DEPARTMENT OF THE ENVIRONMENT

# BELIZE'S NATIONAL COOLING PLAN PROPOSAL

# 2022

KIGALI
COOLING EFFICIENCY PROGRAM

UNDP

UN environment
United Nations Environment Programme

# Foreword

Space cooling is the world's largest consumer of household energy and will rise significantly by 2050. As a result, space cooling demand and energy consumption will grow. Cooling demand growth is likely in the coming years as the economy expands and the population grows. As the demand for cooling rises, so will refrigerant and energy consumption. The Kigali Amendment to the Montreal Protocol aims to phase out HFCs, simultaneously increasing energy efficiency. Cooling is essential to Belizean society; it impacts agriculture, food production, space cooling, health, and transportation.

Increasing energy efficiency and lowering Green House Gas (GHG) emissions in Refrigeration and Air Conditioning (RAC) sector will generate environmental benefits. Improving energy efficiency is the most cost-effective and long-term mechanism to enhance Belize's economy and environment. The market shift toward energy-efficient and low-GWP equipment is critical to long-term economic and environmental development. For this initiative to be successful, a multi-stakeholder, synergistic approach is required. This National Cooling Plan Proposal (NCPP) combines policy and organizational elements from various stakeholders.

The National Cooling Plan Proposal will address long-term cooling in Belize's various sectors. As a result, the NCPP calls for energy-saving measures and low-GWP refrigerants. Finance and policy initiatives, capacity building and partnership initiatives, monitoring, verification, and enforcement must all be implemented to ensure long-term cooling. The NCPP's implementation framework streamlines how these initiatives will be carried out sector-wise.

I want to thank the representatives from government departments/ministries, industry, vocational institutions, and individual RAC industry experts for their participation. Their expertise and assistance have been invaluable to all initiatives. I am grateful to everyone who helped make the NCPP a reality.

Mr. Anthony Mai
Chief Environmental Officer

## Acknowledgments

The creation of Belize's National Cooling Plan Proposal (NCPP) was a collaborative effort involving various national government agencies, public agencies, the private sector, industry associations, and vocational institutions offering Refrigeration and Air Conditioning (RAC) programs.

Key Stakeholders:

- National Government and Agencies (Energy Unit (Ministry of Public Utilities, Logistics, and E-governance), Central Building Authority, Bureau of Standards, Ministry of Finance, Economic Development & Investment, Ministry of Foreign Affairs, Attorney General Office, Customs Department, Policy Unit (Ministry of Sustainable Development, Climate Change and Disaster Risk Management of Belize), Ministry of Health, Belize Tourism Board, Public Utilities Commission (PUC).
- Public agencies (Belize Chamber of Commerce & Industry)
- Private Sector (Industries, Importers)
- Industry Associations/ Non-Profit Organizations (Association of Architects, Association of professional engineers, Association of Refrigeration and Air Conditioning Technicians, Belize Hotel Association
- Vocational Institutions with RAC curriculum

The National Cooling Plan Proposal is the result of collaboration between the Department of the Environment (DOE), the National Ozone Unit (NOU) within the DOE, the United Nations Development Program (UNDP), and the Kigali Cooling Efficiency Program (KCEP).

The consultancy gratefully acknowledges the contributions of all others who have contributed in some way to the project's success.

## Executive summary

This document proposes a National Cooling Plan (NCPP) for the RAC sector in Belize, establishing measures for sustainable cooling. The two primary goals for sustainable cooling in the RAC sector are energy efficiency and direct/indirect GHG emission reduction. Therefore, this would necessitate national-level synergies between climate change mitigation and energy efficiency.

Data collection for analysis was conducted in two stages. The first stage entails secondary information, including the Belize HCFC/HFC Consumption Survey Report 2018-2020, legislative and policy documents of Belize, Annual Energy Reports, Belize Electricity Limited Annual Reports, and online sources. The second stage involved primary information from interviews with various stakeholders and meetings with the Belize Energy Unit, Belize Bureau of Standards (BBS), and the private sector. Utilizing the data analysis, a draft report was produced and presented to selected stakeholders during workshops. The various stakeholders were consulted regarding the viability of projects in the NCPP.

The main factors driving the future demand for RAC appliances in Belize include demographic and socio-economic factors, climate & Environmental Factors, lack of access to cooling, and cold chain supply.

Policies that address climate change in Belize that affect the RAC sector are Climate Action Plan for Belize, Updated Nationally Determined Contribution (NDC) (2021), Low Emission Development Strategy (LEDS) for Belize for the period 2020-2050 (2021), Technology Action Plan for Climate Change Adaptation and Mitigation (2018), Third National Communication to the UNFCCC (2016), Low Carbon Development Roadmap for Belize (2016), National Environmental Policy and Strategy for the period 2014-2024 (2014), National Climate Resilience Investment Plan (2013), and Horizon 2030 – Long Term National Development Framework for Belize (2011).

There are policy instruments that address climate change specific to energy in Belize. These include Climate and Sustainability Goals, Ministry of Energy, Science & Technology and Public Utilities Strategic Plan for the period 2012-2017 (2012), National Energy Policy Framework 2014-2030 (2011), Belize Sustainable Energy Strategy and Action Plan, Sustainable Development Goal 7, and Nationally Determined Contributions (NDCs).

R-134a, R-410A, R-404A, R-507a, R-407c, and R-422b are pure HFCs and blends imported into the country from 2017 to 2021. R-134a makes up 37.34% of the total imported refrigerant mass, followed by R-410A (26.86%) and R-404A (10.86%). These three refrigerants account for 75.1% of the total import market. Between 2017 and 2021, HCFC-22 (135.6 MT) accounted for 23.5% of refrigerants imported.

Belize's most imported equipment types (excluding mobile air conditioning) are domestic refrigerators/freezers, stationary AC units, and commercial refrigerators/freezers. Industrial refrigerators and freezers were seldom imported. All the equipment imported into Belize primarily utilize HFC refrigerants.

Challenges to introducing energy-efficient, low-GWP technologies include the following: There are no incentives for investing in EE, low-GWP equipment, technical staff lack knowledge in good practices for the installation, maintenance, and operation of low-GWP technologies, end-user ignorance about energy conservation and energy efficiency, and the prevalence of obsolete technologies and practices.

Multi-stakeholder and collaborative development are incorporated into the NCPP. The National Ozone Unit (NOU) will serve as the coordinating body of the NCPP. The NOU will establish mechanisms for effective inter-government and triple-sector engagement comprised of selected stakeholders. A steering committee, as well as three working groups, will be formed from these stakeholders. Group 1 will be responsible for developing policy instruments and financing; Group 2 will be responsible for developing capacity-building and partnership initiatives; and Group 3 will monitor, verify, and enforce.

The NCPP will be organized around three work groups to address significant challenges in the RAC sector and to advance toward efficient technologies with alternative low-GWP refrigerants. It also seeks to maximize the benefits of national collaboration with various EE and climate change mitigation policies and programs. Figure 1 depicts the specific actions that NCPP should implement in each working group. Input from workshops directly analogous to the NCPP's purpose is included in the recommended measures.

**1. Development of policy instruments and Finance**

- 1.1 Implementation of MEPS & labeling standards
- 1.2 Implementation of MEES, Building codes
- 1.3 Safety standards for Natural Refrigerants
- 1.4 Assessment of Funding and Financial Mechanisms for Market Transformation

**2. Capacity Building and Partnership Initiatives**

- 2.1 Training & Capacity Building
- 2.2 Outreach and Communication
- 2.3 Opportunities for Regional Collaboration
- 2.4 Bulk Procurement
- 2.5 Retrofitting equipment to use low-GWP equipment & to increase energy efficiency
- 2.6 Mechanisms for Recovery, Recycling, Disposal of Refrigerants & waste management of decommissioned equipment.

