	Reduce 67.5% HCFCs	2025-2019	1,300 t per year
	Reduce 97.5% HCFCs	2030-2039	100 t per year
	Reduce 100% HCFCs	From 2040	0 t per year
HFCs	Fixed emission at baseline	2024-2028	14.0 $MtCO_2e$ emission from HFCs
	Reduce 10%	2029-2034	12.6 $MtCO_2e$ emission from HFCs
	Reduce 30%	2035-2039	9.8 $MtCO_2e$ emission from HFCs
	Reduce 50%	2040-2044	7.0 $MtCO_2e$ emission from HFCs
	Reduce 80%	From 2045	2.8 $MtCO_2e$ emission from HFCs

Source: Developed by consultant

The NGCP action plan proposed to enhance MEPS and expand Energy labelling system while strengthen monitoring activities, harnesses technical and financial resources from domestic and international sources, includes capacity building to eventually have 100% of technicians and management officers certified, and creates community awareness. With these responsibilities, The Ministry of Industry and Trade (MOIT) would spearhead implementation, collaborating with various ministries and stakeholders. NGCP also addresses targets related to gender equality and considerations regarding vulnerable groups that do not have access to modern cooling solutions.

The NGCP proposed to utilise grants, concessional loans and revenues from international and domestic carbon markets to overcome barriers including lack of incentives to promote EE projects, limited commercial financing, requirement for high collateral, complicated documentation and limited know-how and capacity to access finance sources. Instruments proposed including tax exemptions, preferential tax grants/subsidies (Green Credit Trust Fund, Green Investment Facility, Viet Nam Scaling up EE for Industrial Enterprise), loans (Viet Nam RE Development Project, blended finance program, special finance for industries, Sustainable Use of Natural Resources and Energy Finance, concessional and commercial loans). Revenues from sales of ITMOs and energy saving certificates will supplement the revenue supporting these instruments. Develop and implement mixed financing models such as Cooling as a Service, and Green on a wage similar to the one used in Ghana to promote eco-friendly fridges.

Key recommendations for moving forward with the NGCP

In order to move towards achievement of the objectives in the NGCP, the following activities are proposed:

1. Implementation of the Prime Minister's Decision on the Management Plan for phasing out Ozone Depleting Substances and controlled GHGs: The finalisation of the draft Decision is currently

underway by the DCC, MONRE to be submitted for approval and promulgation by the Prime Minister. Following this, DCC will be responsible for developing guidelines to implement the Decision. Continuous technical support will be essential to aid DCC in the formulation of the guidelines, organise training sessions and knowledge sharing for relevant stakeholders. This ongoing support is crucial for ensuring the successful short and long-term implementation of the Decision.

2. Mobilization of technical assistance/support to implement the Viet Nam's commitments under the Global Cooling Pledge.
3. Support for implementation of the pilots of investment projects in the green cooling: three financing models that seem to be most suitable for Viet Nam, under the different phases of the cooling value chain are recommended to be considered further for pilot activities as the following up activities after closing this TA, namely i) Cooling as a service ii) Trade in and iii) Generation and sale of ITMOs under Article 6.2 of the Paris Agreement.

1 INTRODUCTION

1.1 Background

1.1.1 Background and rationale

Cooling activities help reduce health problems caused by extreme heat, and at the same time, play an essential role in a number of other areas such as food preservation, distribution, or vaccine distribution. However, cooling activities, such as using AC and refrigeration constitute 20% of the world's electricity consumption (UNEP, 2023), standing out as a major catalyst for the global surge in electricity demand and one of the largest sources of greenhouse gas emissions.

Viet Nam, marked as one of the most densely populated nations globally, is undergoing rapid economic growth and urbanisation, emphasised by an increasingly warm climate with frequent hot days. This climatic shift has heightened the demand for sustainable cooling solutions. According to the World Bank Group, Viet Nam faced a staggering loss of over 10 billion USD in 2020, equivalent to 3.2% of its GDP, attributable to the impacts of climate change. Notably, a significant portion of this loss, 518 million USD or 4.7% of the total, resulted from increased cooling costs (World Bank Group, 2022).

This economic impact directly resonates among vulnerable groups, including the elderly, children, women, and individuals with low incomes, limiting their access to efficient and sustainable cooling technology. Despite the availability of inexpensive cooling devices in the market, their lack of efficiency translates to higher long-term costs and adverse environmental effects. Addressing this disparity requires proactive solutions and approaches to ensure fairness and equality in access to environmentally friendly cooling technologies.

In alignment with its commitment to achieving net-zero emissions by 2050, as declared at COP26 in 2021, Viet Nam has incorporated the cooling issue into subsequent national policies and strategies to fulfil this ambitious goal. The NDC 2022 specifically outlines mitigation measures related to cooling equipment such as ACs, refrigerators, as well as refrigerants. Additionally, Viet Nam has actively engaged in collaborative efforts to tackle these challenges, emphasising its dedication to creating a sustainable and equitable cooling landscape.

The MONRE is assigned as the national focal point for implementation of international commitments on climate change and ozone layer protection under treaties to which Viet Nam is a contracting party, including the implementation of the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement; to organise, examine and guide the management, consumption and elimination of ozone layer-depleting substances (ODS) and GHGs as specified in the Montreal Protocol on Substances that Deplete the Ozone Layer.

In recent times, Viet Nam has achieved many results in managing and controlling ozone-depleting substances used mainly in the production of cooling equipment. With the increasing trend of using greenhouse gases with high GWP - HFCs, which are used to replace HCFCs in many fields, on 4 September 2019, the Government issued Resolution No. 64/NQ-CP in order to phase down HFC consumption. HFC substances will be managed and eliminated from 2024, with no increase in consumption in the period 2024-2028, compared to the average consumption (of the three years 2020, 2021 and 2022); which decrease by 10% in the period 2029-2034; reduced by 30% in the period 2035-2039; reduced by 50% in the period 2040-2044; and reduced by 80% from 2045.

According to information published by the MONRE, the consumption of HFCs increased continuously in the period from 2015 to 2020 with a sudden increase in consumption in 2020 to more than 6 thousand tons. This increase in consumption slowed in 2021 due to the COVID-19 pandemic situation and continued

till 2022. The total average consumption of HFCs in the period 2020-2022 is about 57 thousand tons (equivalent to 10.7 million tons CO_2e). Although total consumption of HFCs in 2022 had only increased by about 2%, when converted to CO_2 equivalent, the increase is about 9%. This indicates that a significant amount of HFCs that cause high greenhouse gas (GHG) emissions are continuing to increase in use.

Decree No. 06/2022/ND-CP on GHG mitigation and ozone layer protection and Circular No.01/2022/TT-BTNMT on the details for implementation of Law on Environment Protection 2020 on climate change, both dated 07 January 2022, were promulgated by the Government and the MONRE respectively. Under Decree 06/2022/ND-CP, the National Plan for Management and Phase out of controlled substances will be developed and issued by the Government.

1.1.2 Scope of the TA

This assignment to develop the National Green Cooling Plan (NGCP) follows the Memorandum of Understanding signed by DCC, MONRE, and ETP on 21 June 2022. The scope of work for this assignment encompasses two primary components: i) conduct an in-depth study and survey to assess the current state including the technology available, market status, and international/national policies of the cooling sector in Viet Nam; and ii) based on the current state of the cooling sector, propose input to develop the NGCP to promote conversion to high EE and low carbon technologies and increase energy savings in the cooling sector.

The NGCP is envisioned to provide information and basis for national development goals, climate change strategies, and ozone layer protection initiatives, taking into consideration international commitments. The plan should be both comprehensive and coherent, serving as the foundation for the sustainable development goals of the NGCP to align with Viet Nam's NDC targets, the national NZT, and the United Nations Sustainable Development Goals.

As outlined in the contract signed with United Nations Office for Project Services (UNOPS), the assignment was scheduled to be completed within a 12-month timeframe, running from 24 February 2023 to 31 March 2024. The TA was implemented by the consortium comprising Energy and Environment Consultancy Joint Stock Company (VNEEC), EPRO Consulting Joint Stock Company (EPRO), and Perspectives Climate Group GmbH (PCG), collectively referred to as the Consultant. This consortium has been strategically assembled to maximise the collective expertise and capabilities of each firm, combining strong national qualifications and experiences from Viet Nam with international insights and lessons. This collaborative effort ensures the delivery of the assignment with the utmost quality and effectiveness. As outlined in the contract the Consultant signed with United Nations Office for Project Services (UNOPS), the TA was completed within a 12-month timeframe, running from 24 February 2023 to 31 March 2024.

The assignment covers the cooling sector/sub-sectors in Viet Nam, which are defined and categorised based on international practice, the standards on EE in Viet Nam, and the practices of the industries. However, some adjustments to the scope were made when implementing the TA due to the difficulties encountered in classifying cooling equipment. Specifically, the residential AC sub-sector was renamed as the residential and commercial AC sub-sector to cover a wider range of ACs, including both residential and commercial purposes. This change was clarified in Milestone Report 2 during task 3 of the assignment. Table 1 presents the revised classification of the targeted cooling sector/sub-sectors under the NGCP.

Table 1: The revised targeted cooling sector/sub-sectors under this Assignment

No.	Cooling sector/ sub-sector	Definition
1	**AC**	
1.1	Residential and commercial AC	• Non-ducted single-split residential and commercial AC (cooling capacity of 2- 15 kW), which consists of a compressor/heat exchanger unit, known as the condensing unit, which is installed outside the area where cooling or heating is required. The outdoor unit is connected to a fan-coil unit inside the conditioned space. This fan-coil unit is typically wall-mounted, but it can also be installed on the ceiling or floor. • Window AC (small self-contained type ranging from 1-10 kW of cooling sector).
1.2	Central AC and chiller	• Central AC: Multi-split AC (a single outdoor unit may feed two or more indoor units). Variable Refrigerant Volume (VRV)/Variable Refrigerant Flow (VRF) systems are a sub-category of the multi-split AC systems. • Chillers: what distinguishes chillers from other ACs, and refrigeration systems is the cooling of a secondary coolant that is then distributed and used to cool air or another substance. The critical distinction is indirect cooling contrasted with direct cooling of air (as in residential and commercial AC) or other substances (common in industrial refrigeration).
1.3	MAC	AC systems in road transport vehicles (cars, trucks, and buses).
2	**Refrigeration**	
2.1	Domestic refrigeration	Domestic refrigeration appliances include refrigerators and freezers used to store frozen food and beverages. Most domestic appliances are self-contained refrigeration systems that are produced completely in factories.
2.2	Commercial refrigeration	• Stand-alone equipment: self-contained refrigeration systems; comprises a wide variety of appliances such as ice-cream freezers, ice machines, vending machines, and display cases. • Condensing unit systems: comprise one or several compressors, an air-cooled condenser (usually), a receiver, and a liquid line to be connected to the refrigeration circuit. Condensing units are designed for several capacities and are standardised equipment.
2.3	Industrial refrigeration	• Condensing units: exhibit refrigerating capacities ranging typically from 1 kW to 20 kW. • The refrigeration systems are characterised by heat extraction rates in the range of 100 kW to 30 MW. • Centralised and distributed systems are the preferred options in supermarkets.
2.4	Transport refrigeration	Refrigeration systems in trucks, trailers, and refrigerated containers, refrigeration.

Source: RTOC, 2018

1.1.3 Progress and achievement of the TA

The implementation of the TA is divided into 4 Milestones with the summary of the key activities and results as follows:

1.1.3.1 Milestone 1: Inception Report

Task 1: Inception Report

- Activity 1.1: Conduct inception kick-off meeting
    - The inception kick-off meeting was held on 1 March 2023 with the participation of ETP, VNEEC, PCG, and EPRO to introduce members of the Consortium to the ETP team, give a short overview of the project, the detailed approach and an update on inception report outline; and discuss with ETP on issues related to the project, especially activities in the inception phase.

- Activity 1.2: Preparing inception report and updating the work plan
    - The Inception Report was developed based on the work plan considering the context of the cooling sector of Viet Nam and was approved by ETP on 20 April 2023.

1.1.3.2 Milestone 2: Milestone Report 2

Task 2: Organise an Initial Stakeholder Workshop including the participation from financial institutions

- Activity 2.1: Mapping the participants
    - A stakeholder mapping was conducted to identify the participants for the Initial Stakeholder Workshop or Inception Workshop.

- Activity 2.2: Organising a stakeholder consultation workshop
    - The Initial Stakeholder Workshop or Inception Workshop was successfully organised on 11 May 2023 with the participation of 79 stakeholders from relevant line ministries, enterprises, associations, universities, financial institutions, and international organisations with 40 females.

Task 3: Conduct a national data survey, compilation, and analysis

- Activity 3.1: Conducting the national and sectoral top-down stocktaking of data
- Activity 3.2: Conducting surveys to collect bottom-up data
- Activity 3.3: Establishment of baseline for the country in terms of EE and emissions of the cooling sector in Viet Nam
    - A national database from 2018 to 2022 was developed that included data from various sources including the surveys conducted under this TA, reports, statistics, and other publications. The data was then compiled and analysed using appropriate methods and tools to ensure its accuracy and relevance.

Task 4: Conduct the assessment and projections of growth in cooling sectors/sub-sectors based on different criteria

- Activity 4.1: Develop a BAU scenario from 2022 to 2050 of the cooling sector based on chosen criteria
- Activity 4.2: Organise the Second Consultation Workshop
    - Organised on 07 Nov 2023 with the participation of 46 stakeholders from relevant line ministries, enterprises, associations, universities, financial institutions, and international organisations with 20 females.

- Activity 4.3: Prepare the Milestone Report 2
    - Report approved by ETP on 22 Dec 2023

1.1.3.3 Milestone 3: Milestone report 3

Task 5: Conduct sector/sub-sector review (refrigerants, technologies, regulatory, policy) and gap analysis

- Activity 5.1: Technology review and analysis
- Activity 5.2: Using the PAMS model to establish different growth scenarios and gap analysis

Task 6: Develop the NGCP and its roadmap

- Draft of NGCP including roadmap for stakeholder consultation
- Within the framework of TA, the consultant had provided technical contributions to the two draft decisions of the Prime Minister: i) Draft Decision on promulgation of a National Plan on Management Plan for phasing out Ozone Depleting Substances and controlled GHGs ii) Draft Decision on promulgation of regulations on environmental criteria and confirmation of projects granted green credit and issuance of green bonds. The two Prime Minister's Decisions are expected to be issued in April 2024.

Task 7: Conduct a review and analysis of financing, implementation approaches & business models

- Activity 7.1. Development of options for scaling up transformation
- Activity 7.2. Identification of business models and sources of finance
- Activity 7.3: Selection of 1-3 business models plus financial instruments
- Activity 7.4: Consultation with financing institutions

Task 8: Consultation workshops on the draft NGCP and its roadmap

- Activity 8.1: Organising the third consultation workshops
    - A consultative Meeting was held offline in private on 22 January 2024 with the participation of 39 stakeholders from relevant line ministries, enterprises, associations, universities, financial institutions, and international organisations with 15 females.
- Activity 8.2: Revising NGCP based on comments from the third consultation workshop
- Activity 8.3: Prepare the Milestone Report 3
    - Report submitted on 28 March 2024

1.1.3.4 Milestone 4: Final Report

Task 9: Final report and final workshop

- Activity 9.1: Developing the final closing report
    - The final report is expected to be submitted to ETP by the end of March 2024
- Activity 9.2: Organising the final meeting
    - The final meeting was held on 22 March 2024 with the participation of 38 stakeholders from relevant line ministries, agencies, and ETP with 19 females.

The following Table summarises the deliverables completed throughout this assignment.

Table 2: Summary of deliverables completed

Deliverable	Tasks included	Implemented time
Deliverable 1 Inception Report	Task 1: Inception report and project work plan	Mar-Apr 2023
Deliverable 2 Milestone Report 2	Task 2: Organise an Initial Stakeholder Workshop including the participation from financial institutions Task 3: Conduct a national data survey, compilation, and analysis Task 4: Conduct the assessment and projections of growth in cooling sectors/sub-sectors based on different criteria	Apr-May 2023
Deliverable 3 Milestone Report 3	Task 5: Conduct sector/sub-sector review Task 6: Develop the NGCP and its roadmap Task 7: Conduct review & analysis of financing, implementation approaches & business models Task 8: Consultation workshops on the draft NGCP and its roadmap	Nov 2023-Jan 2024
Deliverable 4 Final Report	Task 9: Final report and final meeting	Jan-Mar 2024

Source: Compiled by Consultant

1.2 Objectives of the report

The primary objective of this report is to summarise and convey the results and suggested courses of action derived from the assignment to a diverse group of audience, with a particular focus on policy-makers and key relevant stakeholders. By presenting the results and main findings of the TA, the report aims to offer valuable assessment of the cooling sector in Viet Nam, helps supplement the scientific foundation facilitating informed decision-making processes for policymakers.

1.3 Methodology

1.3.1 Approach and Methodology

The following methodology is applied throughout the implementation of the assignment:

Desk review: In the initial phase, a comprehensive review of scientific research related to cooling technologies and practices was conducted. Additionally, insights were gathered by studying published reports and refrigeration programs implemented in various countries to learn from international experiences.

Data Compilation: Two major national surveys were carried out to gather crucial information. The first is a market survey aimed at understanding device characteristics and pricing, essential for subsequent modelling and calculations. The second involves survey questionnaires distributed directly to entities involved in manufacturing, importing, and distributing cooling equipment in Viet Nam. Data is also inherited from previous projects, including information on HFCs and HCFCs from the World Bank, the National Greenhouse Gas Inventory (base year 2016) from GIZ and The Kigali Cooling Efficiency Program (K-CEP), etc.

Stakeholder Consultations: Engagement with relevant stakeholders is a pivotal step in the methodology. Direct consultations were held with line ministries, departments, associations, universities, and entities directly involved in the cooling sector. This ensures a holistic understanding of the industry and collect valuable insights from key players.

Data Processing: The collected data was then organised into five distinct groups, encompassing market analysis, GHG emission calculations, energy consumption data, and social impact data with a focus on vulnerable groups, gender information, and access to the cooling equipment. Excel was utilised for data processing and modelling to maintain accuracy and reliability.

Modelling: The models based on the Policy Analysis Modelling System (PAMS) model and InterGovernmental Panel on Climate Change (IPCC) Methodology are employed for modelling all sub-sectors. The PAMS model is designed to be open-source and customisable. Customisation ensures alignment with the socio-economic landscape and specific parameters of the cooling industry in Viet Nam. The models are adapted to encompass sub-sectors beyond ACs and refrigerators, to develop three distinct growth scenarios.

Draft Results: A consultation workshop was organised to present preliminary results. Stakeholders were invited to provide feedback and opinions on the findings of the Consultant. This feedback was then incorporated into the final analysis and results to enhance the comprehensiveness and accuracy of the study.

Final Results: The synthesis of feedback culminates in the publication of the final results.

This approach ensures transparency and accountability in the study's methodology and outcomes. The overall methodology is summarised in Figure 2.

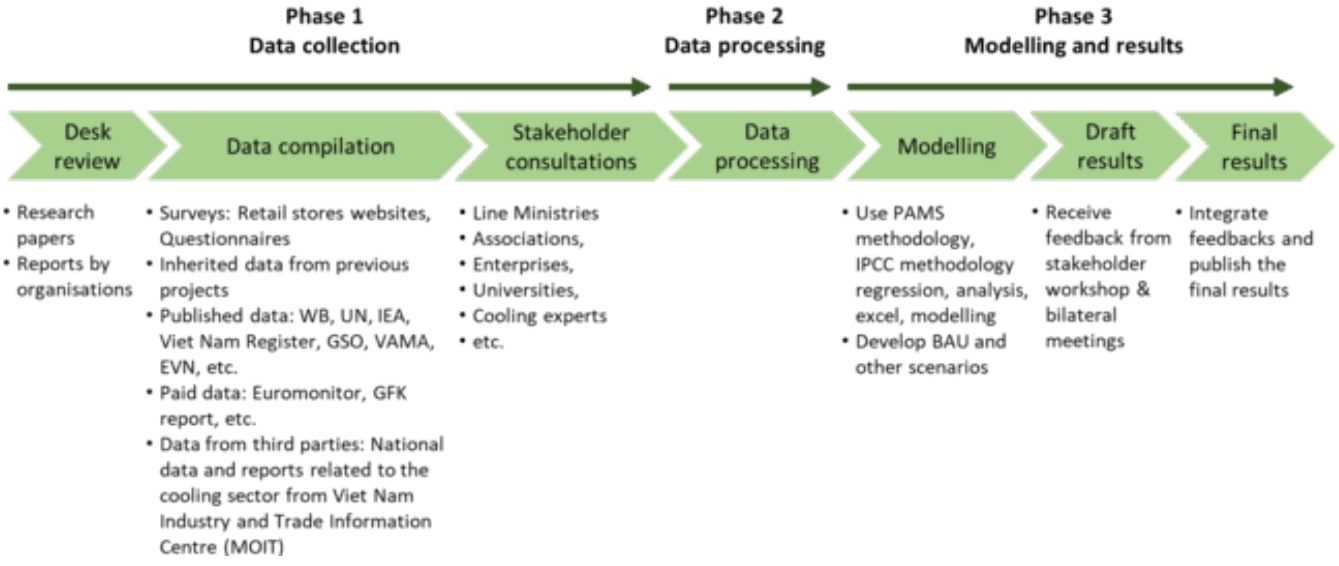


Figure 1: NGCP Methodology

Source: Compiled by Consultant

1.3.2 Scenarios establishment

In this assignment, three scenarios were developed for the NGCP to identify the status of the cooling sector and the gaps to achieve the NDC target in 2030 and NZT in 2050, based on the data collected, and the projections of growth in cooling sectors/sub-sectors. Only commercially available technologies and equipment are considered when establishing the scenarios. The description of the scenarios is detailed as follows:

Table 3: Description of scenarios with the corresponding policies and consideration

Scenarios	Description
Business-as-usual (**BAU)**	The BAU scenario projects the current trend and the development of the market, as follows: • Continued trend of **autonomous improvement** of EE (based on the market survey from 2018-2022, at 0-0.5% per year). • Refrigerant use: HCFCs (R-22, R-123) **elimination pathway** (0% of HCFCs in 2040), and **HFCs reduction** trend (replacing by natural refrigerants such as R-600a, R-290, R-717 and HFOs such as R-1234yf etc.). • an annual **reduction of GEF,** based on the **historical data from 2015-2021** of **2%**. • The current market trend on **electrification** (MAC using electricity instead of gasoline and diesel oil). Policies already implemented in Viet Nam before 2022 including VNEEP1 and VNEEP2 and the list of equipment for disposal and ban (Decision 78/2013/QD-TTg and the succession decision No. 24/2018/QD-TTg), the HCFCs elimination and HFCs reduction according to Montreal Protocol and Kigali Amendment etc.
NDC target in 2030 and NZT in 2050 scenario **(NDC/NZT)**	This scenario will take into account the **NDC target by 2030** and **NZT by 2050:** • The **target EE** as per the NDC and the supporting policies for NDC such as the National Programme on Economical and Efficient Use of Energy 2019-2030 (VNEEP3 - Decision 280/QD-TTg). • **Refrigerant use: More ambitious** HCFCs elimination pathway and HFCs reduction pathway (replaced by natural refrigerants such as R-600a, R-290, R-717 and HFOs such as R-1234yf etc. **20% of refrigerant will be recovered in 2030** according to I5s options. • The **GEF** is based on PDP8 and the Viet Nam political declaration for JETP. • **30% of vehicles in 2030** use electricity **Global Cooling Pledge** of COP28: reducing cooling-related emissions across all sectors by at least 68% globally relative to 2022 levels by 2050.
BAT	• The **target EE** is aligned with **the BAT on the national and international markets**. • **Refrigerant use:** BAT in O&M to reduce operational leakage. The **GEF** is based on the PDP8 and the Viet Nam political declaration for JETP.

Source: Compiled by consultant

2 NATIONAL DATA SURVEY

The national survey under this TA was conducted with two approaches to develop a top-down database and bottom-up database. The survey approach is presented in Figure 2.

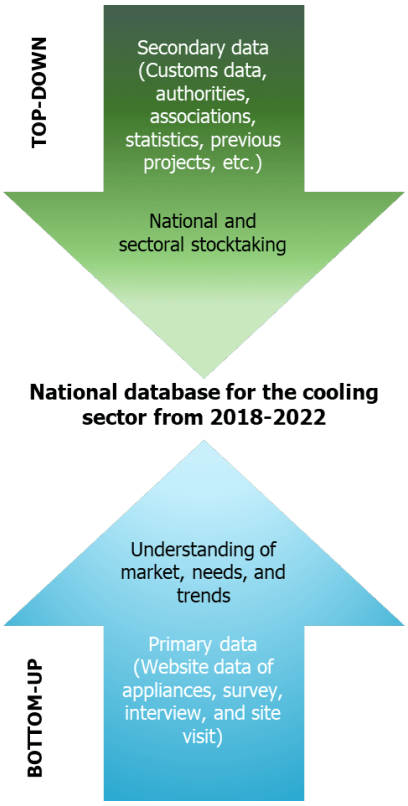


Figure 2: National data survey approach

Source: Developed by consultant

The data collection and survey were conducted after the Inception workshop on 11 May 2023. During the period of May to September 2023, the data collection including the market survey and questionnaire was conducted in parallel with the data processing while the stakeholder consultations were done from July to August 2023.

Table 4 summarise the synthesis sales quantity of cooling equipment for the period 2018-2022.

Table 4: Synthesis sales quantity of cooling sub-sectors (units)

No.	Sub-sector	Quantity (number of units sold)				
		2018	2019	2020	2021	2022
1	Residential and commercial AC	1,898,000	2,530,000	2,627,186	2,433,767	2,542,813
2	Central AC and chiller	12,294	13,617	14,065	13,069	14,752
3	MAC	398,699	507,413	374,112	383,398	509,141
4	Domestic refrigeration	2,513,454	2,375,321	1,991,615	2,040,237	2,307,390
5	Commercial refrigeration	561,216	491,325	477,210	515,491	517,771
6	Industrial refrigeration	7,281	7,834	8,564	6,969	9,751
7	Transport refrigeration	2,626	2,838	2,791	2,892	2,918
	Total	**5,393,570**	**5,928,348**	**5,495,543**	**5,395,823**	**5,904,536**

Source: Compiled from Customs data

The development of a country, as well as the driving force behind the growth of the cooling sector, is reflected in indicators such as gross domestic product (GDP), the increase in household numbers, and the rate of urbanisation. Table 5 lists Viet Nam's GDP indicators for the period 2018-2022.

Table 5. Key socio-economic indicators from 2018-2022

Item	2018	2019	2020	2021	2022
GDP per capita (USD/person, 2015)	3,090.8	3,288.4	3,352.1	3,409	3,655.5
GDP growth (%/year)	6.5	6.4	1.9	1.7	7.2
GDP (Billion USD, 2015)	293.36	314.95	323.97	332.27	358.91

Source: World Bank, 2023

Social data

According to the statistics of the General Statistics Office of Viet Nam (GSO), as of 2022, Viet Nam's population is approximately 99.46 million, with 37.6% living in urban areas and 62.4% in rural areas. Income inequality has worsened, with the GINI coefficient[1] rising from 0.35 in 2018 to 0.37 in 2022. The wealthiest 20% of households earn 7.6 times more than the poorest 20% (GSO, 2022).

In terms of cooling appliances, 77.6% of urban households own ACs, while 91.3% own refrigerators. In rural areas, ownership rates are lower, at 35.1% for ACs and 82.0% for refrigerators (GSO, 2020).

3 STAKEHOLDER MAPPING

The stakeholder mapping related to the cooling sector for the assignment has been identified in the Inception Report and updated via the national data survey along with the consultations with the relevant stakeholders. The stakeholder mapping is illustrated in Figure 3.

[1] The GINI coefficient is created by two factors: The cumulative income ratio of the population and the corresponding cumulative population ratio. The closer the GINI coefficient is to 1, the greater the income inequality within the population.

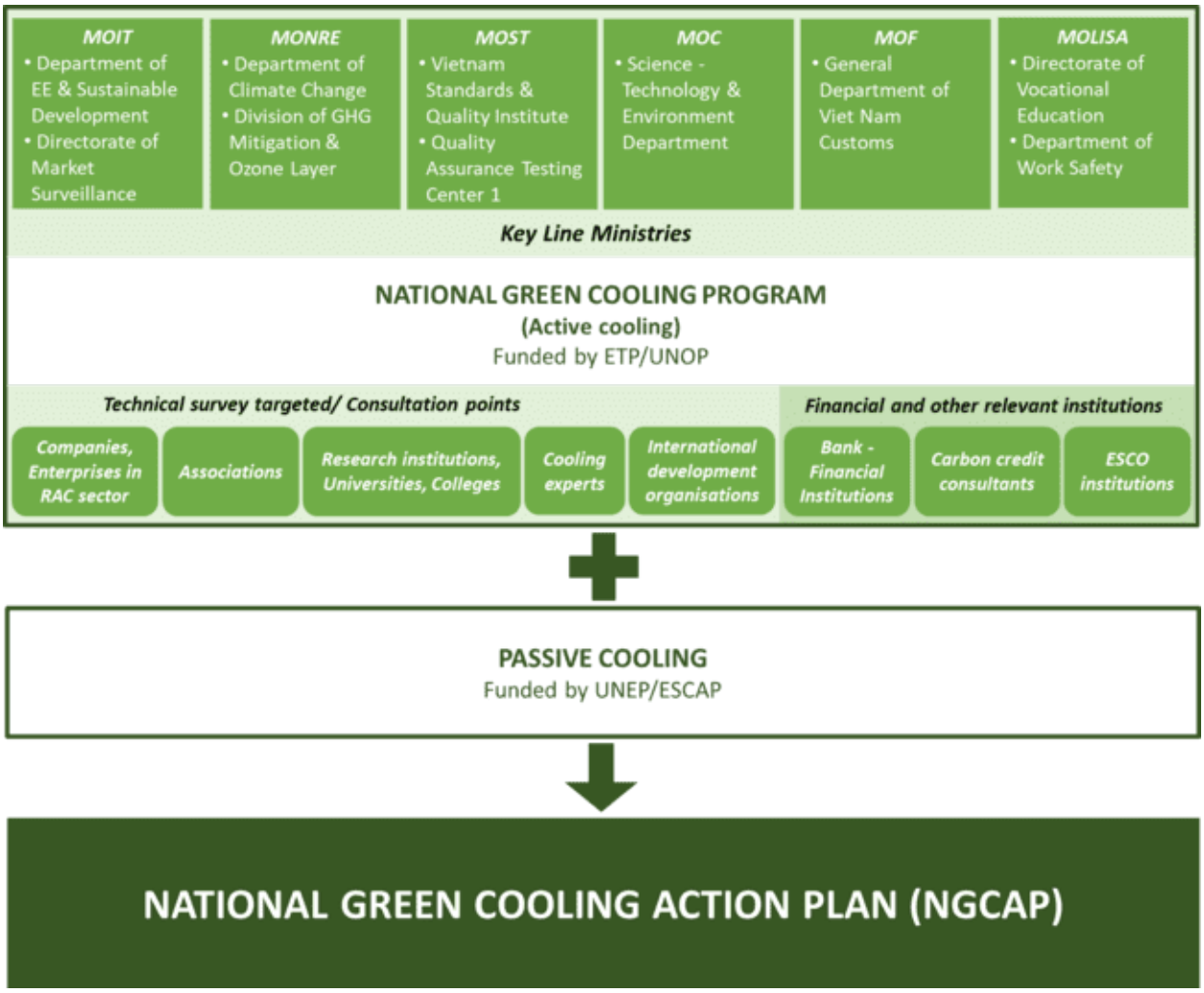


Figure 3: NGCP Stakeholder mapping

Source: Compiled by the Consultant

NGCAP addresses the challenges in the cooling sector to move towards more sustainable cooling practices is expected to be developed upon the integration of active cooling interventions focusing on improving efficiency and transition towards low GWP refrigerants (NGCP funded by ETP) and a passive cooling program including nature-based solutions, space cooling and food cold storage (program currently developed by UNEP). This collaboration between ETP and UNEP will help Viet Nam develop a comprehensive green cooling action plan, as well as contribute to the NDC and NZT targets.

4 VIET NAM COOLING PROFILE

The recent increase in population, economic growth, fast urbanisation, along with global warming phenomenon have resulted in dramatic growth in the demand for RAC in Viet Nam. These indicators strongly suggest that the anticipated growth in urbanisation, coupled with increasing GDP per capita and overall economic expansion, will drive a heightened demand for RAC appliances in the coming years.

Through internal analysis from the import, export and production data, the RAC sector in Viet Nam has an annual growth rate of around 2.3% in the five years period of 2018-2022, in which the residential and commercial ACs sub-sector had the highest annual growth rate of 7.6%. The total import/manufacturing of RAC equipment in this period has increased from 5.4 million to more than 5.9 million units. This has been worsened due to the recent trend of consecutive hottest recorded years.

Furthermore, the importance of the cooling sector has heightened significantly as the economy of Viet Nam pivots towards digitalisation, smart manufacturing, and high-tech production facilities. This leads to the increase in demand for controlled environmental conditions including the cooling demand, particularly in clean rooms, to ensure optimal operational capacities for equipment and machinery. Additionally, the critical role of the refrigeration sector in food processing, storage, transportation, preservation, and distribution has been vividly underscored during COVID-19. During the pandemic, when numerous manufacturing sectors experienced downturns, the RAC industry in Viet Nam exhibited sustained and sizable growth, emerging as the largest within the ASEAN region. Despite experiencing a decline during COVID-19, the RAC sector's growth trajectory remained notably high (Viet Nam Economic News - MOIT, 2023).

The cooling sector is a big energy consumer. In 2022, the TEC of the cooling sector was 71.38 TWh, of which electricity consumption was 65.95 TWh. In addition, 0.71 million m^3 of diesel and 1.23 million m^3 of gasoline were consumed (MAC and Transport Refrigeration). According to the Viet Nam Electricity (EVN) annual report 2022 (EVN, 2022), the total power production and purchase in Viet Nam is 261.686 TWh, which shows that RAC sectors account for about 25.2% of TEC.

Figure 4 below shows the proportion of energy consumption of all sub-sectors (converted to TWh for comparison).

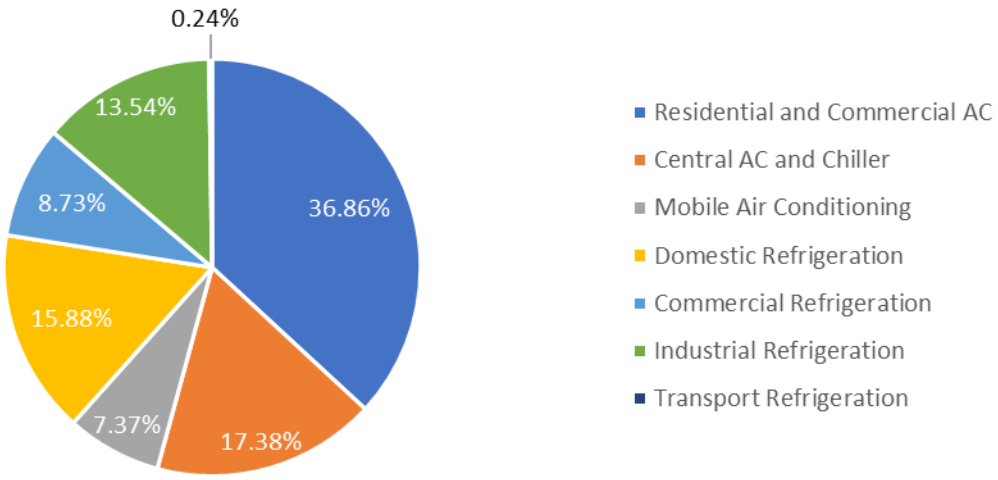


Figure 4: Proportion of energy consumption of cooling sub-sectors in 2022

Source: Compiled from the database of the survey

In 2022, the RAC sector in Viet Nam accounted for 64.68 $MtCO_2e$ of GHG emissions, of which 10.16 $MtCO_2e$ were direct emissions and 54.52 $MtCO_2e$ were indirect emissions, i.e., through energy consumption (15.7% and 84.3% of total GHG emission from the RAC sector, respectively). The total BAU GHG emission for the cooling sector in 2022 is presented in Figure 5.