**3. Monitoring, Verification, and Enforcement**

- Includes all the NCP standards to be established
- Monitoring and Evaluation of NCP implementation

Figure 1: Strategic guidelines for the general actions to be taken for the National Cooling Plan Proposal

Minimum Energy Efficiency Standards (MEES) for buildings, Minimum Energy Performance Standards (MEPS) for equipment, use of low-GWP equipment, use of renewable energy to meet cooling demand, safety standards, capacity building initiatives, retrofitting, and incentives for alternative technologies are all approaches to increasing energy efficiency and lowering GHG emissions in the RAC sector.

Figure 1 above illustrates the general actions to be taken for the NCPP. However, it is essential to incorporate these initiatives in a sector-wise analysis of the RAC sectors in Belize. Included are short-, medium-, and long-term recommendations where applicable. These incorporate capacity building, safety standards, good practices in refrigeration, outreach & communication, and the introduction of alternative equipment. The intervention scenarios will reduce energy consumption through efficient equipment and building structures and facilitate direct/indirect reductions in greenhouse gas emissions.

## Sector-wise analysis

This section examines the different sectors of Belize's RAC industry. The relevant sectors are building space cooling, cold chain and refrigeration, mobile air conditioning, research and development, and servicing.

### Space cooling in Buildings

With population growth, climate change, and rising temperatures, Belize's energy consumption and demand for space cooling will increase. As a result, the NCP must implement effective policies and technologies.

MEES (building codes) reduce cooling demand in buildings, allowing for more efficient equipment operation. MEPS and energy labeling for air-conditioning equipment are two essential measures for lowering the energy required for space cooling. MEPS and labeling will include non-ducted unitary systems, mini- or single-split systems, and window unit configurations. It is also critical to integrate renewable energy into space cooling programs.

Due to the Kigali Amendment, HFC-32 and Hydrocarbon refrigerants consumption will rise while HFC-410A consumption will reduce.

### Cold chain & Refrigeration

The cold chain is a logistical chain of events that includes packing, storing, and transporting perishable food commodities from their point of importation or manufacture to their point of consumption.

Many alternative technologies are emerging in the refrigeration sector; harnessing the application of technologies applicable to the Belizean perspective is critical.

MEPS will target refrigerators and freezers in Belize; this will impact both domestic and commercial refrigeration. Natural refrigerants infiltration in the cold chain sector will decrease the HFC demand in the future; hydrocarbons, $CO_2$, and ammonia are all considered natural refrigerants.

### Mobile Air conditioning

The automobile market expands in lockstep with the population. As a result, the demand for Mobile Air Conditioning (MAC) is increasing. It is critical to develop policy measures in this sector to reduce high GWP refrigerant consumption and increase fuel efficiency.

HFC-134a dominates the refrigerant market in mobile air conditioning. The NCP can direct initiatives toward alternative refrigerant applications in the sector and increase fuel efficiency to reduce direct GHG emissions. Although Belize has no authority over vehicle manufacturing, relevant stakeholders can monitor the refrigerant use and fuel energy efficiency of vehicles imported into the country. Policy initiatives can aid this transition.

The overall goal of this sector is to reduce direct and indirect GHG emissions in MAC. Using natural/alternative refrigerants will reduce direct GHG emissions, and advancing toward fuel-efficient, electric/hybrid vehicles will reduce indirect GHG emissions.

### Research & Development

Research & Development (R&D) is essential for long-term sustainable cooling and thermal comfort. R&D innovation necessitates an additional scientific labor pool and the necessary academic and R&D-enabling environment. Therefore, participation in R&D activities on various cooling aspects, such as refrigerants, cooling equipment, passive building design interventions, emerging technologies, and industry readiness to assimilate new technologies is necessary.

### Refrigeration & Air Conditioning Servicing sector

In Belize, the service sector is divided into formal and informal sectors. Most of the servicing industry is estimated to comprise the informal servicing sector. In 2021, approximately 300 licensed technicians were accounted for, according to the Association of Refrigeration and Airconditioning Technicians (ARACT) licensing scheme. Training is essential for service technicians to understand the technical operation and servicing of emerging alternative technologies and natural refrigerants' safety/occupational hazards. All training programs must include energy efficiency (EE) and alternative refrigerants to HFC.

Vocational institutions with RAC programs provide level 1, level 2, and level 3 training; the levels provided correspond to the number of years of training received by the individual. The vast majority of technicians in Belize are uncertified and are classified as informal. As a result, expanding the certification/licensing scheme so that the majority, if not all, of the RAC sector, are certified/licensed is critical.

The RAC sector in Belize has a significant deficiency of tools. The primary cause is the exorbitant costs; most technicians cannot afford to purchase tools. Training infrastructure is insufficient, requiring cutting-edge equipment for more hands-on training. Therefore, this highlights the need for training centers to adequately improve their training infrastructure to train for the transitioning RAC sector.

Servicing is delivered through three channels. Manufacturing companies, third-party Servicing Companies, and freelance Technicians are among them.

The NCP must address all of the constraints in the sector. Additional initiatives to be launched in this sector include market research, demand assessment, curriculum revision or enhancement, and certification scheme enhancement.

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# List of Acronyms & Abbreviations

| | |
|---|---|
| ARACT | Association of Refrigeration and Air Conditioning Technicians |
| AC | Air Conditioning |
| BBS | Belize Bureau of Standards |
| BEL | Belize Electricity Limited |
| CARICOM | Caribbean Community and Common Market |
| EE | Energy Efficient |
| GDP | Gross Domestic Product |
| GHG | Green House Gas |
| GOB | Government of Belize |
| GSDS | Growth and Sustainable Development Strategy |
| GWH | Giga Watt Hour |
| HC | Hydrocarbon |
| HCFC | Hydrochlorofluorocarbon |
| HFC | Hydrofluorocarbon |
| LEDS | Low Emission Development Strategy |
| Low-GWP | Low Global Warming Potential |
| MAC | Mobile Air Conditioning |
| MEES | Minimum Energy Efficiency Standards |
| MEPS | Minimum Energy Performance Standards |
| NCPP | National Cooling Plan Proposal |
| NCCPSAP | National Climate Change Policy Strategy Action Plan |
| NF | Natural Refrigerant |
| NOU | National Ozone Unit |
| NDCs | Nationally Determined Contributions |

| | |
|---|---|
| OPAL | Online Permit Application Licensing System |
| PUC | Public Utilities Commission |
| RAC | Refrigeration and Air Conditioning |
| RE | Renewable Energy |
| SDGs | Sustainable Development Goals |
| TWH | Terawatt Hour |
| UNFCCC | United Nations Framework Convention on Climate Change |
| CREEBC | CARICOM Regional Energy Efficiency Building Code |
| CROSQ | CARICOM Regional Organization of Standards and Quality |
| CRS | CARICOM Regional Standards |

## 1. Introduction

The importance of refrigeration and air conditioning (RAC) in contemporary life is well acknowledged. The significance of RAC technologies is felt widely across the nation due to their effects on vaccine distribution and storage, food sector production and processing, cold chain connections, mobile air conditioning, and space cooling. Henceforth, cooling needs directly affect agriculture, the food industry, the building sector, health, and transport. Belize is especially salient in the dairy, meat, and poultry industry, which require refrigeration for processing and the sequential cold chain movement.

The energy used for space cooling increased threefold between 1990 and 2016 and is the component within buildings with the fastest growth in global energy consumption. 6,200 Tera Watt Hours (TWh) of energy is projected to be consumed by space cooling alone by 2050. This is explained by the 70% growth, especially in the residential sector. Equipment used in the RAC industry emits greenhouse gases (GHGs) due to leaks or poor refrigerant disposal (direct GHG emission). However, the generation of the electricity required to run this equipment can also add to the emissions of greenhouse gases (indirect GHG emissions). Although it is well known that fossil fuels are primarily utilized to generate power, several programs are in place to boost the usage of renewable energy as a source of electricity (International Energy Agency, 2018).

This document first analyzes RAC and energy sectors. An in-depth examination of Belize's RAC sector, stressing the critical components taken into account before proposing mitigation solutions to reduce GHG emissions and increase energy efficiency. These variables include the primary factors driving future demand for RAC appliances in Belize, policy instruments relating to energy efficiency and GHG emission reduction in Belize, equipment/refrigerant imports and classification, RAC servicing sector, Belize’s electricity sector and mix, the regulatory structure of the electricity subsector, and the policy framework.

Secondly, the NCPP comprises developing mitigation actions to reduce GHG emissions and boost energy efficiency in the RAC sector. The NCPP incorporates conservation, climate action, and energy efficiency to create sustainable cooling throughout Belize.

It is a known fact that RAC technologies are important in Belize. However, most of these technologies utilize HFC refrigerants, which have a high global warming potential (GWP). The Kigali amendment to the Montreal Protocol will require Belize to phase down HFCs and increase energy efficiency in the RAC sector. It is, therefore, critical to synergize the NCPP with international commitments such as the Kigali Amendment, the Paris Agreement, and the Sustainable Development Goals (SDGs).

## 2. National Background

### 2.1 Data collection

The methodology used to collect all the background information and data required to develop this National Cooling Plan Proposal was in two stages. The first stage entailed secondary information from different documents that were reviewed and analyzed, including the Belize HCFC/HFC Consumption Survey Report 2018-2020, legislative and policy documents of Belize, Annual Energy Reports, Belize Electricity Limited Annual Reports, and online sources for demographic, socio-economic, climatic and environmental factors for Belize, and other NCPPs.

The second stage involved primary information from interviews with various stakeholders and meetings with the Belize Energy Unit, The Belize Bureau of Standards (BBS), and other relevant stakeholders.

Based on data collection and analysis, a draft NCPP report was created. A stakeholder group that supported NCPP projects was formed, and the report was presented at a national stakeholder workshop to examine potential avenues for achieving the goals. Concerning the viability of projects for the NCPB, various stakeholders were consulted. After that, a validation workshop was held to finalize the NCPP initiatives. Thirty-three key holders were present throughout the workshops; the stakeholders were representatives of various types, see annex 1.

### 2.2 Main factors driving the future demand for RAC appliances in Belize

- Demographic and socio-economic factors:
  - Rate of population growth
  - Rate of economic growth/ purchasing power
  - Rate of urbanization
  - Growth of electrification
- Climate & Environmental Factors:
  - Temperature
  - Humidity
- Lack of access to cooling
- Cold chain supply

Annex 2 includes details of each driving factor for the future demand for RAC appliances.

### 2.3 Policies to address climate change in Belize

Long-term sustainable development policy documents integrating national commitments and priorities toward Climate Change mitigation and adaptation have been developed in Belize. These documents include the following:

- Climate Action Plan for Belize
- Updated Nationally Determined Contribution (NDC) (2021)

- Low Emission Development Strategy (LEDS) for Belize for the period 2020-2050 (2021)
- Technology Action Plan for Climate Change Adaptation and Mitigation (2018)
- Third National Communication to the UNFCCC (2016)
- Low Carbon Development Roadmap for Belize (2016)
- National Environmental Policy and Strategy for the period 2014-2024 (2014)
- National Climate Resilience Investment Plan (2013)
- Horizon 2030 – Long Term National Development Framework for Belize (2011)

### 2.3.1 Policy instruments to address climate change specific to energy

- Climate and Sustainability Goals
- Ministry of Energy, Science & Technology and Public Utilities Strategic Plan for the period 2012-2017 (2012)
- National Energy Policy Framework 2014-2030 (2011)
- Belize Sustainable Energy Strategy and Action Plan
- Sustainable Development Goal 7
- Nationally Determined Contributions (NDCs)

Annex 3 includes the details of each policy instrument that addresses climate change in Belize.

### 2.3.2 Existing regulations related to Montreal protocol implementation and others (refrigerant use, equipment imports).

Montreal has undergone several amendments, and Kigali is the fourth amendment done in 2016. Belize has ratified the London Amendment (1990), the Copenhagen Amendment (1992), The Montreal Amendment (1997), and the Beijing Amendment (1999). Unfortunately, Belize still needs to ratify the Kigali Amendment but is expected to do so soon.

Under The Pollution Regulation Act, the CFCs' import and export licensing system was implemented in 2002. The importation of CFC-bases systems was permitted until 2002; the importation of CFC refrigerants was phased out by 2010. Subsequently, under the Pollution regulations amendment (2009), an import license was required to import or export CFCs and HFCs.

Belize committed to Hydro-chlorofluorocarbon Phase-out Management Plan (HPMP) to reduce consumption of HCFCs by 10% between 2014 to 2019 and to achieve a 35% reduction in 2020. Belize has significantly reduced its consumption of HCFCs, and a complete phase-out is expected by 2030.

## 2.4 Refrigerant Imports

### Table 1: Historical imports of refrigerants in metric tons per year for 2017-2021

| Refrigerant Imported | Annual Imports in MT | | | | | |
|---|---|---|---|---|---|---|
| | 2017 | 2018 | 2019 | 2020 | 2021 | Total |
| HCFC-22 | 39.660 | 33.28 | 29.85 | 24.51 | 8.31 | 135.606 |
| HCFC-141b | 1.178 | 0.600 | 0.530 | 0.400 | | 2.708 |
| HFC-134a | 38.836 | 50.550 | 71.920 | 17.530 | 36.796 | 215.633 |
| HFC-410A | 44.940 | 35.960 | 33.490 | 8.720 | 32.025 | 155.135 |
| HFC-404A | 34.670 | 11.010 | 8.967 | 3.310 | 4.754 | 62.711 |
| HFC- 507A* | | | 0.230 | | 0.565 | 0.795 |
| R-407C* | | | | 0.170 | 0.565 | 0.735 |
| R-422B* | | | | 0.020 | 0.023 | 0.043 |
| Hydrocarbon- 290 | 0.394 | 0.090 | 0.764 | 0.340 | | 1.697 |
| Hydrocarbon- 600a | | 0.472 | 0.027 | 0.430 | 0.768 | 1.588 |
| HFO-1233zd* | | | | 0.030 | 0.003 | 0.778 |
| HFO-1234yf* | | | | 0.035 | 0.748 | 0.038 |

Source: Belize HCFC/HFC Consumption Survey Report 2018-2020 & Online Permit Application & Licensing System

From 2017-2021, R-134a, R-410A, R-404A, R-507a, R-407c, and R-422b comprise the HFCs pure and blends imported into the country. R-134a (215.6 MT), R-410A (155.1 MT), and R-404A (62.7 MT) are the three HFCs (pure & mixes) that are imported the most. R-134a accounts for 37.34 % of the total mass of imported refrigerant, followed by R-410A (26.86%) and R-404A (10.86%). These three refrigerants comprise 75.1% of the import market collectively. As noted above, HFC-134a is the most imported individual refrigerant; HFC-134a is primarily used in mobile air conditioning and domestic and commercial refrigeration.

HFCF-22 and HCFC-141b are two HCFC refrigerants imported into the nation. HCFC-22 was imported the most, while HCFC-141b was only occasionally imported. The HCFC-22 (135.6 MT) accounts for 23.5% of refrigerants imported between 2017 and 2021. HCFC-22 is primarily utilized in stationary air cooling, while HCFC-141b was used as a flushing agent. It's significant to note that there was no HCFC-141b importation in 2021.

## 2.5 Equipment Imports

### Table 2: Number and types of equipment imported 2017-2021

| Type of Equipment | Imported in 2017 | Imported in 2018 | Imported in 2019 | Imported in 2020 | Imported in 2021 |
|---|---|---|---|---|---|
| Domestic refrigerators/freezers | 14,403 | 9,324 | 13,759 | 2,778 | 12,104 |
| Commercial refrigerators & freezers, | 4,283 | 1,803 | 1,102 | 2,544 | 3,539 |

| | | | | | |
|---|---|---|---|---|---|
| Industrial refrigeration & freezers | | 5 | 1 | 4 | |
| Stationary AC units | 11,771 | 8,492 | 11,733 | 1,613 | 10,575 |

Source: Belize HCFC/HFC Consumption Survey Report 2018-2020 & Online Permit Application & Licensing System

Belize's most imported equipment type is domestic refrigerators/freezers, stationary AC units, and commercial refrigerators/freezers. Industrial refrigerators and freezers were seldom imported.