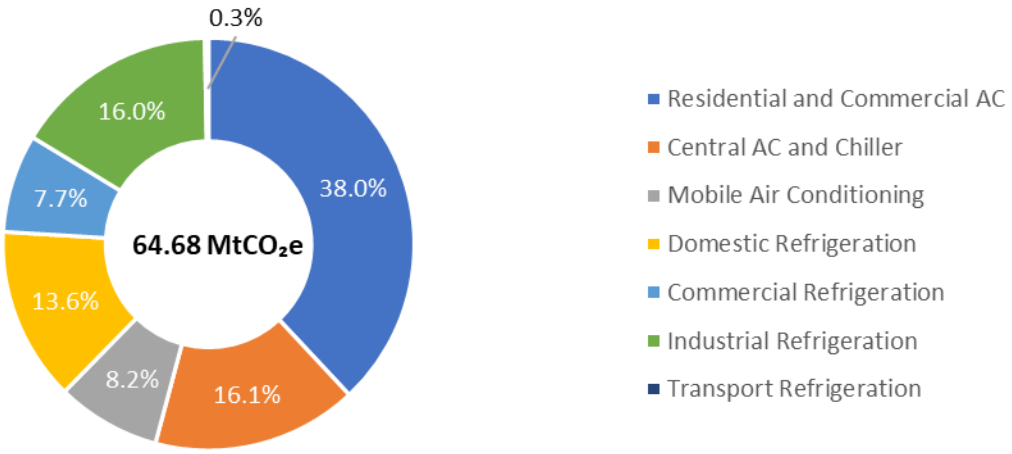


Figure 5: Total BAU GHG emission for the cooling sector in 2022

Source: Compiled from the database of the survey

Figure 5 shows that emissions from the residential and commercial AC sub-sectors account for the largest share of emissions in the cooling sector (38.0%), followed by Central AC and Chiller and industrial refrigeration with around 16% of the total emissions. Given the residential and commercial AC market is growing rapidly, and the recent high sales trend is expected to continue in the future, residential and commercial AC emissions will keep its position as the top emission sub-sector until 2050 (see Figure 6).

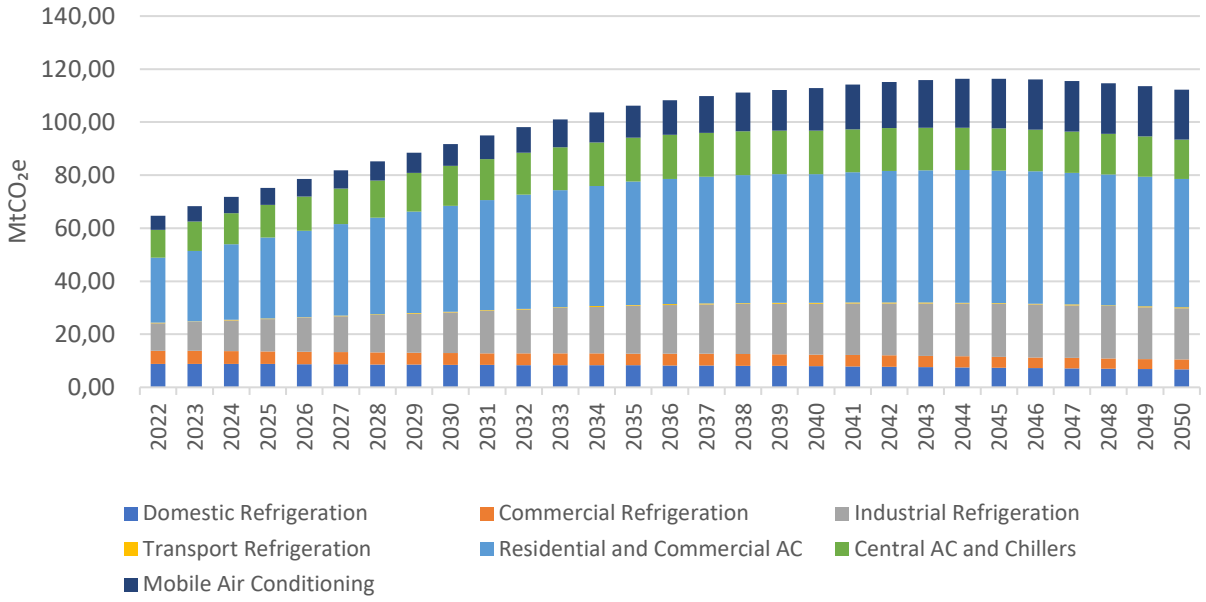


Figure 6: The development of BAU emissions of the cooling sector in Viet Nam from 2022 to 2050

Source: Compiled from the database of the survey

According to Viet Nam's NDC 2022, in BAU, in 2025, the projected emission for the energy sector is 500.7 $MtCO_2e$ and the total emissions are 726.2 $MtCO_2e$. In 2030, the projected emission for energy is 678.4 $MtCO_2e$ and the total emissions is 927.9 $MtCO_2e$ (NDC, 2022). To have a big picture of how the cooling

sector/sub-sectors contributed to the national emission, Table 6 and Table 7 summarise the share of emissions from cooling in comparison to the NDC baseline.

Table 6: Share of cooling sub-sector emissions from energy use in comparison to the energy sector emissions of NDC baseline

Sub-sector	Indirect emissions ($MtCO_2e$)		Share of NDC BAU energy sector emissions (%)	
	2025	2030	2025	2030
Residential and commercial AC	24.78	32.83	4.95%	4.84%
Central AC and chiller	10.91	12.96	2.18%	1.91%
MAC	5.41	7.01	1.08%	1.03%
Domestic refrigeration	8.62	8.47	1.72%	1.25%
Commercial refrigeration	4.58	4.38	0.91%	0.65%
industrial refrigeration	8.66	11.16	1.73%	1.64%
Transport refrigeration	0.17	0.19	0.03%	0.03%
Total	**63.12**	**77.00**	**12.61%**	**11.35%**

Source: NDC, 2022

Table 7: Share of cooling sub-sector emissions in comparison to the national emissions of NDC baseline

Sub-sector	Total emissions ($MtCO_2e$)		Share of NDC BAU national emissions (%)	
	2025	2030	2025	2030
Residential and commercial AC	30.53	39.97	4.20%	4.31%
Central AC and chiller	12.32	15.04	1.70%	1.62%
MAC	6.35	8.17	0.87%	0.88%
Domestic refrigeration	8.80	8.47	1.21%	0.91%
Commercial refrigeration	4.79	4.42	0.66%	0.48%
industrial refrigeration	12.18	15.39	1.68%	1.66%
Transport refrigeration	0.20	0.24	0.03%	0.03%
Total	**75.18**	**91.70**	**10.35%**	**9.88%**

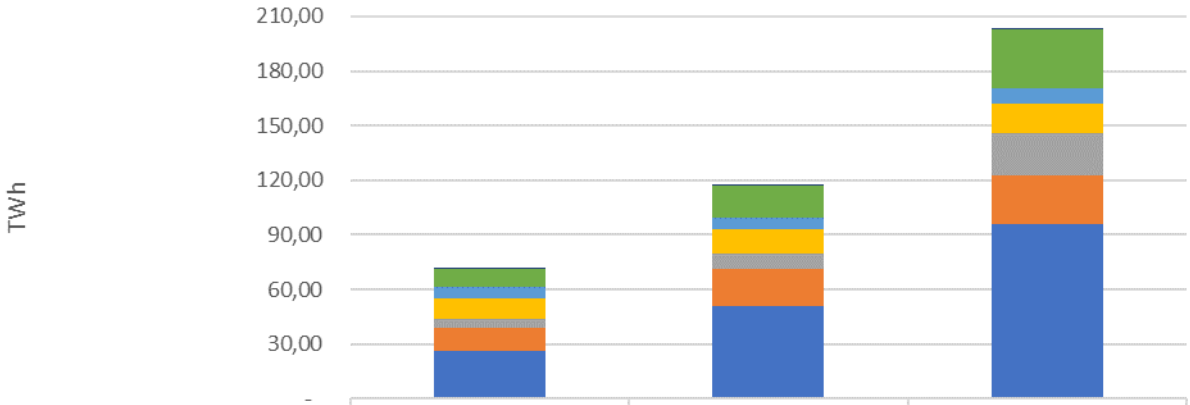
Source: NDC, 2022

The core factor which leads to the increase in CO_2e emissions is the increase in the number of cooling equipment. With the current trend, the number of cooling equipment will double in 2035 and to nearly 2.5 times in 2050 compared with the 2022 figures. The number of equipment results directly in the energy consumption and refrigerant use. The measures which help to reduce the emissions includes the reduction of the direct emissions, and the use of lower GWP refrigerants such as R-600a, R-290, R-717, etc. Compared to the NDC baseline the cooling sector BAU accounts for about 10.35% of national emissions in 2025 and shows a reduction trend. This demonstrates that the cooling sector as per the latest BAU is already lower than the NDC BAU, due to the implementation of measures such as EE, RE transition, and phased out high GWP refrigerants. This shows a very positive figure about Viet Nam actions in the cooling sector, but it is not enough to achieve the NDC target in 2030 or the NZT target in 2050. More ambitious actions with a clear roadmap are needed to achieve these targets.

5 BAU SCENARIO PROJECTION OF THE COOLING SECTOR IN VIET NAM FROM 2022 TO 2050

The cooling sector emissions in 2022 are 64.68 $MtCO_2e$, projected to rise to 91.7 $MtCO_2e$ in 2030 (accounting for 9.88%) as per the NDC BAU scenario. Direct emissions contributed 15.7%, while indirect emissions contributed 84.3% in 2022. The share of indirect emissions is a significant contributor to total cooling emissions, influenced by Viet Nam's relatively high GEF, which was 0.7221 tCO_2/MWh in 2021. From 2022 to 2050, the total cooling sector emissions are expected to double with the peak of emissions in 2045, with the consideration to the current trend of GEF reduction. In 2050, residential and commercial ACs are expected to have the highest emission share, due to the growing penetration of ACs in residential areas. In the Refrigeration sector, industrial refrigeration holds the largest share. Overall, there is a general trend toward transitioning to lower GWP refrigerants, although the adoption of natural refrigerants or zero GWP is minimal without strong policy incentives. There is an increasing dominance of inverter technology across the cooling sector and by 2050, the market is expected to comprise higher efficiency inverter models.

To achieve the NDC and NZT, it is imperative to reduce the indirect emissions, which constitute nearly 85% of the total emissions. This necessitates upgrading EE levels for residential and commercial AC, domestic refrigeration, and the adoption of MEPS in sub-sectors such as industrial refrigeration, MAC, commercial refrigeration, and transport refrigeration. Direct emissions require a focus on control measures and market instruments to be able to transition towards natural refrigerants with zero GWP. Additionally, through dedicated waste disposal centres disposal emissions can be minimised. Capacity building, training, and granting certification for service technicians contribute to the reduction of servicing emissions in the RAC sector. Based on these measures, scenarios like NZT and BAT are modelled for impact assessment. assess their impact



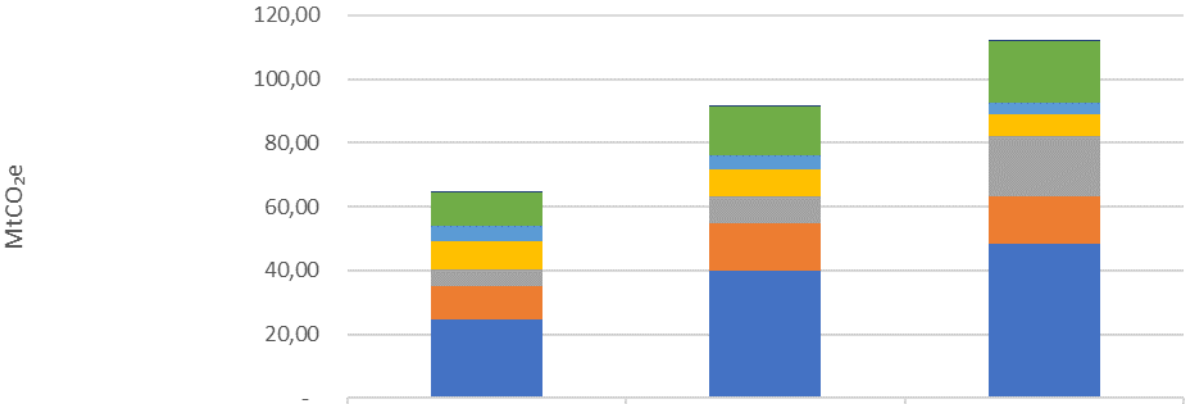
	2022	2030	2050
Transport Refrigeration	0,17	0,22	0,30
Industrial Refrigeration	9,67	17,37	32,41
Commercial Refrigeration	6,23	6,81	8,52
Domestic Refrigeration	11,33	13,19	15,74
Mobile Air Conditioning	5,26	8,37	23,64
Central AC and Chiller	12,41	20,19	26,91
Residential and Commercial AC	26,31	51,12	95,69

Figure 7: Energy consumption by sub-sectors (TWh)

Source: Compiled from the database of the survey

The details of energy consumption by sub-sectors are presented in Figure 7. The cooling sector is a big energy consumption sector in Viet Nam. In 2022, the sector consumed 65.95 TWh of electricity (25.2% of total electricity bought and generated by EVN), 0.71 million m^3 of diesel and 1.23 million m^3 of gasoline. Energy consumption is projected to triple by 2050 with the increase in cooling demand.

The GHG emissions from all sub-sectors are summarised in Figure 8.



	2022	2030	2050
Transport Refrigeration	0,19	0,24	0,33
Industrial Refrigeration	10,37	15,39	19,36
Commercial Refrigeration	4,98	4,42	3,71
Domestic Refrigeration	8,82	8,47	6,75
Mobile Air Conditioning	5,28	8,17	18,87
Central AC and Chiller	10,44	15,04	14,91
Residential and Commercial AC	24,59	39,97	48,39

Figure 8: GHG emission from all sub-sectors ($MtCO_2e$)

Source: Compiled from the database of the survey

Regarding the use of refrigerants, HFCs are currently dominating the market, especially for Commercial and Residential AC, and Central AC and Chiller sub-sectors. R-22 and R-123 are the only HCFCs in use, mainly in industrial refrigeration and will be quickly phased out and completely replaced by HFCs and natural refrigerants by 2040. Natural refrigerants such as R-600a and R-290 are gradually increasing and becoming dominant in domestic refrigeration. R-717 (NH_3) is being utilised in large industrial refrigeration systems.

6 GROWTH SCENARIOS PROJECTION AND GAP ANALYSIS OF THE COOLING SECTOR IN VIET NAM TOWARD NDC 2030 AND NZT 2050

6.1 Targets and actions to increase EE under the scenarios

The targets and actions are proposed to increase EE in comparison with the cooling sector BAU, while in line with options mentioned in the NDC and policies supporting the NDC. Table 8 summarises the specific targets across the 7 sub-sectors of cooling according to the current policies of Viet Nam.

Table 8: Current targets related to the improvement of EE in cooling sectors

Cooling sector/ sub-sector	Current NDC targets for Cooling Sectors
Overall target related to the cooling sector (Energy sector)	**Emission reduction target of the energy sector** in NDC: **7%** (unconditional contribution) and **24.4%** (conditional contribution with international support). Emission reduction potential compared with BAU is cumulative 382.66 $MtCO_2e$ in the 2021-2030 period and 64.78 $MtCO_2e$ in 2030. **Energy consumption reduction target** according to **VNEEP3 (support for NDC)** (Decision 280/QD-TTg): achieve energy saving of **5-7% of total energy consumption in the** 2019-2025 period, and **8-10%** in the **2019-2030 period**.
Residential and commercial AC	**NDC option E1**: By 2030, highly efficient AC will reach 85% of the total households (or 11.4 million households) which have AC in urban areas and reach 75% (or 12.5 million households) in rural areas. The high EE AC is 30% more efficient compared to the AC model of the base year (2014). Emission reduction potential compared with BAU is 9.16 $MtCO_2e$ in the 2021-2030 period and 2.37 $MtCO_2e$ in 2030. **Global Cooling Pledge for COP28:** global average efficiency rating of new AC equipment sold by **50%** by at the latest 2030 from global 2022 installed baseline.
Central AC and chiller	**NDC option E27:** use high-efficiency equipment to reduce energy demand by 15% in 2030 in comparison with BAU
MAC	**NDC options E24** and **E26** increase the penetration rate of **EVs** by **30%** of total vehicles in 2030 (bus and car). **NDC option E17:** Limit fuel consumption for vehicles: small car: 4.7 L of gasoline/100 km, medium car 5.3 L of gasoline/100 km, big car 6.4 L of gasoline/100 km.
Domestic refrigeration	**NDC option E2**: By 2030, highly efficient refrigerators will reach 80% of all households (or 10.7 million households) having refrigerators in urban areas and 75% (or 12.5 million households) in rural areas. The high EE AC is 30% more efficient compared to the AC model of the base year (2014). Emission reduction potential compared with BAU is cumulative 4.19 $MtCO_2e$ in the 2021-2030 period and 0.87 $MtCO_2e$ in 2030.
Commercial refrigeration	**NDC options E27:** use high efficiency equipment to reduce energy demand by 15% in 2030 in comparison with BAU
Industrial refrigeration	No specific target
Transport refrigeration	No specific target

Source: Compiled by consultant

Table 9 summarises the proposed targets for each cooling sub-sector, in consideration of the current EE level, the best equipment on the market, the NDC targets and the global cooling pledge. These targets will be used to establish the scenarios and identify the gaps in policies and actions needed to achieve the targets in 2050.

Table 9: EE increase targets for cooling sub-sectors with corresponding interventions

Cooling sub-sector	Target for EE improvement to achieve NDC/NZT	Target for EE improvement to achieve BAT (%)	Action to achieve targets
Residential and commercial AC	**50%** higher EE compared to the current level in 2030. **80%** higher EE compared to the current level in 2050.	**60%** higher EE compared to the current level in 2030. **100%** compared to the current level in 2050.	Increase MEPS, rising star level, and incentive for buyers to buy highly efficient ACs.

Cooling sub-sector	Target for EE improvement to achieve NDC/NZT	Target for EE improvement to achieve BAT (%)	Action to achieve targets
			Market transformation through demand aggregation and targeted rollout in Government and private/retail sectors. Sustainable Public Procurement. Buyback of old and used cooling equipment and safe disposal/end of life.
Central AC and Chiller	**15%** higher EE than the current level in 2030. **20%** higher EE compared to the current level in 2050.	• Chiller: **18%** higher EE than the current level in 2030. **25%** higher EE compared to 2022 in 2050. • Central AC: **20%** higher EE compared to 2022 in 2030. **30%** higher EE compared to 2022 in 2050.	Including in the building EE policies (QCVN) which are not only limited to EE buildings (QCVN 09:2013/BXD). Implement a specific MEPS for VRV/VRF and other types of multi-split ACs. Develop new TCVN for chiller which includes MEPS. Develop standards for chillers O&M by recognised and accredited experts and a mechanism to monitor. An incentive to use higher efficiency types of equipment.
MAC	**30%** of cars in 2030 are EVs. **100%** of cars in 2050 are EVs. **30%** increase in the EE for MAC in 2030. **35%** increase in the EE for MAC in 2050.	**30%** of cars in 2030 are EVs. **100%** of cars in 2050 are EVs. **30%** increase in the EE for MAC in 2030. **35%** increase in the EE for MAC in 2050.	Develop TCVN for MAC or vehicles with MAC which includes MEPS. (MEPS for MAC or control via fuel efficiency MEPS of vehicles with MAC) Restrict importing old MAC equipment. Training and capacity building of technicians for the O&M of vehicles with MACs. Incentives for buying EVs.
Domestic and commercial refrigeration	**15%** higher EE compared to the current level in 2030. **30%** higher EE compared to the current level in 2050.	**20%** higher EE compared to 2022 in 2030. **35%** higher EE compared to 2022 in 2050.	Rising MEPS, rising star level. Support or incentive of buying high efficiency equipment, especially in rural areas. Energy labelling for commercial equipment (specify the type of equipment and EE according to TCVN 10289:2014).
Industrial and Transport Refrigeration	**7%** higher EE compared to the current level in 2030. **10%** higher EE compared to the current level in 2050.	**10%** higher EE compared to 2022 in 2030. **15%** higher EE compared to 2022 in 2050.	Develop TCVN and MEPS for equipment. Develop standards for O&M by recognised and accredited experts and a mechanism to monitor the performance of the industrial system.

Source: Compiled by consultant

6.2 Target and action about refrigerant use according to scenarios

Viet Nam has successfully implemented two phases of the HCFC Phase out Management Plan (HPMP I and HPMP II) which help to eliminate HCFCs and transition from HCFCs to alternatives (HFCs, HCs, HFOs, R-

717). The next phase, HPMP III, along with Kigali HFC Implementation Plans Phase 1 (KIP I) will be implemented. The specific targets for HCFCs and HFCs phase out are summarised in Table 10.

Table 10: Specific targets for HCFCs and HFCs phase out

Refrigerant	Elimination Roadmap	Implementation period	Quota
HCFCs	Reduce 67.5% HCFCs	2025-2019	1,300 t per year
	Reduce 97.5% HCFCs	2030-2039	100 t per year
	Reduce 100% HCFCs	From 2040	0 t per year
HFCs	Fixed emission at baseline	2024-2028	14.0 $MtCO_2e$ emission from HFCs
	Reduce 10%	2029-2034	12.6 $MtCO_2e$ emission from HFCs
	Reduce 30%	2035-2039	9.8 $MtCO_2e$ emission from HFCs
	Reduce 50%	2040-2044	7.0 $MtCO_2e$ emission from HFCs
	Reduce 80%	From 2045	2.8 $MtCO_2e$ emission from HFCs

Source: Compiled by consultant

The targets for scenario projection are considered with the current policies, the Viet Nam NDC target and the future HPMP III and KIP I. Table 11 summarises the targets for the cooling sub-sectors in comparison with the BAU.

Table 11: Targets related to refrigerant use with corresponding interventions

Cooling sector/ sub-sector	BAU	NDC/NZT and BAT
General	No recovery and recycling system in place. HCFCs and HFCs, the management and phaseout roadmap (according to Decree No. 06/2022/ND-CP).	***Achieve NDC I5/I5s option:*** Converting to lower GWP refrigerant. In 2030: 90% for domestic ACs, 50% for commerce and industrial ACs, 60% for domestic and commercial refrigerators, and 80% for industrial refrigeration. The rate of recovery, recycling, and disposal (without direct release) will be 20% in 2030. ***Proposed:*** The rate of recovery, recycling, and disposal (without direct release) will be 100% in 2050.
Residential and commercial AC	***Refrigerant in use:*** R-22, R-32, R-410A, R-134a, R-417A ***Transition path:*** All converted to R-32.	Introduce R-290 AC to the market in 2025 with the target of 5% penetration in 2030. Reach 80% penetration in 2050. Reduce refrigerant leakage via better O&M.
Central AC and chiller	***Refrigerant in use:*** Chiller: R-22, R-123, R-410A, R-407c, R-717 Central AC: R-407c, R-32, R-410A, R-22 ***Transition path:*** Mainly use HFCs and other available replacements (R-717)	Chiller: R-717, R-1234ze, R-1233zd, R-290. Central AC: R-1234yf, R-1234ze, HFOs blend with HFCs. Reduce refrigerant leakage via better O&M.
MAC	***Refrigerant in use:*** R-134a, R-1234yf, R-407c ***Transition path:***	Faster transition to R-1234yf (25% in 2030 and 100% in 2050). Reduce refrigerant leakage via better O&M.

Cooling sector/ sub-sector	BAU	NDC/NZT and BAT
	Slow conversion to R-1234yf due to high price. (7% in 2030 and 27% in 2050)	
Domestic refrigeration	***Refrigerant in use:*** R-600a, R-134a ***Transition path:*** Completely converted to R-600a in 2030	Completely converted all equipment to R-600a in 2029. Reduce refrigerant leakage via better O&M.
Commercial refrigeration	***Refrigerant in use:*** R-600a, R-134a, R-290, R-404a, R-407c ***Transition path:*** Complete transition to use R-290 and R-600a for standalone equipment in 2030. R-290 is used for small remote condensing equipment.	Large equipment and another refrigerant (HFOs: R-1234ze, R-1234yf and their blend with HFCs in transition phase). Completely eliminated HFCs from 2045. Reduce refrigerant leakage via better O&M.
Industrial refrigeration	***Refrigerant in use:*** R-134a, R-404A, R-407c, R-507A, R-410A, R-22, R-717. ***Transition path:*** - Transition to R-717, R-134a and R-404A still used for small equipment.	No new R-404A, R-507A, or R-410A equipment from 2029. From 2035 no new R-134a equipment. Reduce refrigerant leakage via better O&M.
Transport refrigeration	***Refrigerant in use:*** R-134a, R-404A (for frozen vehicle) ***Transition path:*** Not available.	From 2029 no new R-404A equipment needs to be replaced by a blend with lower GWP or R-744. From 2035 no new R-134a equipment needs to be replaced by R-1234yf or blend with GWP lower than 750. Reduce refrigerant leakage via better O&M.

Source: Compiled by consultant

6.3 Actions needed for NDC/NZT

The NDC/NZT targets for cooling sectors can be achieved through the adoption of the following actions.

6.3.1 Establish and revise MEPS and Energy Labelling categories

Currently, among all equipment in cooling sectors, only refrigerators, refrigerator-freezers and freezers, non-ducted ACs and commercial refrigerated cabinets have and implemented MEPS. VRV/VRF AC have TCVN about EE, but no MEPS is specified. The main reason is due to the lack of proper testing equipment capable of identifying the efficiency of VRV/VRF AC.

To reach the targets of increasing the EE, the MEPS is crucial to force manufacturers and importers to improve the efficiency of the equipment on the market. Also, the star rating for the retail equipment needs to be revised to match the autonomous increase in EE level.

For the cooling equipment with MEPS already implemented, the current MEPS will be high enough to reach the NDC/NZT targets on EE. In the global cooling pledge, the target for the EE increment of new AC equipment is set to 50% compared to the 2022 baseline. Hence, Viet Nam needs to be more ambitious about revising MEPS to be able to reach this target.

Currently, the average CSPF of AC ranges from 3.26 to 3.71 depending on the cooling capacity of the equipment; the larger equipment tends to have lower CSPF. The current MEPS for AC in Viet Nam is 2.8 to 3.1 depending on the cooling capacity. With the target of a 50% increment in average CSPF, it is estimated that the MEPS will need to increase 35% by 2030 (3.8 to 4.2). The cooling capacity vs. CSPF with MEPS line and star rating criteria in 2023 is presented in Figure 9.

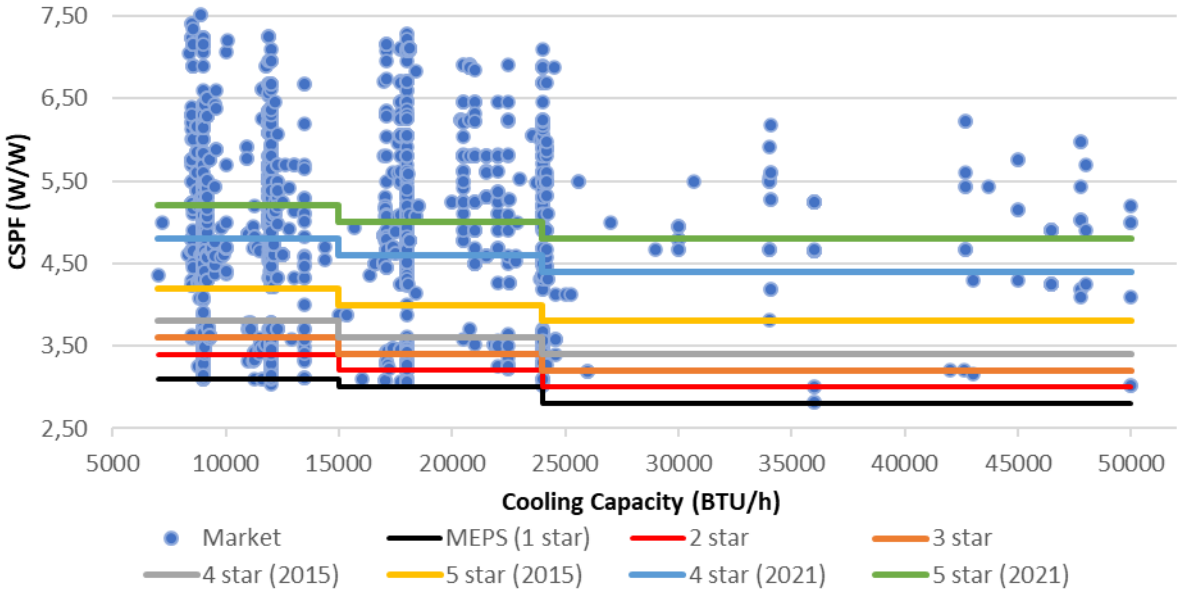


Figure 9: Cooling capacity vs. CSPF with MEPS line and star rating criteria in 2023

Source: Compiled from the database of the survey

The gap between the new TCVN released to the time the TCVN is applied for controlling MEPS is from 4-10 years and there is only a 6-year time gap to the target of 2030. The most recent Prime Minister Decision about MEPS revision is Decision No. 14/2023/QD-TTg released in 2023 and new MEPS will be applied from 2025. To achieve the 2030 targets. the TCVN needs to be developed and revised immediately and the next Prime Minister's Decisions about MEPS revision needs to be released in in the period of 2026-2029.

TCVN for chillers and industrial refrigeration equipment should be developed. In the QCVN 09:2017/BXD for National Technical Regulation on EE Buildings, the minimum efficiency required for central AC and chiller is required to follow the international standard but only applied for the EE buildings. The new TCVN standard for Central AC and Chiller needs follow the international standard mentioned in the QCVN 09:2017/BXD and applied to all the equipment on the market.

MAC and transport refrigeration equipment differ from other types of equipment because it is only part of other systems (car, bus, containers, transport refrigeration vehicles). Hence, it is not feasible and a waste of resources to develop and control MEPS for separate equipment. The efficiency of MAC and transport refrigeration equipment can be controlled via the minimum fuel efficiency of vehicles with MAC or transport refrigeration equipment.

6.3.2 Better O&M of the cooling system

Most EE programs focus on retrofitting or upgrading the equipment. Maintenance is also a source of EE improvement. Under the growth scenarios, the EE of the equipment is assumed to not reduce over time, but in real life, the performance will deteriorate if not properly operated and maintained. According to the research from the Florida Solar Energy Center about the performance degradation of AC systems, the median degradation rate estimated in the study was 5.2% per year for unmaintained systems (K. Fenaughty and D. Parker, 2018). Therefore, it is applied to properly maintain the cooling systems. Degradation faults occur slowly and continuously. In a short time, users could not see it happen. Degradation failure leads to two possible results: a decrease in performance or a decrease in cooling output (Firdaus, Prasetyo, and Luciana 2016). The larger systems such as industrial refrigeration, central ACs and chillers, require more maintenance than the small and sealed systems in refrigerators and standalone commercial equipment. Real-time monitoring and analysing systems are good solutions for improving and maintaining the performance of the large cooling system.

To implement this action, depending on the type of cooling sub-sectors a combination of training, and TA in O&M will be necessary. This action should be integrated as a part of the national EE program which organise training about O&M best practices technical assessment for the existing system and financial support to maintain and improve the cooling system. These activities not only help to preserve the performance of the system but can also improve the performance, especially in industrial refrigeration sub-sector.

6.3.3 Recovery, recycling and disposal system for cooling equipment

Currently, there is no recovery and recycling system for cooling equipment at the end of life in Viet Nam. The equipment at the end of life is collected by the traditional collecting system, refrigerant is directly released into the environment. The mechanical parts then will be disassembled and recycled as metal scraps or utilised as spare parts for repairing other equipment. Because of improper disposal, a large amount of refrigerant is vented to the atmosphere.

To solve this problem, proper recovery and recycling of cooling equipment at the end of life is required. According to the NDC, the I5s options target for the rate of recovery will be 20% in 2030. To achieve this or even more ambitious targets, the recovery system needs to be built starting from 2025.

6.3.4 Accelerate the transition to environmentally friendly refrigerants

Currently, the dominant refrigerants in Viet Nam are HFCs such as R-32, R-410A etc. While HCFCs are still being used for servicing old AC equipment and in industrial refrigeration sub-sectors.

With the phase-out of ODS, there has been growing application of flammable refrigerants. Following the Kigali Amendment concerning the phase-down of HFCs, it is highly likely that flammable refrigerants will comprise the majority of refrigerants in the medium to long term.

HFCs are currently the popular refrigerants for sub-sectors. The refrigerants currently used in room ACs in Viet Nam are R-22 (for servicing), R-410A and R-32, while natural refrigerants such as HCs are not common yet at a commercial scale due to the concern over fire safety and related issues of standards and servicing technician capacity. With the current trend, R-32 AC will dominate AC in Viet Nam by 2028, while HCFC and R-410A refrigerated AC will be eliminated. But to comply with Kigali Amendment, R-32 needs

start to be replaced by a lower refrigeration in the next few years. Currently, R-290 most potential alternative, the R-290 AC needs to be introduced into Viet Nam market as soon as possible to support Viet Nam reaching the HFCs phase out target. As for the industrial refrigeration sub-sectors, R-717 and R-744 are the potential alternative refrigerants. While HFOs (R-1234yf, R-1234ze, etc.) are the new generation of refrigerants which have a wide range of applications in all sub-sectors. For MAC, R-1234yf is the current best alternative for R-134a. The blend of HFOs and HFCs can be used in the transition phase of HFCs phase out.

The current challenge is to accelerate the research and development of new refrigerants since the current alternatives have many downsides such as being flammable (HCs, HFOs), toxic (R-717) and release persistent contaminants to the environment (HFOs release trifluoroacetic acid) (EFCTC, 2023).

6.3.5 Improve the quality and knowledge in operating and servicing

Servicing for cooling equipment in Viet Nam is mainly conducted by service shops with no regulations on the minimum criteria for the training and qualification of workers. Vocational colleges in Viet Nam have training courses on equipment and services but not all technicians are graduated from there. In many service cases, the diagnosis of problems, maintenance and repair is based on the learning-by-doing knowledge and experience that workers accumulate from the working process. The knowledge of ODS refrigerants, EE and safety standards is low and rarely updated. Tools and equipment for servicing are also primitive which reduces the quality of the service.

With the Multilateral Fund and other international/bilateral support, the training and technical support for technicians in the RAC sector has been provided in the country. However, there is still an enormous demand, and it is crucial to organise continuous training combining technical/financial support in improving the quality and knowledge in servicing sector to meet the new standards on EE and discharge of ODS refrigerants. Technicians who install, operate, maintain and repair equipment containing controlled substances must have appropriate diplomas and certificates.

Proper training and certification are essential when handling cooling equipment, particularly those containing toxic and flammable substances like R-600a, R-290, and R-717. Adequate training ensures safety protocols are followed to minimise risks associated with these substances. Additionally, improved O&M practices for cooling equipment, facilitated through training and equipment assessment, are crucial for reducing refrigerant leakage. By implementing these measures, both safety and efficiency in cooling system operations can be significantly enhanced.