## 2.6 Classification of Belize's RAC sector according to the equipment type and alternative refrigerants as per the Kigali Amendment

### Refrigeration:

- Domestic refrigeration
    - 89% of the market is made up of HFC-134a-containing equipment, while HC-600a makes up 11%.
        - The recommended replacement for HFC-134a is the refrigerant HC-600a.
- Commercial refrigeration (standalone equipment, Upright Cooler/refrigerated display cases for beverages, chest type freezers, walk-in cooler, etc.).
    - 68% of the market is made up of HFC-134a-containing equipment, 15% of it is HFC-404A, 12.5% is HC-600a, and 4% is HC-290.
        - The recommended replacement for HFC refrigerants is the refrigerant HC-290, which is expected to take over in the forthcoming years.
- Industrial refrigeration (Used in the food and beverage industry- industrial walk-in freezer, etc.).
    - The market share of equipment containing HFC-404A is 55%, followed by HFC-134a (23%), HCFC-22 (12%), R-717 (8%) and R-499a (2%).
        - The recommended low-GWP refrigerant alternative is R-717(ammonia)
- Refrigerated transportation (e.g., trucks)
    - 84% of the market comprises equipment using HFC-404A, whereas 16% of all refrigerated transportation is composed of HCFC-22.
        - R-744 ($CO_2$) and HFO-1234yf have been considered viable low-GWP alternatives.

### Air Conditioning:

- Stationary air conditioning (splits, compact equipment, chillers)
    - Residential equipment (compact equipment, wall-mounted split) and commercial (Close control, Rooftop unit, Ducted commercial split, VRF, Multi-split)

        - 83.47% of the market is made up of HFC-410A, whereas 16.14% is composed of HCFC-22. Few pieces of equipment containing HFC-32 were seen in the market.
            - The low-GWP refrigerant that is recommended, especially for smaller systems, is HC-290. Given that it has lower flammability than C-290, HFC-32 is a viable option for larger systems.
    - Air conditioning systems (Chillers)
        - The market share of equipment containing R-410A is 50%, followed by HFC-407c-33%, and HFC-134a-17%.
            - HFC-32 is a viable low-GWP refrigerant replacement.
- Mobile air conditioning
    - The market share of equipment containing HFC-134a is 91.5%, followed by HFO-1234yf with 8.5%.
        - In Belize, all mobile vehicles are imported; hence, there is no internal jurisdiction over the type of refrigerants used. However, the emerging trend is that HFO-1234yf, an alternative to HFC-134a, is used in newer model vehicles. Hence, it is expected that HFC-134a will be phased out parallel to international vehicular market trends.

## 2.7 Technology suppliers

There are forty-six importers of equipment and ten importers of refrigerants. The online system, Online Permit Application & Licensing System (OPAL), does not include retailers of refrigerants, which may include all hardware, retail, and auto shops in the nation.

As cooling demand rises, so does the need for RAC equipment. The increased use of RAC equipment presupposes more servicing. The servicing sector directly impacts refrigerant consumption and equipment energy efficiency. The Kigali Amendment will induce the phase-down of HFC refrigerants, and natural refrigerants will be widely employed. In particular, hydrocarbon refrigerants, ammonia, and HFC-32 will saturate the space cooling and refrigeration sector. These refrigerants are known to be flammable, toxic, or hazardous. Hence In Belize, the safe handling and best practices of such equipment are a significant impediment to the Kigali amendment initiative. As a result, it is critical to address these issues.

## 2.8 Electricity Sector & Energy Matrix

Through several mitigation and adoption measures, Belize has been striving to create a low-carbon economy and increase its capacity to resist climate change. Due to its geographical location, which allows for the possibility of harnessing vast amounts of renewable energy, Belize has the opportunity to diversify its energy mix.

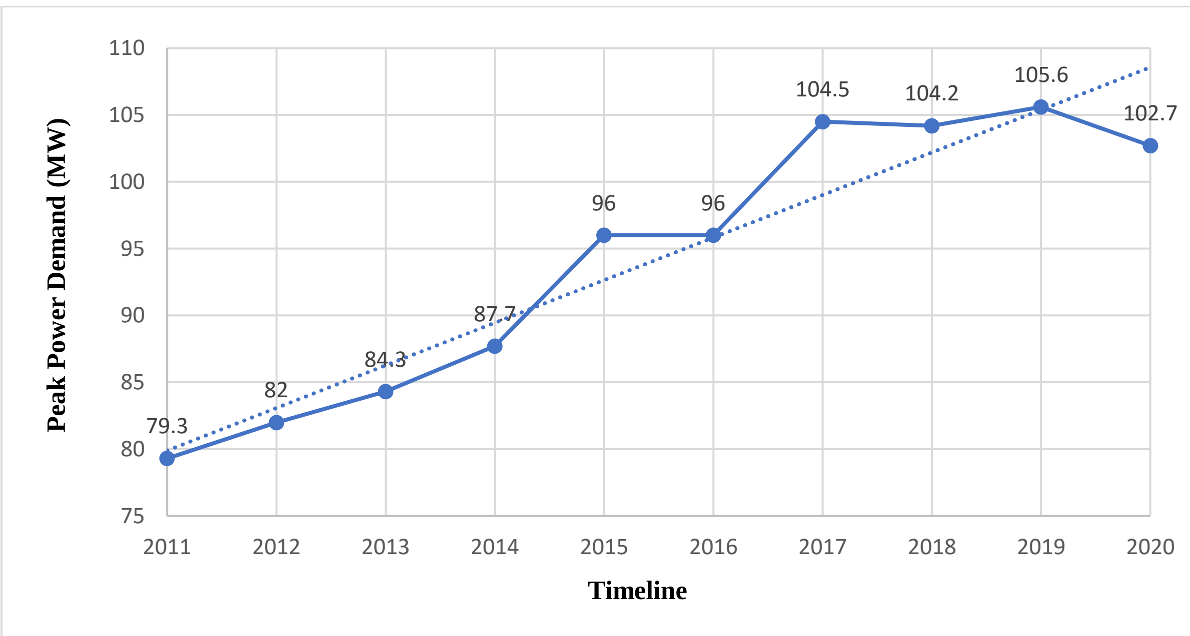
Belize produces a small amount of crude oil; no refinery is present. Belize, therefore, imports petroleum products and secondary fuels.

### 2.8.1 Installed Electricity Generation Capacity

In 2020, Belize's installed capacity was 131.7 Mega Watts (MW). Of this total, 58% was ascribed to renewable energy and 42% to non-renewable generation. The total installed capacity does not include electricity imports. National energy imports consist of electricity from Mexico's state utility, Comisión Federal de Electricidad (CFE)

### 2.8.2 Peak Electricity Demand

Between 2011 and 2020, Belize's peak electricity demand experienced a general increase (Figure 2). Population growth and the expansion of economic activity are the main drivers of this overall increase.




Source: Energy Unit. (2021). 2020 Annual Energy Report. Ministry of Public Utilities, Energy & Logistics, Belmopan City, Belize.

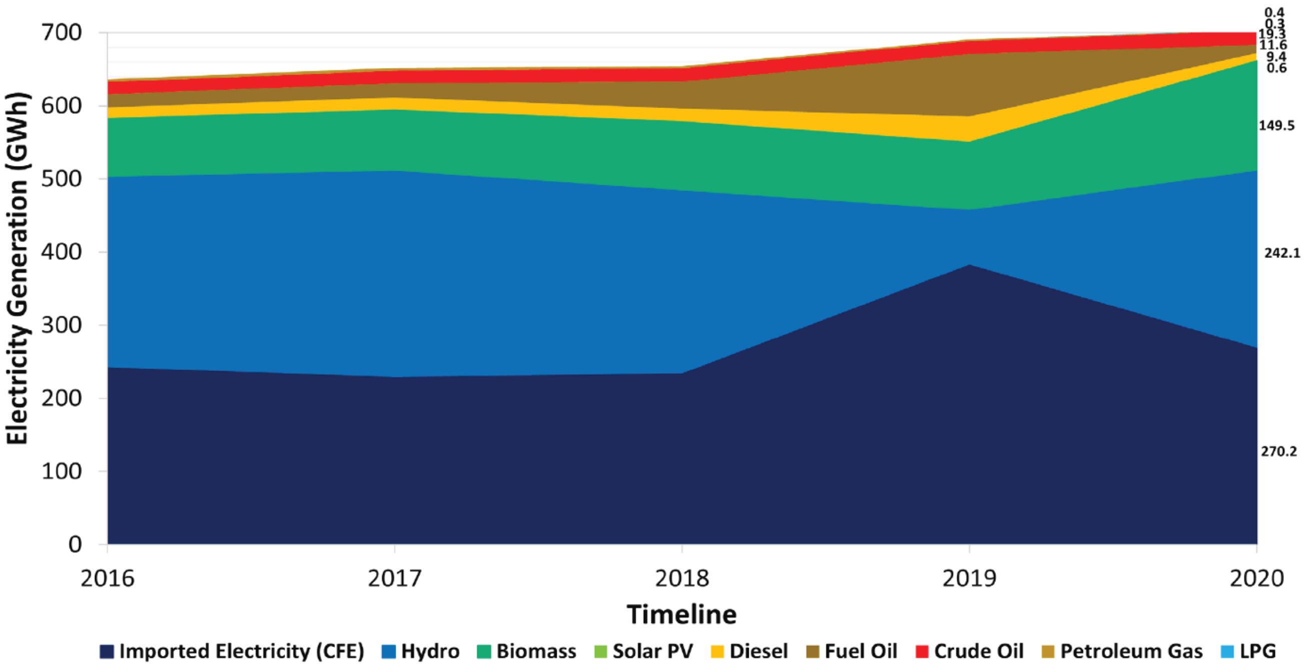
Figure 2. Historical timeline of Peak Power Demand in Belize.

### 2.8.3 Gross Electricity Production

The gross electricity production in Belize has shown a general increase from 2011-2020 (Annex 4). A general increase in electricity production is anticipated since it has an intimate relationship with the country's installed capacity and power demand.

### 2.8.4 Electricity Production by fuel type

Electricity imports from Mexico accounted for the most significant single electricity supplier in 2020 with 270.2 GWh, followed by hydropower with 242.1 GWh, and biomass with 149.5 GWh. This overall trend is visible for the years 2016 through 2020. Crude oil, with 19.3 GWh; fuel oil, with 11.6 GWh; diesel, with 9.4 GWh; solar photovoltaic, with 0.6 GWh; LPG, with 0.4 GWh; and natural or petroleum gas, with 0.3 GWh, are additional, less significant contributors to the mix of energy sources that generate electricity (Figure 3.).




Source: Energy Unit (2021).

Figure 3. Historical Timeline of Electricity production by fuel type.

### 2.8.5 Electricity Production by Fuel and Technology Share in 2021

Indigenous renewable energy (RE), imported electricity, and non-RE each comprised 39.6%, 51%, and 9.4% of the total electricity generation by supply type. The growing importance of renewable energy in Belize's electrical mix is congruent with the strategic and policy commitments Belize made as part of its transition to a sustainable energy future (Annex 4).

### 2.8.6 Electricity Generation mix by supply technology in 2021.

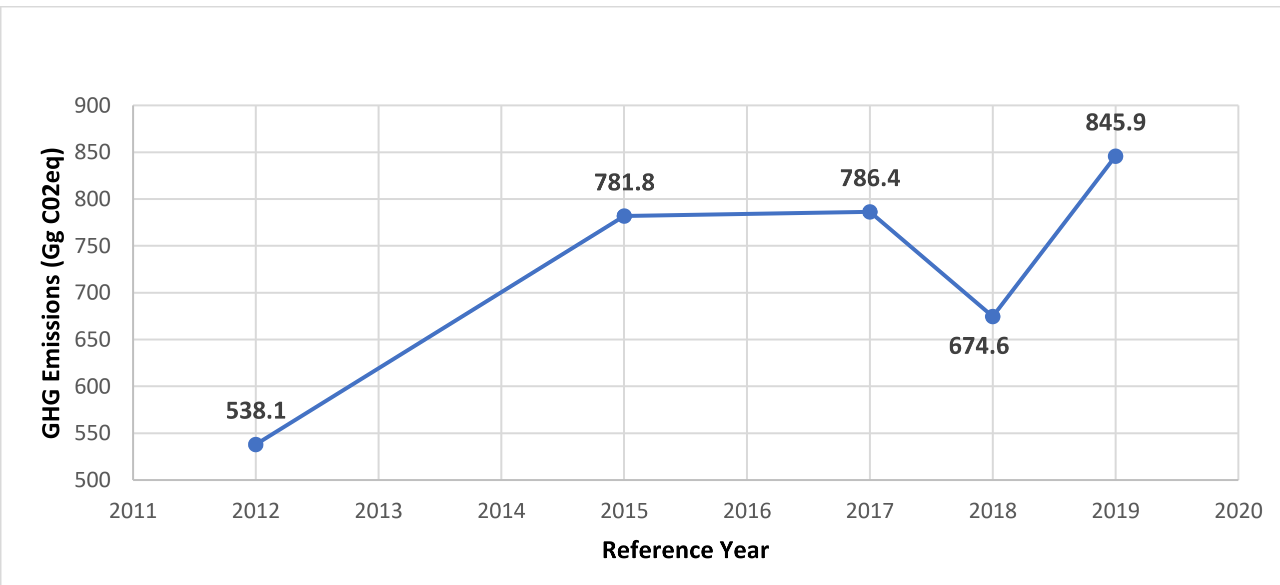
Displays renewable energy sources, fossil fuel sources, electricity imports, and the generation mix per said sectors (Annex 4).

### 2.8.7 Gross electricity consumption by Sector

Electricity consumption in the commercial, industrial, residential, and street lighting sectors can be found in Annex 4. With 249.8 GWH, the commercial sector in Belize had the highest gross electricity consumption in 2020. The residential sector came in second with 245.5 GWG of gross electricity consumption. Following that, with 24.645 and 19.5 GWG in 2020, the industrial and street lighting sectors consumed significantly less gross energy (Belize Electricity Limited's Annual Report, 2021). The RAC sector accounts for a significant portion of commercial and residential energy consumption. As a result, it emphasizes the importance of increasing EE in the RAC sector.

## 2.9 National Greenhouse Gas Emissions

Energy consumption is the primary source of GHG emissions worldwide, responsible for 75.6% (37.6 Giga tons of CO2eq). This points out the importance of targeting the energy sector to reduce global emissions (World Resources Institute, 2022). The GHG emissions are presented in carbon dioxide equivalent (CO2 eq), using the units of gigagram of carbon dioxide equivalents (Gg CO2 eq). Figure 4. displays the GHG emissions for Belize between the years 2012-2019; it can be observed that the general projection of Belize's GHG emissions is experiencing upward growth. It is important to note that this is not specific to the RAC sector alone but all GHG emissions in the country.




Source: Energy Unit (2021).

Figure 4. Total Direct GHG Emissions for the Energy Sector over reference years 2012-2019.

### 2.9.1 Total GHG Emission by Energy Sub-Sectors

The transportation subcategory accounts for a substantial proportion of Belize's overall GHG emissions, accounting for 460 and 544 (Gg CO2 eq) in 2018 and 2019, respectively. Subsequently came emissions from other industries, such as the energy sector. Compared to the other sub-sectors, oil and natural gas emissions were minimal. This data is general and does not only apply to the RAC sector (Annex 4).

### 2.10 Mean Electricity Rate

From 2012 to 2014, the mean electricity rate (MER) increased; however, from 2013 to 2016, the MER decreased. The MER gradually increased from 2016 to 2020; in particular, the MER for 2020 was recorded at 0.422 $/KWH (Annex 4).

### 2.11 Regulatory structure of electricity sub-sector

Under its license granted by the Public Utilities Commission (PUC), Belize Electricity Limited (BEL) is the sole entity responsible for generating, purchasing, transmitting, and supplying electricity throughout Belize.