6.3.6 Promote a green lifestyle via the use of high EE equipment

Awareness regarding climate change has increased in Viet Nam in recent years. This is a positive sign for green lifestyle practices in the country which should be maintained and strengthened in the future by the policies to promote green demand. Conducting regular public awareness programs on EE technologies and practices, change customers' behaviours and have positive impacts on climate change and ozone layer protection in general and particularly in retail cooling equipment will contribute to facilitating the transition to non-ODS and low GWP refrigerants as well as to adopt low carbon emission technologies by manufacturers. Furthermore, the demand side shifting towards better technologies and more climate/ozone friendly refrigerants would give the service and technical sector a boost.

6.4 Cooling sector growth projection

The BAT scenario of EE would achieve a total energy saving of 10.57 TWh in 2030 and 62.09 TWh in 2050 compared to the BAU scenario. residential and commercial ACs would be the most relevant sub-sector with potential savings of up to 7.48 TWh in 2030 and 43.76 TWh in 2050.

The NZT and the Global Cooling Pledge would aim to increase the efficiency of AC by 50% compared to the world average in 2022. Here, the potential energy saving for the cooling sector is 9.03 TWh in 2030 and 54.48 TWh in 2050. The potential for energy saving of each sub-sector is summarised in Table 12.

Table 12: Potential energy saving of the cooling sector under the NZT scenario

Cooling sub-sectors	Potential saving in 2030		Potential saving in 2050	
	Saving (TWh)	%	Saving (TWh)	%
Residential and commercial AC	6.55	72.6%	38.82	71.3%
Central AC and chiller	0.72	8.0%	4.05	7.4%
MAC	0.58	6.4%	4.62	8.5%
Domestic refrigeration	0.44	4.9%	2.66	4.9%
Commercial refrigeration	0.37	4.1%	1.77	3.3%
Industrial refrigeration	0.36	3.9%	2.54	4.7%
Transport refrigeration	0.01	0.1%	0.03	0.0%
Total Saving	**9.03**	**100%**	**54.48**	**100%**

Source: Compiled by consultant

With interventions for increased EE, the energy saving potential is increasing as the penetration of highly efficient equipment gradually increases in the cooling sector equipment stock. Compared to BAU the effect of energy saving is more visible in the more distant future. Figure 10 depicts the trend of increase in energy consumption in BAU in comparison to NZT and BAT scenarios.

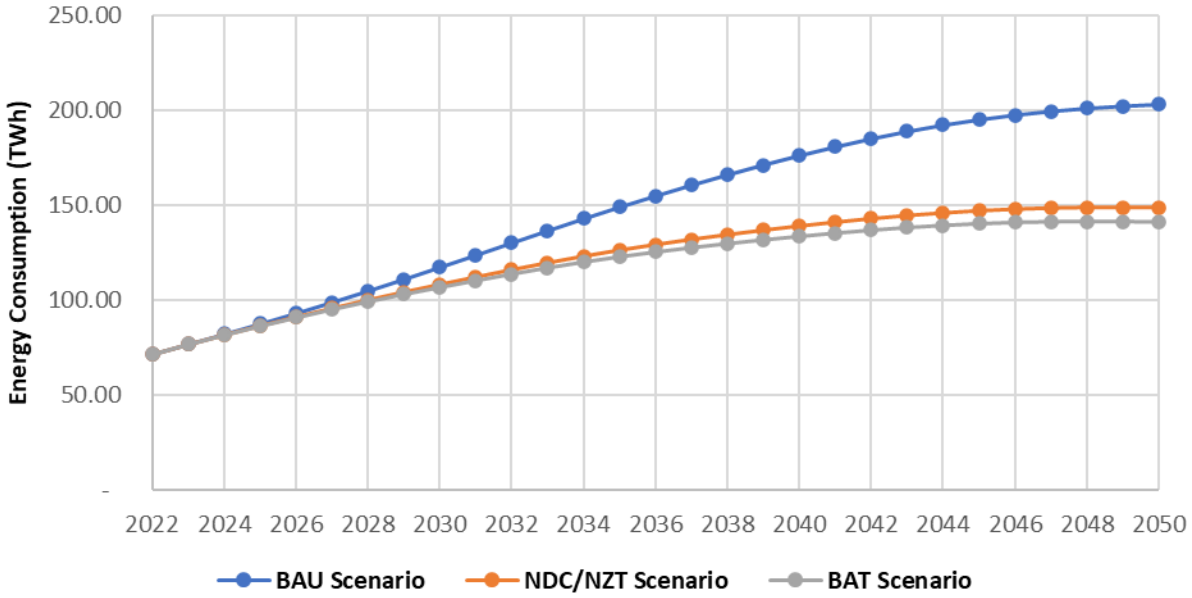


Figure 10: Total energy consumption by the cooling sector under BAU, NZT and BAT scenarios

Source: Compiled by consultant

Looking at GHG emissions, in the BAU scenario, total emissions are gradually increasing from the 2022 level to reach the peak in 2045 with a total emission of 116.38 $MtCO_2e$, and then gradually falling due to the effect of GEF reduction and EE improvement described in section 4.2.1.

With the NZT scenario in 2050, the GEF will reach near zero due to increased electricity sources from renewable energy and the HFCs phase out and transition to alternative refrigerants such as HCs, HFOs, R-744 and R-717, both direct and indirect emissions are significantly reduced to just 4.71 $MtCO_2e$.

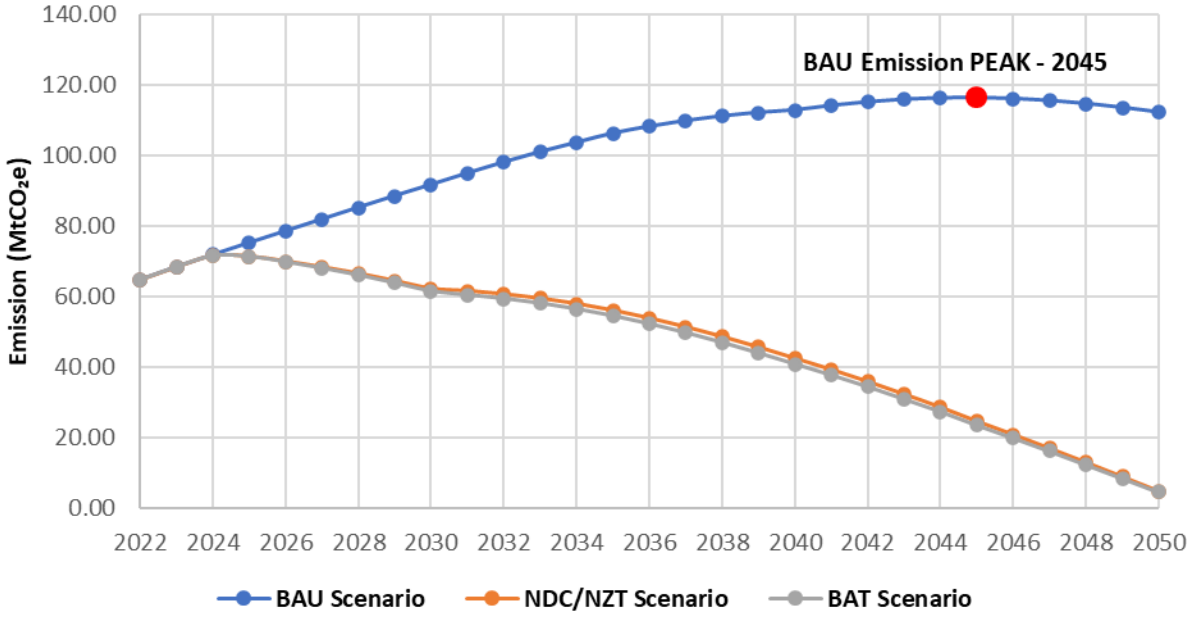


Figure 11: Total CO_2e emission by cooling sector under BAU, NZT and BAT scenarios

Source: Compiled by consultant

Regarding direct emissions, the main source of emission is high GWP refrigerants. HCFCs phase out alone can help to reduce the CO_2e emissions but not enough to meet the Kigali roadmap to reach NZT. To comply with the CO_2e emission limit, equipment with low GWP refrigerant (GWP < 150) must be taken up in all sub-sectors. Figure 12 depicts the projection about direct emission of the cooling sector in Viet Nam for BAU and NZT scenarios with emission limits according to the Kigali amendment.

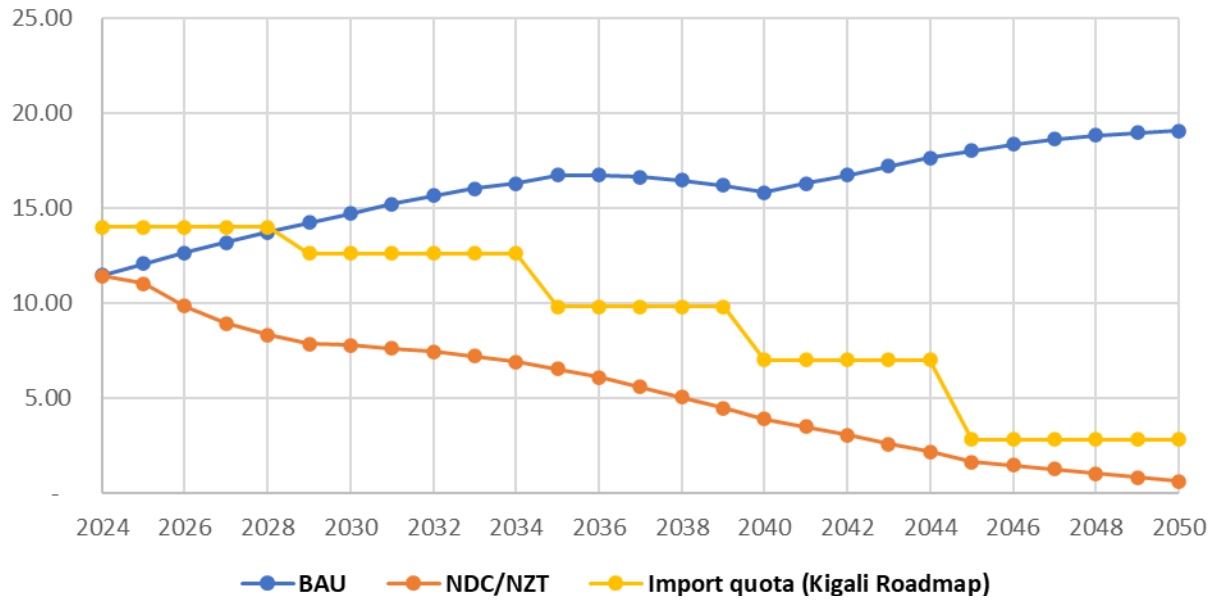


Figure 12: Projected direct NZT emission in comparison with BAU and Kigali roadmap

Source: Compiled by consultant

The potential direct emission reduction for the four sub-sectors with significant emission reduction potential is summarised in Table 13 below:

Table 13: Potential emission reduction of the cooling sector under the NZT scenario

Cooling sub-sectors	Reduction potential in 2030		Reduction potential in 2050		Alternative for HCFCs, HFCs with GWP < 150
	$MtCO_2e$	%	$MtCO_2e$	%	
Residential and commercial AC	3.74	53.8	7.02	38.0	R-290, R-1234yf, R-1234yf blend with R-32
Central AC and chiller	0.92	13.2	3.14	17.0	R-1234yf, R-1234ze, and other HFOs or HFOs blend with HFCs.
MAC	0.27	3.8	2.74	14.9	R-1234yf
Industrial refrigeration	2.01	28.9	5.46	29.6	HFOs, R-717, R-744 systems
Other sub-sectors	0.02	0.3	0.11	0.6	HFOs, HCs
Total emission reduction potential	**6.95**	**100**	**18.48**	**100**	

Source: Compiled by consultant

6.5 Remaining gaps, barriers and opportunities for green cooling

The necessary time gap between the issuance of a TCVN and the decision to use TCVN takes effect to control MEPS, making it hard to increase the MEPS. According to the most recent Decision No. 14/2023/QD-TTg, the revised version of TCVN for equipment in domestic refrigerators (TCVN 7828:2016) and residential and commercial AC sub-sectors (TCVN 7830:2021) will be applied to define MEPS from 2025. In the regular roadmap, the next MEPS may be issued in 2030 as a 5-year gap is needed for preparation. The current MEPS and the next version of MEPS are not ambitious enough. To reach the target, especially a 50% improvement for EE of AC in 2030 the next TCVN and decision about MEPS must be developed outside of the regular schedule of Viet Nam.

Introducing new equipment featuring low GWP refrigerants is imperative in the residential and commercial AC sub-sector. This aligns with the target outlined in the HFCs phase-out roadmap, in which newly developed AC systems shall utilise refrigerants with a GWP lower than that of R-32. To adhere to these emission reduction targets, the current viable alternative for ACs is R-290, a refrigerant already successfully employed in numerous countries as a replacement for HFCs. In the context of Viet Nam, a strategic initiative is needed to promote R-290 AC systems, beginning at least by 2030, with a targeted market penetration of 10%. This proactive measure aims to diminish the usage of R-32 and contribute to the overarching objectives of the HFCs phase down plan.

However, the transitional hurdle lies in the fact that alternative refrigerants present many challenges. The selected substitutes, such as HCs, pose the risk of being highly flammable (classified as A3). Consequently, cautious measures must be taken in the operation, servicing, production, and transportation of AC systems employing HCs. HFOs bring another set of concerns, as they have the potential to emit TFA, toxic to the environment and organisms. Additionally, R-717 stands out as a toxic refrigerant, further emphasising the need for a meticulous and well-managed transition to alternative refrigerants within the cooling sector.

Establishing an effective disposal and recycling system is currently lacking in Viet Nam, presenting a significant gap in infrastructure. To meet the NDC target, specifically I5/I5s, which entails recovering and recycling 20% of refrigerants without direct release, it is crucial to initiate comprehensive studies and development efforts for the recovery and recycling processes at the earliest possible juncture. These endeavours will be instrumental in not only addressing the existing gap in the disposal and recycling system but also in advancing sustainable practices that align with the specified environmental targets.

Financial barriers pose a significant challenge in accessing high-efficiency cooling equipment, primarily due to considerable increased costs associated with enhancing efficiency or transitioning to alternative refrigerants. Manufacturers, in order to achieve improved efficiency or adopt eco-friendly refrigerants, incur additional costs, which are typically reflected in the market prices of the equipment. The cost-benefit study indicates the relative difference in price. For instance, the price disparity between a low and high-efficiency version of a small AC is substantial, amounting to 73%. In contrast, a similar efficiency increment for larger ACs results in a comparatively smaller difference of 26%. This discrepancy creates a financial barrier regarding the assessment of cooling equipment with higher EE towards the low-income consumers, since this group typically requires smaller and lower-capacity equipment.

To address this disparity and facilitate broader access to efficient cooling technologies, financial support mechanisms are essential. This support can be directed towards low-income groups, aiming to mitigate the financial burden faced when acquiring small and low-capacity cooling equipment. Alternatively, efforts to reduce the overall market price of such equipment can also play a pivotal role in overcoming financial barriers and promoting equitable access to energy-efficient cooling solutions.

7 ACTION PLAN AND ROADMAP FOR THE NGCP

In order to achieve the NDC and NZT as well as the target of the JETP, Viet Nam should consider proposed control measures including developing and implementing stringent MEPS for all types of appliances, ensuring compliance is enforced with these MEPS through mandatory inspection and undertaking penal actions against violators, along with other measures.

In this context, the NGCP is proposed that covers the following key components:

7.1 Overall NGCP objectives

Viet Nam has committed to significantly reducing the overall GHG emissions of the AC and refrigeration sector by ratifying the Kigali Amendment to the Montreal Protocol and signing the Global Cooling Pledge at COP28. These commitments are translated into specific EE and refrigerant-related targets as follows:

Table 14: Specific EE and refrigerant-related targets of NGCP

Activity	Target 2030	Target 2050
Increasing the EE in new AC appliances/ equipment	50 %	80 %
Efficiency rating of new cooling equipment (except ACs)	7 % - 30 %	10 % - 35 %
Recovery of refrigerant at the EOL	20 %	100 %
Phasing down the HFC consumption	10%	80%

Source: Developed by consultant

The direct and indirect emissions reductions from the cooling sector are crucial to achieving the NDC, the target of the JETP and the NZT for 2050. The NGCP assumes that the electricity grid will be decarbonised as per the roadmap of PDP8 and the JETP.

At the same time, the Government of Viet Nam implemented measures to promote the production and use of climate-friendly, high EE cooling appliances appropriate for the cooling needs of society, ensuring that vulnerable groups have access to modern cooling solutions.

The Government of Viet Nam needs to take continuous measures to promote judicious use of energy, minimising energy misuse and waste, and orientate the consumption preference towards climate-friendly cooling products.

7.2 Specific approaches to achieve the overall objectives of the NGCP

The following roadmap proposes the development and issuance of suitable laws, regulations, policies and guidelines to achieve the EE improvement and emissions reduction objectives laid out above, with two important milestones of 2030 and 2050. It will leverage resources and expertise from industry and academia. The Government of Viet Nam should use domestic resources and harness international climate finance as well as official development assistance, and revenues from international carbon markets to finance activities under the NGCP. Details are provided in the action plan below.

7.2.1 Viet Nam's target and roadmap until 2030

Viet Nam has defined clear and ambitious targets to be achieved by 2030, these targets are improving EE, awareness raising, training of the technicians, and improving the recovery of the used refrigerant at the end of life of the cooling equipment and appliance. The few key actions and targets are proposed in the figure below:

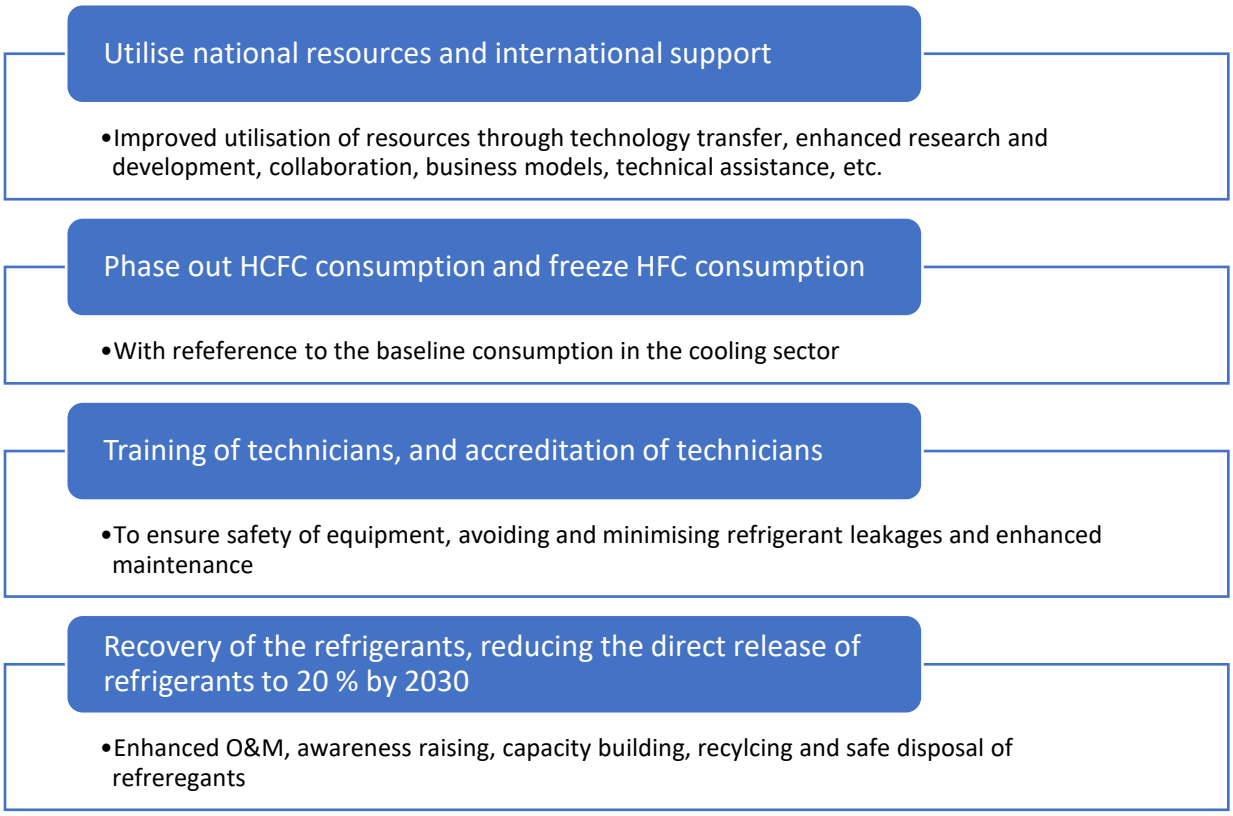


Figure 13: Key actions and targets for the cooling sector by 2030

Source: Developed by consultant

7.2.2 Viet Nam's target and roadmap until 2050

The roadmap to 2050 for Viet Nam is proposed with the target to ratchet up EE to 80%, complete phase out of HFCs and ensure the state-of-the-art recycling of refrigerants. These approaches are elaborated in the figure below:

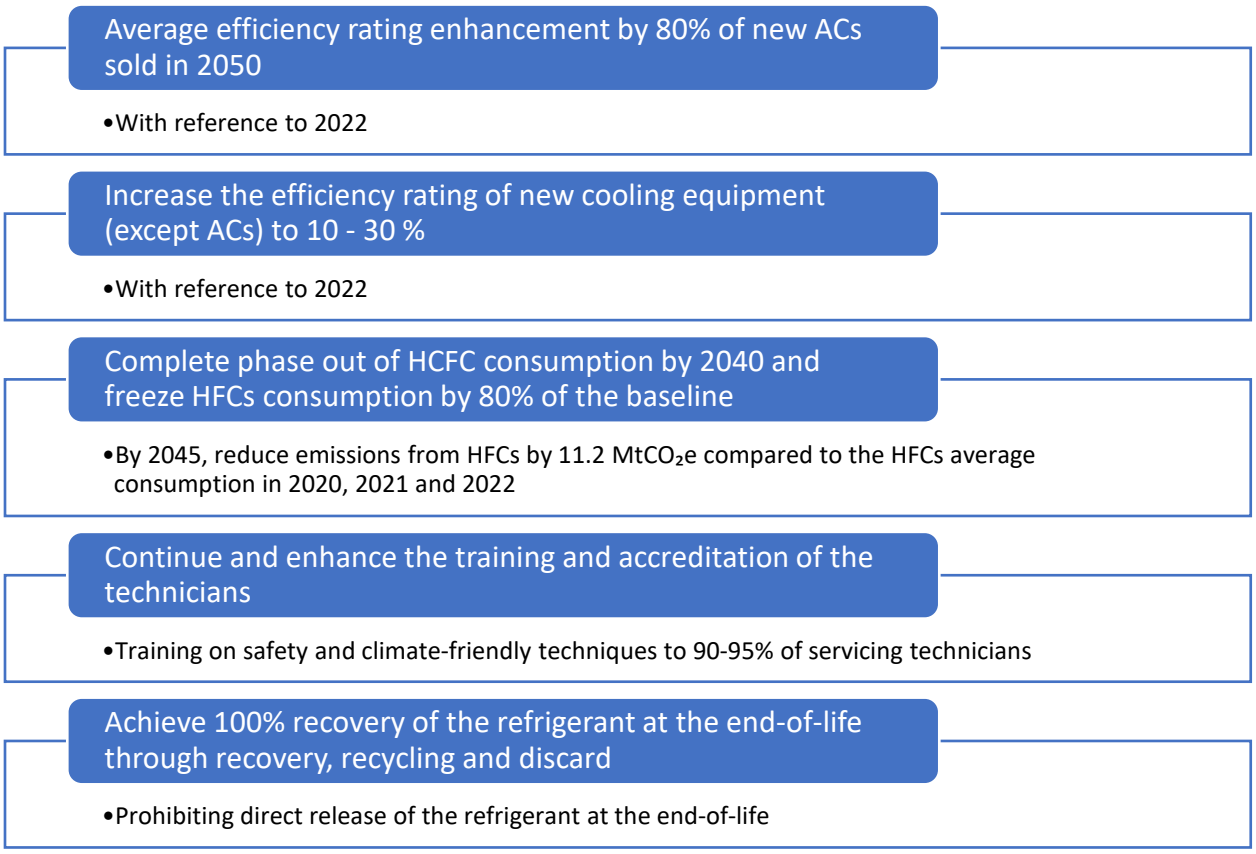


Figure 14: Key actions and targets for the cooling sector by 2050

Source: Developed by consultant

7.3 Action plan

The action plan is divided into four components, as given below, building on strengthened inter-ministerial coordination leading to the two-way communication between relevant authorities leading to the implementation of the NGCP as well as consideration of the NGCP in the updates of national socio-economic development plans and future sectoral programs. The activities are expected to implement during the period of 2024-2050.

7.3.1 Component 1

Review current management and control measures, develop and implement new measures to ensure penetration and use of climate-friendly cooling equipment in line with NDC, JETP and NZT. The first component of Viet Nam's NGCP is presented in the following figure:

Update MEPS	Revision, supplementation, and enforcement of other policies
• By 2050, ratchet up the MEPS for single-split AC by at least 80% from the current level • By 2050, ratchet up the MEPS for domestic refrigeration by at least 30% from the current level • Ratchet up the Star Rating Labelling Program for domestic refrigeration in line with the updates of the MEPS • Expand the MEPS to other cooling equipment such as VRV/VRF, chiller, industrial refrigeration compressors, and others	• Revise and enforce regulation on HFCs/equipment using HFCs in line with the Kigali Amendment • Technical standards on recovery of refrigerants -> achieve 100% recovery of refrigerants at the end of life of cooling appliances by 2050 • By 2025, revise, amend, supplement and enforce criteria for climate friendly cooling equipment products in public procurement • Regulations for monitoring and verification of the refrigerant usage and deployment in the cooling equipment, starting with a comprehensive inventory of HCFCs and HFCs in the air conditioning and refrigeration sector • By 2025, develop a manual and guidelines on the inspection, supervision, and evaluation of the implementation of legal regulations on MEPS, energy efficiency labelling and HCFC as well as HFC phase-down.

Figure 15: Component 1 - Reviewing management and control measures

7.3.2 Component 2

Harnessing technical and financial resources from multiple channels, in accordance with the Budget Law, Public Investment Law and Investment Law and other measures including direct state budget, international support or private resources (further details of analysis on the sources of financial resources are presented in Section 6) to promote efficient and low-GHG cooling equipment production and mainstream successful business models and financing schemes for their upscaling. The second component proposed for Viet Nam's NGCP is presented in the following figure.

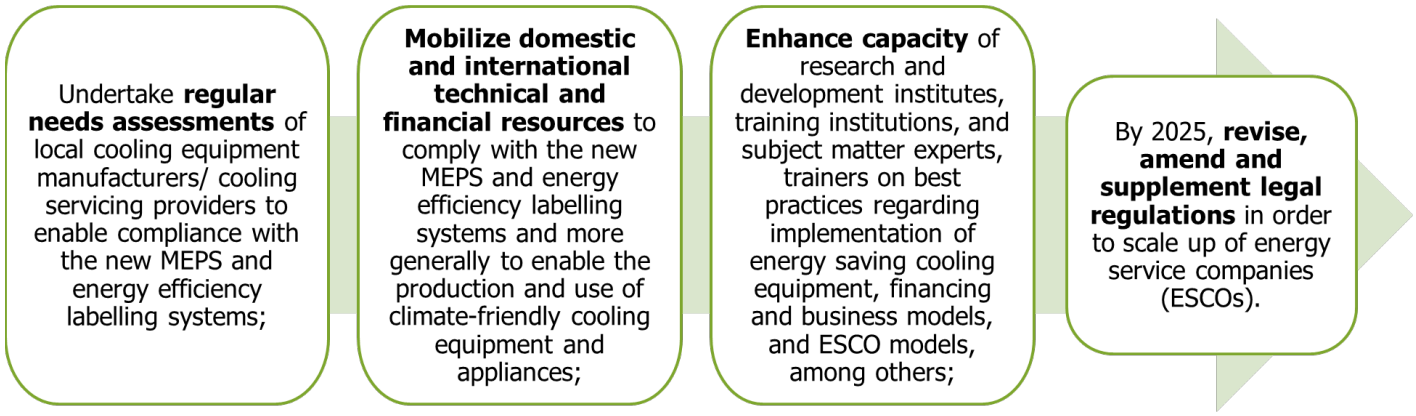


Figure 16: Component 2 - Harnessing technical and financial resources

7.3.3 Component 3

Capacity building on the handling, usage, O&M of high efficiency and low GHG refrigerant cooling equipment and design of projects upscaling use of such equipment as well as life cycle management of controlled substances. The third proposed component of Viet Nam's NGCP is described in the following figure.

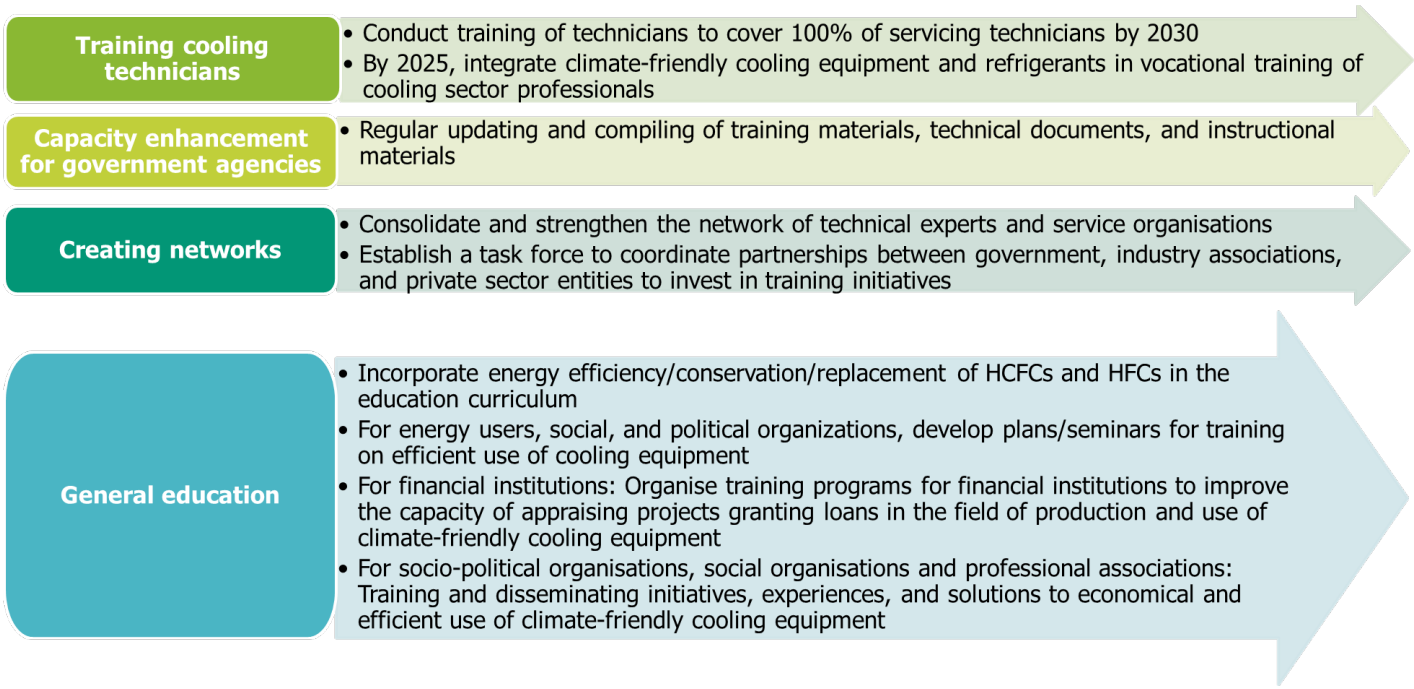


Figure 17: Component 3 - Capacity building

7.3.4 Component 4

Raising awareness about climate-friendly cooling equipment is crucial in mitigating the environmental impacts of traditional cooling systems. Promoting the adoption of green cooling technologies can significantly contribute to reducing GHG emissions and combating climate change. The last NGCP component focusing on awareness raising is depicted in the following figure:

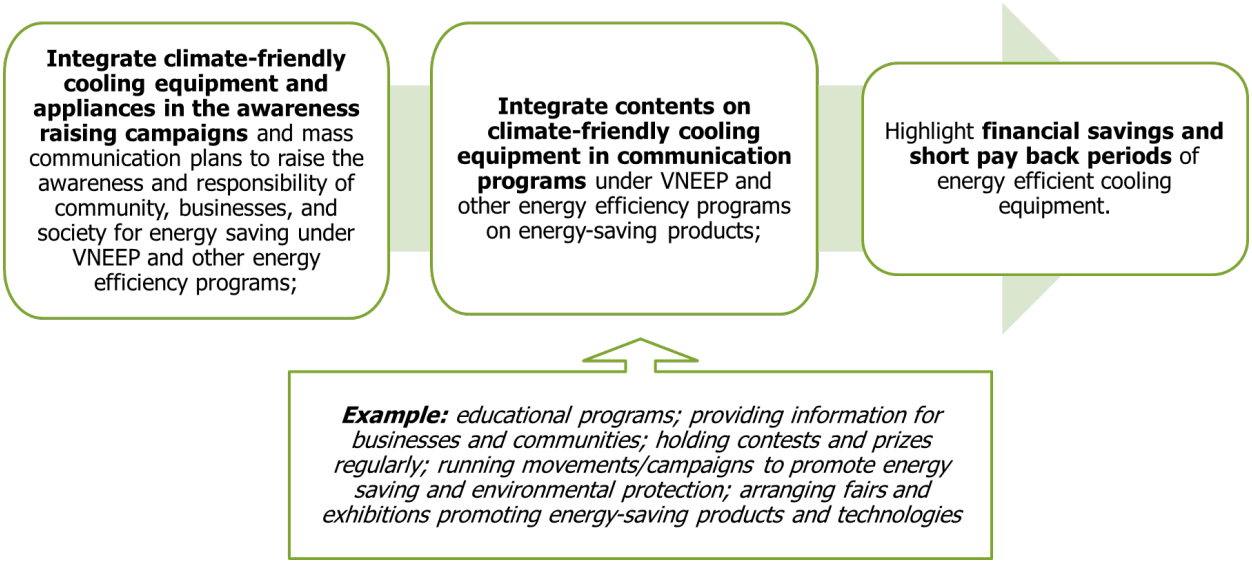


Figure 18: Component 4 - Awareness raising

7.4 Arrange and assign implementation of NGCP

The roadmap for the implementation of NGCP with relevant responsibilities and agencies is presented in Annex 1. The key agencies and responsibilities for the NGCP are highlighted below.