#### 2.11.1 Transmission and Distribution

BEL's national energy grid connects all significant municipalities in Belize. Transmission lines connect Belize with Mexico's grid in the north and traverse from Belize's north to south. Concerning the backbone transmission lines, in particular, 115kV transmission lines span the entirety of Belize's northern and western zone, while 69kV transmission lines serve the country's southern half. BEL owns two diesel-powered power plants, a 20 MW wind turbine for energy security, and an off-grid power plant that provides Caye Caulker (Belize Electricity Limited Annual Report, 2021).

### 2.12 Energy Sector Policy and Legislative Framework

- 2000 – Electricity Act
- 2003 – Electricity Subsidiary Act
- 2012 – National Energy Policy Framework
- 2015 – Belize Sustainable Energy Strategy and Action Plan
- 2018 – Belize Consolidated Project Plan

Annex 5 contains information about each energy sector policy and legislative framework mentioned above.

### 2.13 Challenges to introducing energy-efficient, low-GWP technologies include the following:

- There are no incentives for investing in EE, low-GWP equipment, including financial, technical, and capacity-building incentives.

- Technical staff lacks knowledge of low-GWP technologies, best practices for installation and maintenance, and the need to increase capacity for refrigerant recovery, recycling, and disposal.
- End-user ignorance about energy conservation and energy efficiency opportunities and benefits.
- The prevalence of obsolete technologies and practices regarding energy efficiency and refrigerant use.

## 3. National Cooling Plan Proposal

### 3.1 NCPP Introduction

#### 3.1.1 Purpose of the NCPP

The National Cooling Plan Proposal is a plan for Belize to embrace cooling measures that can be sustainable. The plan will impact the interdependence between climate action, energy conservation, and energy efficiency implementation.

The NCPs are essential tools that governments employ to comply with the Kigali Amendment's obligations to gradually reduce HFCs while enhancing energy efficiency in the many sectors that use air conditioning and refrigeration (cooling) equipment and processes, through a plan of precise actions with defined goals, timelines, stakeholders, and resources required.

Developing an NCP strategy can offer significant benefits for Belize, including:

- Lowering costs for consumers and businesses through increased energy efficiency;
- Decreasing emissions that contribute to climate change while building a more robust, more sustainable energy system and improving air quality;
- Enhancing access to cooling to reduce food waste, enhance health, and boost productivity;
- The NCP will explore cooling growth prospects and prospective routes in Building Cooling, Cold Chain & Refrigeration, Air Conditioning & Refrigeration Technologies, R&D and Production Sector (alternative refrigerants and technologies), Servicing Sector, and Cross-cutting Policy and Regulations.

#### 3.1.2 Priorities for Belize leading to the NCP:

- Compliance with the Kigali Amendment
- Supporting SDGs
- Energy/electricity security

#### 3.1.3 The NCP is essential, but it has its challenges. Some significant limitations during the construction of this NCPP were:

- Since no single government entity is entirely responsible for cooling, a collaborative approach involving the governmental, public, and private sectors is required.
- Data accessibility, quality, and dependability.
    - Calculating RAC sector-related GHG emissions is critical but not included in this report. Understanding how much the RAC sector contributes to national GHG emissions is vital.

        - Projections under Business-as-Usual Scenario (BAU) and the implementation of the NCP.
    - Calculating RAC sector-related energy consumption is critical but not included in this report. It is essential to comprehend the extent to which the RAC contributes to energy consumption.
        - Projections under Business-as-Usual Scenario (BAU) and the implementation of the NCP.
- Uncertainties in mitigation data related to RAC sector technologies used, energy consumption, and overall GHG emissions
- The time allotted for formulating the NCPP was insufficient to include all requirements.

### 3.2 NCPP General Structure

The NCPP's organization is structured around three work groups that collectively strive to address significant challenges in the RAC sector to advance toward efficient technology with alternative low-GWP refrigerants. It also seeks to maximize the benefits of collaborating with various EE and climate change mitigation policies and programs at the national level. Figure 5 displays specific actions the NCPP should incorporate in each working group. Measures recommended include input from workshops directly analogous to the NCPP's purpose.

**1. Development of policy instruments and Finance**

- 1.1 Implementation of MEPS & labeling standards
- 1.2 Implementation of MEES, Building codes
- 1.3 Safety standards for Natural Refrigerants
- 1.4 Assessment of Funding and Financial Mechanisms for Market Transformation

**2. Capacity Building and Partnership Initiatives**

- 2.1 Training & Capacity Building
- 2.2 Outreach and Communication
- 2.3 Opportunities for Regional Collaboration
- 2.4 Bulk Procurement
- 2.5 Retrofitting equipment to use low-GWP equipment & to increase energy efficiency
- 2.6 Mechanisms for Recovery, Recycling, Disposal of Refrigerants & waste management of decommissioned equipment.

**3. Monitoring, Verification, and Enforcement**

- Includes all the NCP standards to be established
- Monitoring and Evaluation of NCP implementation

Figure 5: Strategic guidelines for the general actions to be initiated for the National Cooling Plan Proposal.

Annex 6 details the actions displayed in Figure 5.

### 3.3 Sector-wise analysis of the RAC sectors in Belize & recommendations toward sustainable cooling.

It is essential to incorporate the strategic guidelines from the general actions of the NCPP (Figure 5) in a sector-wise analysis of the RAC sectors in Belize. This includes building space cooling, cold chain and refrigeration, Mobile Air Conditioning (MAC), research and development (R&D), and the service sector. Throughout the sector-wise analysis, lines from annex 6 are incorporated. Included are short-, medium-, and long-term recommendations where applicable.

#### Interventions

Implementation of MEES for buildings, MEPS for equipment (possibly including Mobile Air Conditioning), use of low-GWP equipment, use of renewable energy to meet cooling demand, safety standards, capacity building initiatives, retrofitting, and incentivization for alternative technologies are approaches to increase energy efficiency and reduce GHG emissions.

#### Impact of Suggested Interventions

The intervention scenarios shall reduce energy consumption due to efficient equipment and building structures and facilitate direct and indirect greenhouse gas emission reduction.

### 3.3.1 Space cooling in Buildings

Energy consumption and demand in space cooling shall rise in Belize due to population growth and rising temperatures. Therefore, the NCPP must adopt effective policies and efficient technologies. Reducing direct and indirect GHG emissions from space cooling is also essential. As a result, it is vital to utilize key areas in energy efficiency policy, such as Minimum Efficiency Performance Standards (MEPS) for equipment and Minimum Energy Efficiency Standards (MEES) for buildings, to increase energy efficiency and decrease indirect GHG emissions from the RAC sector. Room air conditioners (non-ducted systems) are among the space cooling technologies targeted in Belize for MEPS. Non-ducted unitary systems include mini- or single-split and window unit configurations. Using natural refrigerants to replace HFCs and HCFCs in this equipment effectively reduces direct GHG emissions.

Belize had 55,834 households in 2000 and 79,492 in 2010. The number of households increased by 42.4% during those ten years (Statistical Institute of Belize,2022). However, it is known that only a small proportion of these households have air conditioning; an increase is expected over the next decade as the economy, urbanization, and temperatures rise. Building design can reduce cooling demand considerably if built in a climate-sensitive manner.

#### Refrigerant demand space cooling

Figure 6 below depicts the demand for HFC refrigerants in space cooling for the business as usual (BAU) scenario and the intervention scenario induced by the Kigali Amendment.

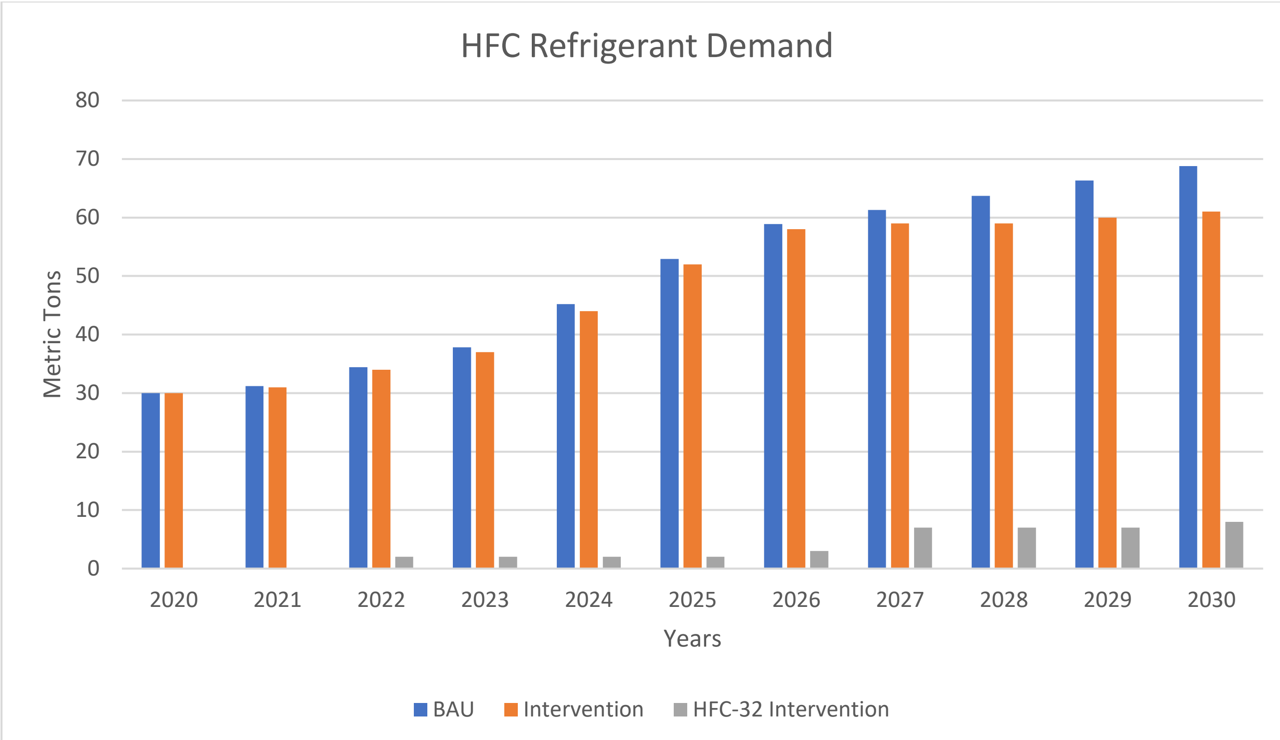



Figure 6: HFC refrigerant demand in space cooling under BAU scenario and Intervention scenario.

It is worth noting that HFC-32 and hydrocarbon refrigerants consumption are expected to increase in the coming years. Hence, it is critical to emphasize that HFC-32 has a GWP of 675, Hydrocarbon-290 has a GWP of 3, and HFC-410A, primarily used in space cooling, has a GWP of 2,088. Therefore, this is significant in terms of Belize's commitment to the Kigali Amendment. The introduction of these alternative refrigerants shall further reduce HFC-410A demand in tandem with population growth and market expansion.

### Policies that reduce the energy used for space cooling.

Minimum energy performance standards (MEPS) and energy labeling for air-conditioning equipment are two key measures for reducing the energy required for space cooling. MEPS for equipment incentivizes the RAC market to become more efficient by phasing out inefficient equipment. Energy labeling is also highly significant since it allows consumers to make informed decisions regarding purchasing energy-efficient equipment. Minimum Energy Efficiency Standards (MEES), synonymous with building codes, play an essential role in reducing heat exchange between the interior room and external environmental temperatures. Therefore, MEES reduces cooling demand in buildings, allowing equipment to run at peak efficiency.

It is critical to integrate renewable energy within space cooling programs. For example, in the operation of cooling equipment, it is essential to include photovoltaic and solar thermal energy.

### Short-term Recommendations

- MEPS and labeling for RAC equipment are currently nonexistent. However, initiatives have been set in place; MEPS and labeling will be rolled out for non-ducted air conditioning units (line 1.1).
- It is essential to incorporate capacity building, outreach, and communication to encourage consumers to opt for energy-efficient, low-GWP equipment and services (lines 2.1 & 2.2).
- Labelling should provide information regarding the energy efficiency of equipment (line 1.1).
- Development of Safety Standards (line 1.3).
- Retrofitting of Equipment to use low-GWP refrigerants (line 2.5).
- It is essential to convince consumers to opt for energy-efficient equipment. Key points should include cost savings due to less energy consumption and environmental benefits (line 2.2).
- Research and development of best practices, policies and energy pathways for space cooling are critical. Changes must be incorporated into NCP.
- Integrate energy data collection and reporting, including statistics on energy efficiency indicators (line 3).
- Recovery, Recycling, Disposal of Refrigerants & waste management of decommissioned equipment (line 2.6).
- Outreach campaigns regarding the importance of building design and potential MEES to be established (line 2.2).

### Medium-term Recommendations

- Promote sustainable building designs to reduce heat exchange between indoor and external temperatures. This drastically reduces the cooling load (line 2.2).
- Formulation of building codes (MEES) for energy-efficient building design and implementation in the new government and commercial buildings. These codes reduce cooling loads of buildings by utilizing cool roof technology, application of low U-value materials, and cool shading, to name a few (line 1.2).
- Implement (MEES) for commercial buildings by requiring environmental clearance to be provided if the building design implementation corresponds to the building codes (line 1.2).
- Utilization of a comfort-based set-point for air conditioning operation. This can be included in building codes. An example is a set point of 24$^{o}$C implemented in other countries (line 1.2).
- Outreach and communication campaigns are important to disseminate the benefits of building codes (MEES) (Line 2.2).
- Belize shall work closely with the CREEBC to accomplish energy retrofit policies for existing buildings (line 1.2).
- Incentives and finances are important for these initiatives to be rolled out nationally (lines 1.4, 2.1 & 2.4).

### Long-term Recommendations

- MEES implemented for all buildings in Belize.
- Installation of energy-efficient, low-GWP, and photovoltaic equipment on a large scale. It is also critical to conduct ongoing research and development on alternative equipment and integrate it into the NCP initiatives.

## 3.3.2 Cold chain & Refrigeration

The cold chain is a logistical chain of actions that includes packing, storing, and transporting perishable commodities from the point of importation or manufacturing to the end of consumption. Pack-house or source sites, refrigerated transportation, cold storage, commercial refrigeration, and domestic refrigeration are the links that make up cold chain movement. The cold chain is critical in the sequential movement of perishable goods. It enables the products to be exposed to appropriate temperatures, preventing textural degradation, discoloration, bruising, and microbiological growth. Quality products increase demand, and cold chain movement also enables public health security (Global Cold Chain Alliance, 2020).

In the refrigeration sector, many alternative technologies are emerging; it is important to harness the application of these technologies to the Belizean perspective. Magnetic Refrigeration Systems (MRS) are an example of future technologies. MRS makes use of magnetocaloric effect technology (MCE). Cooling is accomplished by passing a magnetic field over a material, eliminating the need for refrigerant gasses. The equipment operates at low pressure and rotating speed, decreasing vibrations, noise, and maintenance costs. MRS is also energy efficient, which makes it a viable option. It is also essential to consider alternative technologies such as electrocaloric refrigeration, magnetic refrigeration, thermionic refrigeration, solar photovoltaic, and solar thermal systems.

### Cold chain analysis

Data on the cold chain have yet to undergo thorough analysis. The information gathered in Annex 7 shall be completed and analyzed to provide comprehensive cold chain data. This analysis will be generated and submitted to the NOU and included in the NCPP report.

### Refrigerant demand in Cold Chain & Refrigeration

Figure 7 below shows HFC refrigerant demand in Cold Chain & Refrigeration for the business per usual scenario (BAU) and the intervention scenario induced by the Kigali Amendment.