- MONRE in close consultation/collaboration with other key ministries in Viet Nam such as MOLISA, MOIT, Ministry of Public Security, and Ministry of Finance, among others to perform the following tasks:
    - MONRE and MOLISA lead to equipping technicians with the necessary knowledge on installing, operating, maintaining, and repairing equipment containing controlled substances before they can commence work in this field. Developing a training program on the collection and disposal of controlled substances. MONRE guides the content and builds the training program on controlled substance collection and disposal of HCFCs. Coordinating with MOLISA for training and issuing certificates for technicians requires the qualification of technicians to work with controlled substances.
    - Overseeing import quotas applied by the importers beginning 2024, before applying for importing licenses from MOIT to import controlled substances into Viet Nam.
    - Leading the development of national technical standards on the collection, transportation, storage, reuse, and treatment of controlled substances and establishing them before 10 October 2023.
    - Leading the development and conducting pilot activities under the NGCP.
- MOIT is primarily responsible for integrating NGCP into the implementation plan of the VNEEP3 and future EE programs; assumes the prime responsibilities for the inspection and evaluation of the results of NGCP; at the same time assumes the prime responsibilities for and coordinates with line ministries and sectoral authorities in implementing the NGCP. The specific collaboration includes:
    - Collaborate with MONRE in tracking the results of and updating targets for the GHG emission reduction from cooling equipment in the NDCs; in controlling of import and export of HFCs and HFCs contained products; in supporting local manufacturers to convert to produce climate-friendly products;
    - Collaborate with Ministry of Science and Technology (MOST) for developing, revising and adopting MEPS and Energy labelling systems for all types of cooling equipment;
    - Collaborate with MOC, MOST for revising and amending Building Codes in residential buildings to bring a shift towards EE buildings practices, focusing on the transition to climate-friendly cooling equipment;
    - Collaborate with the Ministry of Finance for approval of concessional sovereign loans and allocating financial resources to implement the NGCP activities; and
    - Other agencies and institutions on research and conducting public awareness promote the transition to climate-friendly cooling equipment.
- MOST is primarily responsible for revising, amending, supplementing and enforcing technical standards and regulations in the cooling sector proposed in the NGCP, including:
    - Collaborate with MOIT for developing, revising and adopting TCVNs for all types of cooling equipment;

- Collaborate with MOC for revising and amending Building Codes in residential buildings to bring a shift towards EE buildings practices, focusing on the transition to climate-friendly cooling equipment;
- Collaborate with MONRE for monitoring and verification of refrigerant usage and deployment in the cooling equipment, starting with a comprehensive inventory of HCFCs and HFCs in the AC and refrigeration sector

7.5 Considering gender equality and vulnerable groups in the NGCP

The following steps should be taken to reduce the negative impact of low-income consumer groups that cannot afford modern cooling solutions, and women include:

- Conduct gender-disaggregated surveys within Viet Nam to understand the impact of the absence of cooling on different groups such as the disabled and poor people with regard to the aspects related to productivity, general health, mortality, etc. The result would help the policymakers making informed decisions to provide equitable access to cooling systems with higher EE;
- Disseminate relevant information and warnings on impending heatwaves; impose restrictions on outdoor work during peak heat conditions;
- Introduce financial support programs for workers in informal sectors to combat heat stress.;
- Offer incentives for energy-efficient cooling systems, focusing on low-income and female-led households;
- Implement solutions to reduce disparities in access to cooling technology/equipment between urban/high-income and rural/low-income groups through financial and microfinance solutions promoting sustainable cooling

8 FINANCING LANDSCAPE FOR NGCP-RELATED GHG REDUCTIONS

Grants, concessional loans and revenues from international and domestic carbon markets are crucial instruments to mobilise GHG reductions in the cooling sector.

The national budget is limited for the technology transformation at an early stage. It is allocated to public institutions mainly for policy development, R&D, capacity building, and communications as well as for demonstration and piloting and is provided as a public fund.

According to the Viet Nam Environmental Protection Fund (VEPF), cooling projects are currently not eligible for state budget allocation through VEPF.

Reported by World Bank, general barriers to EE investments in Viet Nam including the cooling sector are (World Bank, 2022):

- Insufficient incentive structure: Banks are not incentivised to lend to manufacturing enterprises for EE projects despite EE being a strategically important goal for the Government.
- Limited commercial financing: The financial feasibility of EE improvement activities is not considered an important factor to consider for lending;

- High collateral requirements: Collateral-to-loan ratios in small and medium-sized enterprises lending is high at 218%. Besides, there is uncertainty about the enforceability of claims for both unsecured and secured lending.
- Lack of capacity and awareness: Commercial banks lack adequate capacity to appraise EE projects and
- Documentation requirements: Lack of standardised documents for EE lending may be a hindrance.

Traditionally, an investment is capitalised with a loan from one or more local FIs besides its own (equity). Being a low-income country, in the past Viet Nam has received grants for TA as well as financial assistance from international FIs. As its development status has improved considerably over time, grants have been replaced by concessional loans. Further forms of financing include commercial loans from private international and local FIs in Viet Nam. Bank and sovereign guarantees can mobilise such loans for novel technologies such as low-GHG refrigerant operated cooling devices. Finally, revenues from the sale of carbon credits increase the financial attractiveness of projects. Figure 19 below presents proposed financing mechanisms for investment into a low carbon transformation project in Viet Nam.

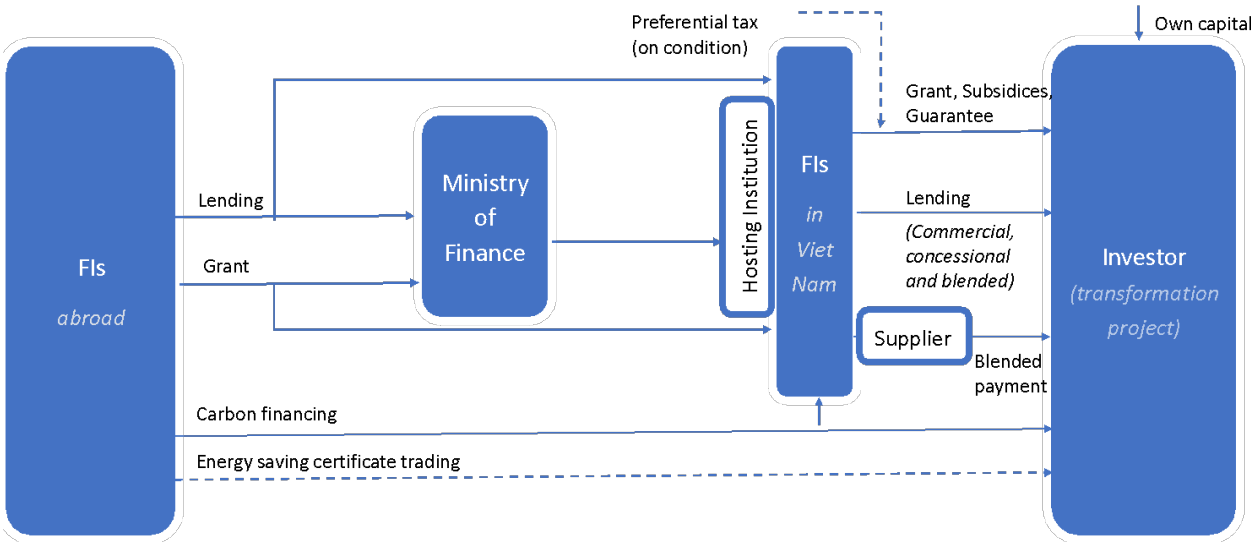


Figure 19: Financing mechanisms for a low carbon transformation project in Viet Nam

Source: Compiled by consultant

Financing can principally go through the Government or directly to the investor. When going to the Government, financing into RE, EE is commonly hosted by MOIT while that of waste treatment and disposal, and ODS management is hosted by MONRE. Currently, Viet Nam Development Bank (VDB) is assigned as the national focal point to receive financing from the Green Climate Fund (GCF).

Since 2016, the Government of Viet Nam has become highly reluctant to accept concessional loans from international FIs; Decree No. 114/2021/ND-CP dated 16 December 2021 on management and use of official development assistance (ODA) and concessional loans provided by foreign donors has essentially limited such loans. Moreover, due to inconsistency in the definition between the Law on Environmental Protection (2020) and the Revised Law on State Budget (2020) on whether a public fund can be operated as a FI, each and every public fund is limited to access international FIs for funding.

8.1 Main stakeholders for financing cooling sector GHG emissions reductions

A successful financing mechanism will need the active participation of four main groups as follows:

(1) Policymakers (ministries) to push market demand

(2) Main players in the cooling value chain (importer, manufacturer, service provider, end-user, e-waste collector and treatment) to behave according to the green cooling roadmap

(3) FIs (international and national) to leverage investment and

(4) Technical professional (evaluator, auditor) to provide technical support and confidence to FIs

The list of potential stakeholders is summarised in Figure 20.

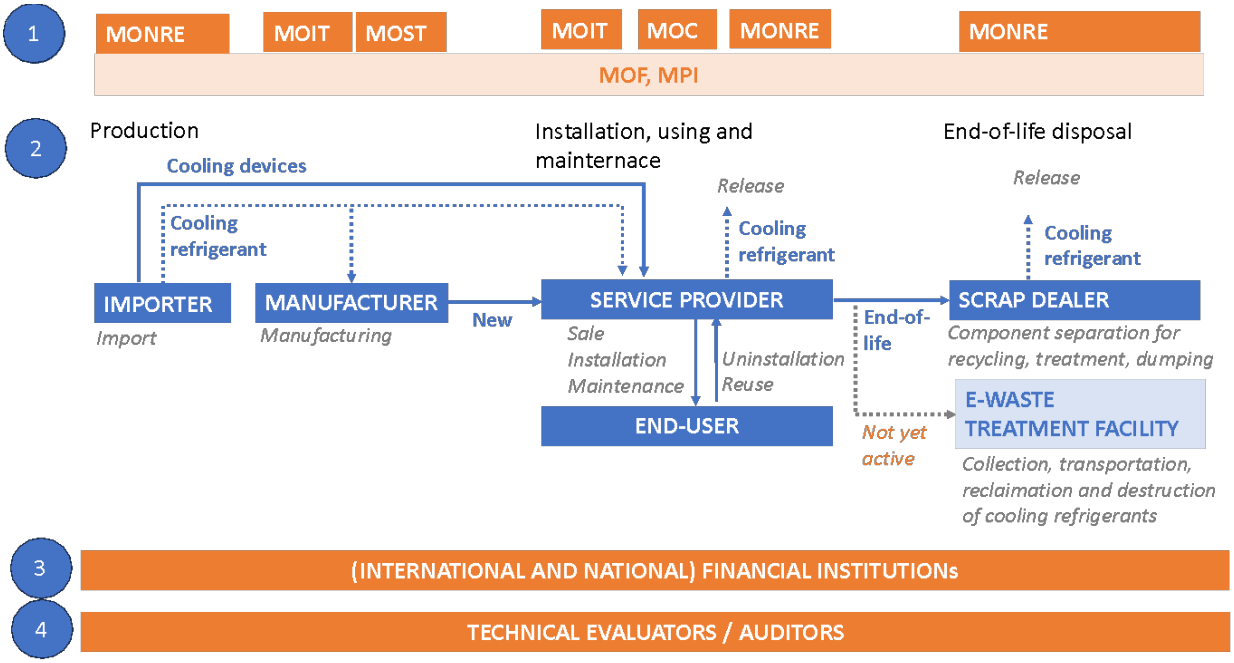


Figure 20: List of potential stakeholders for financing a cooling project

Source: Compiled by consultant

8.2 Financing and business models for scale-up of GHG reductions in cooling in Viet Nam as the following activities

There are various business models for financing the cooling sector tested in international practice. Not all are applicable in Viet Nam due to the need to ensure payback to FIs as well as stakeholder structure in the value chain, in which Viet Nam has a very strong end of life collection network of scrap dealers. Three models seem to be most suitable for Viet Nam, under the different phases of the cooling value chain that are recommended to be considered for pilot activities as the following up activities after closing this TA.

8.2.1 Model - Cooling as a service

This model pilots the willingness, participation and contribution of stakeholders in the second phase of cooling devices, i.e. installation use and maintenance. This pilot confirms the reduction potential in total energy consumption of the cooling sector.

Under this pilot, at least two ESCOs receive finance to cover the investment cost of equipment and cooling service. A cooling service contract will be signed between the ESCO and cooling user, monitored by the auditor for identification of payback to ESCO and, thus to FIs. The performance of different stakeholders is as follows:

- ESCO pays for equipment under the positive list and performs installation and maintenance of a cooling device/system. This helps ESCO to be more active without financial burden.
- The manufacturer provides equipment, guarantees its performance and receives immediate payment by ESCO.
- End-user pays for the cooling volume he uses. The cooling service will be charged in USD/cooling unit, which is higher than the electricity price. This helps reduce energy consumption and up-front payment for cooling users. This also helps cooling users not to worry about the performance of the system.
- FIs provide financing to ESCO and receive payback per financing contract.
- Technical evaluator helps FIs in the assessment, evaluation and post evaluation of cooling service.

The pilot model will provide technical support to FIs in the evaluation of the ESCO contract, development of a positive list, providing cooling reader and cooling reading database and arranging finance to FIs.

The concept of the pilot model is presented in Figure 21 below.

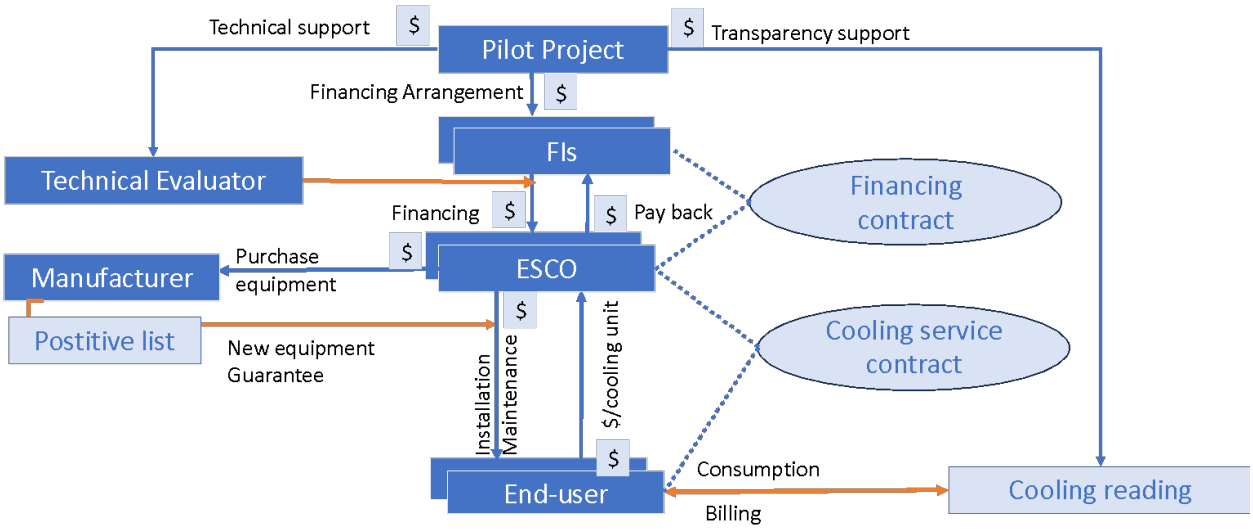


Figure 21: Pilot concept of Cooling as a Service model in Viet Nam

Source: Compiled by consultant

Based on current initiatives of Daikin, the model should be considered to pilot in the commercial sector, i.e. ACs in the commercial sector.

8.2.2 Model - Trade in

This model pilots the willingness, participation and contribution of stakeholders in the third phase of cooling devices, i.e. end of life disposal. This pilot confirms the possibility of avoiding leakage of cooling refrigerant from end-of-life disposal.

Under this pilot, at least two e-waste treatment facilities receive finance perform trade-in services and equipment under the positive list. The fee for treatment of collected cooling devices, including recovery, reclamation, and destruction of cooling refrigerant will be negotiated between the facility and manufacturer on the e-waste contract.

The performance of different stakeholders is as follows:

- E-waste treatment facility purchases equipment from the manufacturer per positive list pays technician for dismantling and installation of cooling equipment, performs e-waste treatment and pays back FIs per financing contract.
- The manufacturer provides equipment guarantees its performance and receives immediate payment by E-waste for recapitalise and production. Manufacturer pays e-waste treatment facility for collection, transportation and treatment of its end-of-life e-waste per e-waste contract and obligation under the Extended Production Responsibility.
- End-user registers trade-in equipment and pays for the difference.
- The pilot project will provide technical support to FIs in the evaluation of e-waste financing contracts, development of a positive list, trade-in database and arrangement finance.

The concept of the pilot model is presented in Figure 22 below.

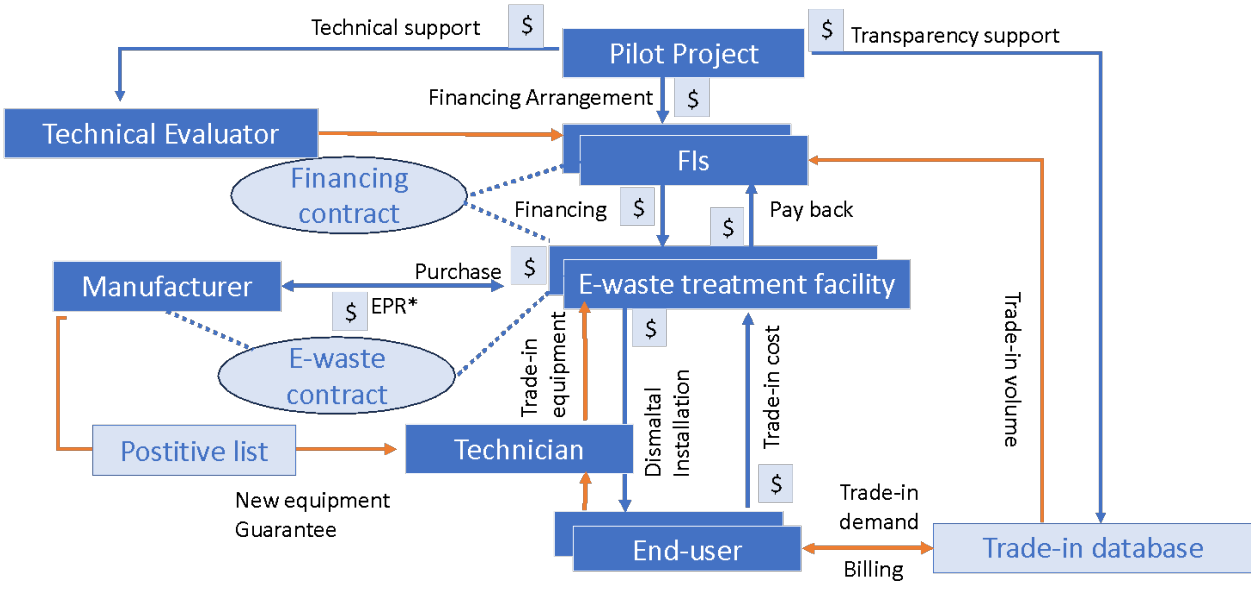


Figure 22: The pilot concept of trade-in a model in Viet Nam

Source: Compiled by consultant

Based on international practice, this model should be piloted with residential AC.

8.2.3 Model - Generate and sell ITMOs under Article 6.2 of the Paris Agreement

This model is based on revenues from international carbon markets for EE improvement of cooling devices or recovery and reuse of high-GWP refrigerants. The approach would function as follows, using a concrete, but fictitious example:

For example, if the Government of Viet Nam agrees with a Government of a buying country on an Article 6.2 cooperation covering the cooling sector. Under that collaboration, private or public developers of EE improvement activities of cooling devices or recovery and reuse of high-GWP refrigerants can develop and submit project ideas for approval and authorisation of ITMOs for the mitigation achieved by the projects. These projects need to apply a baseline and monitoring methodology agreed upon by the buying country and Viet Nam. The emission reductions must be verified by independent third-party auditors accredited by the Governments; these could be auditors accredited under ISO 14065 or the CDM.

The buying country in this example is willing to buy ITMOs at a price of 40 USD/tCO_2e. The Government of Viet Nam approves ITMOs only for 50% of the reductions actually achieved in order to cover the need for a corresponding adjustment of its emissions balance.

In this example, a project developer works with retailers to offer 100,000 ACs with an efficiency level of 30% higher than the baseline level, which is the 75% percentile of the efficiency of ACs sold in Viet Nam in 2022 at a discounted price. As a baseline ACs use 1,000 kWh/year (V. T Le and A. Pitts, 2019). The average savings per AC reaches 300 kWh/year, so a total of 30 GWh is saved annually.

Given a baseline GEF of 900 gCO_2/kWh (DCC, 2020), the annual mitigation reaches 27,000 tCO_2. The crediting period of the project is 10 years, so a total of 0.27 million tCO_2 mitigation is achieved, and 0.135 million ITMOs would be approved. The accumulated revenue would reach 5.4 million USD. Therefore, a retail discount per AC of several hundred USD could be offered and the project developer would still make a profit. Given that the ITMO sales revenues would only accrue ex post, a loan from a domestic private bank would have to be used to pre-finance the retail discount, secured through the ITMO revenue.

Another project developer would recover refrigerant at the end of the life of ACs operating on R-22. Given each AC contains 1 kg of R-22 with a GWP of 1,760 (IPCC 5th Assessment Report), hence preventing the release of the R-22 generates an emissions reduction of 1.76 tCO_2e, i.e. generates 0.83 ITMO. The carbon credit revenue would estimate to reach 33 USD for each AC treated in the recycling plant.

Figure 23 details the process for the generation of ITMOs through Article 6.2 below.

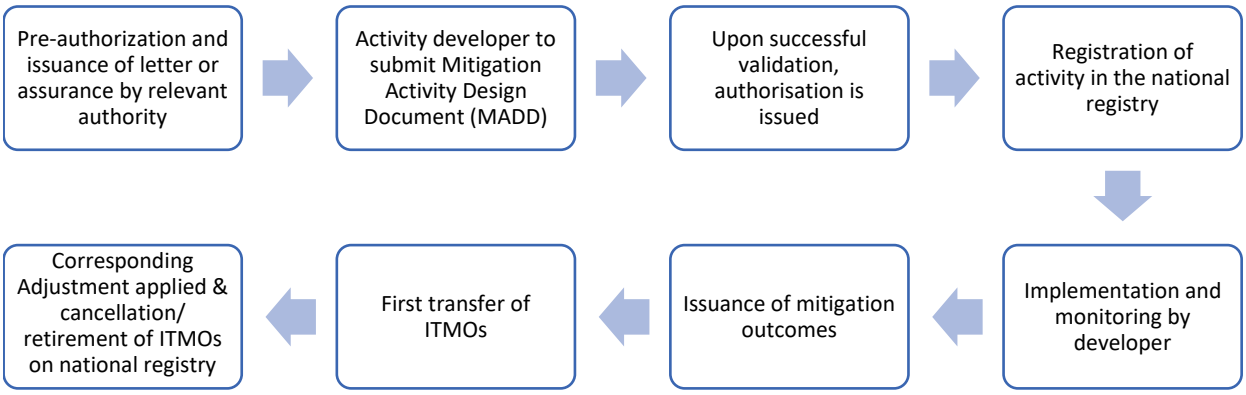


Figure 23: Process for generation of ITMOs through Article 6.2

Source: Compiled by consultant

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions and recommendations on NGCP

While the demand for cooling in Viet Nam is soaring, the Government of Viet Nam has made international commitments under the Kigali Amendment to the Montreal Protocol, the Paris Agreement, the NZT announced at COP26 and the Global Cooling Pledge made at COP28. Honouring these commitments requires strong action to increase the EE of cooling appliances while switching to low-GHG refrigerants.

The NGCP is proposed to implement in the period of 2024- 2050. Its targets for 2030 and 2050 are derived from the above-mentioned international commitments and are differentiated between sub-sectors of the cooling sector. Given the relevance of indirect emissions from electricity consumption, the planned decarbonisation of the electricity sector as per the PDP8 and the JETP political declaration is a crucial precondition for achieving the cooling sector target. The most stringent EE target is set for AC units and less stringent ones for commercial and industrial units. Targets for phasedown of HFCs and recovery of refrigerant when decommissioning cooling equipment complete the array of cooling targets. The four proposed components of the NGCP include the strengthening, expansion and enforcement of MEPS in line with the committed targets, harnessing of domestic and international financing sources for the improvement of cooling equipment production and use, capacity building of key actors to ensure proper handling, usage, O&M of high efficiency and low GHG refrigerant cooling equipment and awareness raising regarding climate-friendly cooling equipment. The proposed NGCP also addresses recommendations related to of gender equality and vulnerable groups. The key aspects of financing activities under the NGCP are shown in Table 15 below.

Table 15: Opportunity and challenge in financing to the cooling sector in Viet Nam

Category	Opportunity	Challenge	Consideration for financing model to cooling sector
Legal context	Availability of MEPs, standards, labels, draft action plan and roadmap	Coverage and enforcement for pushing market demand	To ensure market demand through strengthening control and management measures
Financial resources	Availability from international FIs	Lack of domestic financing	To prioritise blended financing sources
Financial mechanism	Familiar with variations of financing mechanisms Revenue from international carbon market mechanisms can be highly attractive.	Limited experience in cooling sector	To strongly engage in international carbon markets
		Not able to access energy saving certificate trading	
		Behaviour changes of cooling user	To introduce performance contract/agreement (commercial and industrial user), blended payment (residential user)
Financial Instruments	Green credit lines with performance contracts were introduced successfully with at least 20% reduction in energy or GHG emission	Defining credit awarding criteria for the cooling sector The Government of Viet Nam has strict requirements for accepting concessional sovereign loans	To define a positive list and preferential criteria for allocation of concessional financing
Participating stakeholders	Industrial manufacturers and consumers are familiar with financial mechanisms	Participation of cooling service provider due to its connection to domestic and commercial consumers from installation until end-of-life- life	To include the participation of ESCO

Category	Opportunity	Challenge	Consideration for financing model to cooling sector
	More and more local financing institutions interested in green financing	Sufficient incentive structure and technical support	To include technical support, attractive size of financing and structure
	Interest in international FIs and suppliers	Capacity of receiving bodies	To include capacity building along with technology transfer

Source: Compiled by consultant

Overall, the NGCP proposes a coordinated response to address the climate change contribution of the cooling sector in Viet Nam. There are still many challenges in implementing and enforcing HSNL policies related to the cooling sector that need to be resolved. By overcoming these challenges, the cooling sector will play an important role in ensuring Viet Nam achieves its climate change mitigation targets.

9.2 Conclusions and recommendations on implementation of the TA and the next steps

The TA's objectives were achieved through the proposed NGCP. Specifically, the implementation of the two main components and outputs has been made with the following details:

- an in-depth study and national survey to assess the current state including the technology available, market status, and international/national policies of the cooling sector in Viet Nam that were conducted from March to November 2023 with Deliverable 1 - Inception Report and Deliverable 2 - Milestone Report 2.
- based on the current state of the cooling sector, NGCP promotes conversion to high EE and low carbon technologies and increases energy savings in the cooling sector was developed from November 2023 to January 2024 with Deliverable 3 - Milestone Report 3 and Deliverable 4 - Final Report in March 2024.

In addition, within the framework of TA, the consultant had provided technical contributions to the two draft decisions of the Prime Minister: i) Draft Decision on promulgation of a National Plan on Management Plan for phasing out Ozone Depleting Substances and controlled GHGs ii) Draft Decision on promulgation of regulations on environmental criteria and confirmation of projects granted green credit and issuance of green bonds. The two Prime Minister's Decisions are expected to be issued in April 2024.

The Result Based Monitoring Framework of the NGCP as required by ETP is presented in Annex 2.

Throughout the implementation of the TA, the close consultations with the DCC, MONRE and other key relevant stakeholders from other line ministries, governmental agencies, associations, research institutes and cooling industries have been maintained in order to seek the feedbacks/recommendations. These consultations ensure the consistency of the outcomes, findings and Deliverables under the TA with the existing along with the planning policies and practices.

To sustain the results and research as well as develop the results of this TA, the following activities should be considered for implementation:

- Implementation of the Prime Minister's Decision on the Management Plan for phasing out Ozone Depleting Substances and controlled GHGs: DCC will need additional technical support to develop guidelines according to the Decision to implement the Decision and organise training courses and instructions for relevant stakeholders needed after the issuance of this Decision to ensure successful implementation in the short and long term

- Mobilisation of technical assistance/support to implement the Viet Nam's commitments under the Global Cooling Pledge.
- Support for implementation of the pilots of investment projects in the green cooling: three financing models that seem to be most suitable for Viet Nam, under the different phases of the cooling value chain are recommended to be considered further for pilot activities as the following up activities after closing this TA, namely i) Cooling as a service ii) Trade in and iii) Generation and sale of ITMOs under Article 6.2 of the Paris Agreement.

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10 ANNEX

Annex 1: Roadmap for NGCP

The roadmap for the implementation of NGCP is proposed in Table 16 below:

Table 16: Roadmap for NGCP implementation

No.	Task	Responsible entities	Timeframe						Financial resources
			2024-2030	2031-2035	2036-2040	2041-2045	2046-2050	2051 onward	
1	**Reviewing current, developing new policies and enforcing them to ensure penetration and use of climate-friendly cooling equipment in line with NDC, JETP and NZT**								
1.1	Until 2030 ratchet up the MEPS for single-split AC by at least 50% from the current level in TCVN:7830 2021 through equal annual increases of the MEPS, and ensuring their enforcement;	MOIT, MOST and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
1.2	From 2030 to 2050 ratchet up the MEPS for single-split AC by at least 80% from the current level in TCVN:7830 2021 through equal increases of the MEPS every five years, and ensuring their enforcement;	MOIT, MOST and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
1.3	Until 2030 ratchet up the MEPS for Domestic Refrigeration by at least 15% from the current level in 2021 through equal annual increases of the MEPS, and ensuring their enforcement;	MOIT, MOST and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
1.4	From 2030 to 2050 ratchet up the MEPS for Domestic Refrigeration by at from the current level in 2021 through equal increases of the MEPS every five years, and ensuring their enforcement;	MOIT, MOST and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
1.5	Ratchet up the Energy Labelling Programme for Domestic Refrigeration in line with the updates of the MEPS as specified above, and ensure its enforcement;	MOIT, MOST and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
1.6	Expand the MEPS to other cooling equipment such as VRV/VRF, chiller, Industrial refrigeration compressors, and others, with a view of MEPS for chillers to be at least 15% above the 2021 average efficiency level of new chillers in 2030 and 20% higher in 2050, and MEPS for industrial refrigeration to be at least 7% above the 2021 average efficiency level of	MOIT, MOST and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector

No.	Task	Responsible entities	Timeframe						Financial resources
			2024-2030	2031-2035	2036-2040	2041-2045	2046-2050	2051 onward	
	new such appliances in 2030 and 10% higher in 2050; and ensuring their enforcement;								
1.7	Revise, amend, supplement and enforce regulation on controlling import/export, usage and production of HFCs and equipment using HFCs in line with the Kigali Amendment phasedown schedule;	MONRE and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
1.8	Revise, amend, supplement and enforce technical standards and regulations on recovery of refrigerants in servicing and using of cooling equipment to achieve 20% recovery of refrigerants at the end of life of cooling appliances by 2030 and 100% by 2050;	MONRE and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
1.9	By 2025, revise, amend, supplement and enforce criteria for climate friendly cooling equipment products in public procurement in order to prioritise such equipment;	MOF, MOST and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
1.10	Revise, amend, supplement and enforce technical standards and regulations for monitoring and verification of refrigerant usage and deployment in the cooling equipment, starting with a comprehensive inventory of HCFCs and HFCs in the AC and refrigeration sector;	MONRE, MOIT, and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
1.11	By 2025, develop a manual and guidelines on the inspection, supervision, and evaluation of the implementation of legal regulations on MEPS, Energy labelling and HCFC phase out as well as HFC phase down.	MOST, MOIT, MONRE and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
2	**Harnessing technical and financial resources from multiple channels, including the direct state budget, international support or private resources to promote efficient and low-GHG cooling equipment production and mainstream successful business models and financing schemes for their upscaling**								
2.1	Undertake regular needs assessments of local cooling equipment manufacturers/ cooling servicing providers to enable compliance with the new MEPS and Energy labelling systems;	MOIT							☑ State budget ☐ International support ☐ Private sector
2.2	Mobilise domestic and international technical and financial resources to meet the needs of local cooling equipment manufacturers/ cooling servicing providers to comply with the new MEPS and Energy labelling systems and more generally to enable the production and use of climate-friendly cooling equipment and appliances;	MOIT and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector

No.	Task	Responsible entities	Timeframe						Financial resources
			2024-2030	2031-2035	2036-2040	2041-2045	2046-2050	2051 onward	
2.3	Enhancing the capacity of research and development institutes, training institutions, and subject matter experts, trainers on energy best practices regarding the implementation of, energy saving cooling equipment, financing and business models, and ESCO models, among others;	MOIT and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
2.4	By 2025, revise, amend and supplement legal regulations in order to scale up ESCOs.	MOIT and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
3	**Capacity building on the handling, usage, O&M of high efficiency and low GHG refrigerant cooling equipment and design of projects upscaling use of such equipment as well as life cycle management of controlled substances**								
3.1	Conduct training of technicians on best practices in installation, commissioning and maintenance, and accreditation of technicians ensuring the safety of equipment, avoiding and minimising refrigerant leakages and ensuring enhanced maintenance to cover 100% of servicing technicians by 2030;	MONRE, MOLISA and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
3.2	By 2025, integrate climate-friendly cooling equipment and refrigerants in vocational training of cooling sector professionals;	MONRE, MOLISA and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
3.3	Capacity enhancement for officials and Government agencies on all levels ranging from the central to local regarding economical and efficient use of energy in the cooling sector as well as replacement of HCFCs and HFCs by climate-friendly refrigerants;	MOIT, MONRE and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
3.4	Regular updating and compiling of training materials, technical documents, and instructional materials, in line with global best practices and technology advancement;	MONRE, MOLISA and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
3.5	Incorporate the EE and conservation as well as replacement of HCFCs and HFCs in the cooling sector in the education curriculum;	MOIT and relevant stakeholders							☑ State budget ☐ International support ☐ Private sector
3.6	Consolidate and strengthen the network of technical experts and service organisations on energy saving and phasedown of HCFCs and HFCs nationwide on the central to local level;	MONRE, MOLISA and relevant stakeholders							☑ State budget ☐ International support

No.	Task	Responsible entities	Timeframe						Financial resources
			2024-2030	2031-2035	2036-2040	2041-2045	2046-2050	2051 onward	
									☐ Private sector
3.7	For energy users, develop plans for training and enhancing the capacity for economical and efficient use of cooling equipment and organise seminars and conferences to guide, discuss and share experiences on such use;	MOIT and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
3.8	For FIs: Organise training programs to improve the capacity of appraising projects granting loans in the field of production and use of climate-friendly cooling equipment;	MONRE, MOIT and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
3.9	For socio-political organisations, social organisations and professional associations: Training and disseminating initiatives, experiences, and solutions to economical and efficient use of climate-friendly cooling equipment;	MONRE, MOIT and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
3.10	Facilitate partnerships between the Government, industry associations, and private sector entities to jointly invest in training initiatives and related infrastructure development. Establish a task force to oversee and coordinate these collaborative efforts.;	MOIT, MONRE and relevant stakeholders							☑ State budget ☑ International support ☐ Private sector
4	**Awareness raising regarding climate-friendly cooling equipment**								
4.1	Integrate climate-friendly cooling equipment and appliances in the awareness raising campaigns and mass communication plans to raise the awareness and responsibility of the community, businesses, and society for energy saving under VNEEP and other EE programs;	MOIT							☑ State budget ☑ International support ☐ Private sector
4.2	Integrate contents on climate-friendly cooling equipment in communication programs under VNEEP and other EE programs on energy-saving products, including educational programs; provide information for businesses and communities; hold contests and prizes regularly; run movements/campaigns to promote energy saving and environmental protection; arrange fairs and exhibitions promoting energy-saving products and technologies;	MOIT							☑ State budget ☑ International support ☐ Private sector
4.3	Highlight financial savings and short payback periods of energy efficient cooling equipment.	MOIT							☑ State budget ☑ International support ☐ Private sector

Source: Compiled by consultant