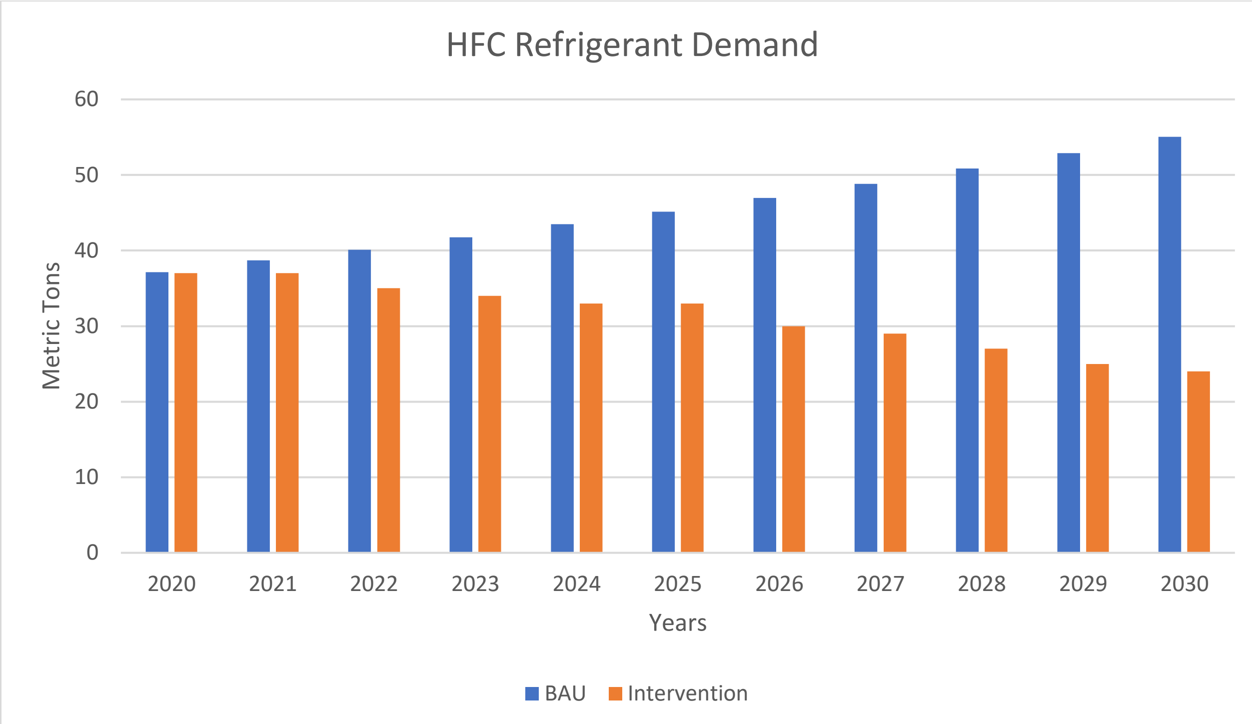


Figure 7: HFC refrigerant demand in cold chain & refrigeration under BAU scenario and Intervention scenario.

The infiltration of natural refrigerants in the cold chain sector can be responsible for the decrease in HFC demand for the intervention scenario; hydrocarbons, $CO_2$, and ammonia are included.

### Short-term Recommendations

- MEPS and labeling implementation are a top priority. Initiatives are currently being activated in Belize to implement MEPS and labeling for refrigerators and freezers. It is critical to facilitate the process collaboratively through the NCPP (line 1.1).
- Inverter technologies are known to be energy efficient; therefore, it is important to encourage such technologies.
- For professionals and technicians, capacity building and training in refrigeration best practices are required (1.3, 2.1 & 2.6).
- Safety standards must be established for the use of ammonia in industrial refrigeration and hydrocarbon in other commercial/domestic refrigerators, and the safe recovery and recycling of refrigerants (lines 1.3 & 2.6)
- Installation of refrigerant detectors to warn of leakages (line 1.3).
- It is critical to establish research and development for low-cost technologies, solar energy applications, and other alternative options that may become available.
- Track and include information on infrastructure development and energy efficiency in the forthcoming statistical system (line 3).

- Reduce refrigerant leakage by training and building capacity in good refrigeration practices (lines.1 & 2.6). It is important to select technologies less prone to leakages, such as hermetic compressors.
- Recovery, Recycling, Disposal of Refrigerants & waste management of decommissioned equipment (line 2.6).
- Encourage using energy-efficient cooling systems like cooling towers and evaporative condensers (line 2.2).
- Discuss the possibility of implementing design standards for new cold chain infrastructure components.
- Promote renewable and alternative energy technologies for the cold chain sector (line 2.2)
- Outreach and communication campaigns should instill user awareness and benefits of energy-efficient efficient, low-GWP equipment (line 2.2)

#### Medium-term Recommendations

- Retrofit cold storage equipment. This could include improving insulation and switching to more energy-efficient cooling equipment (2.5).

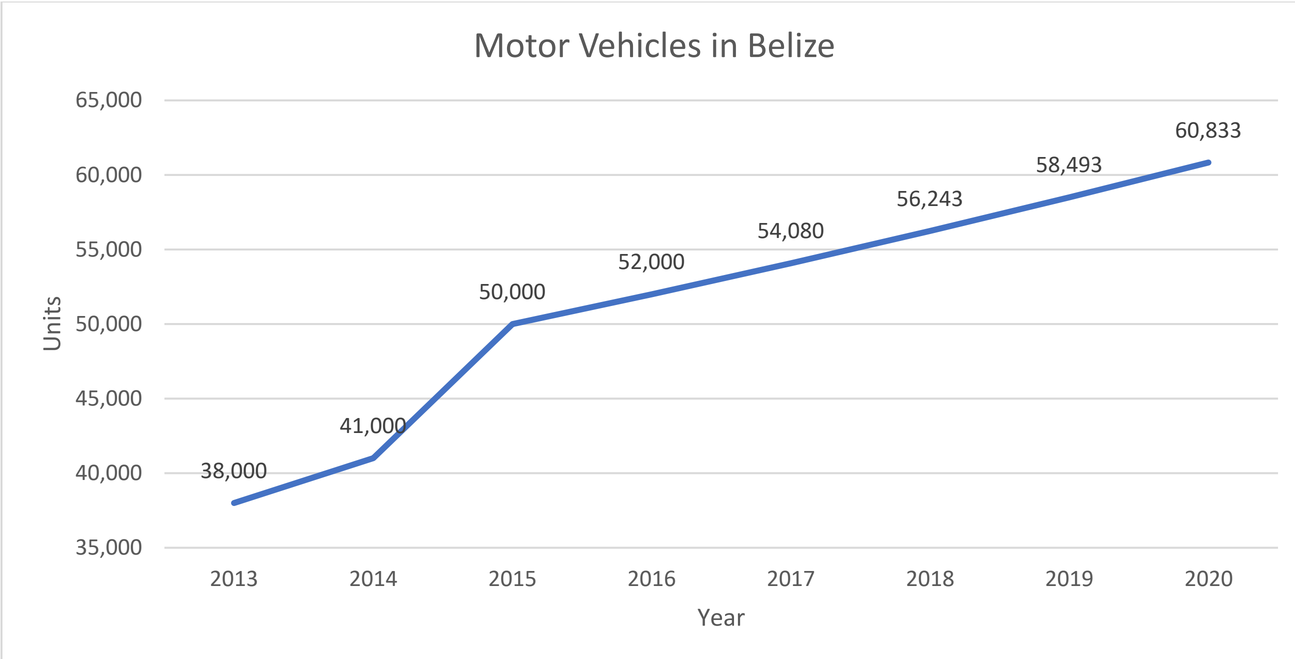
#### Long-term Recommendations

- Selective adoption of feasible new cold-chain and refrigeration technologies. This shall include the equipment that utilizes refrigerants of low-GWP and the highest energy efficiency benchmarks available in the market.

### 3.3.3 Mobile Air conditioning

The number of automobiles on the market grows in lockstep with the population. As a result, the demand for mobile air conditioning (MAC) increases. Automobiles have direct GHG emissions from refrigerants and indirect emissions from fuel consumption. Consequently, developing policy measures to reduce high GWP refrigerant consumption and increase fuel efficiency in this sector is critical.

HFC-134a widely dominates the MAC sector. In Belize, HFC-134a is the refrigerant most consumed; it is very important to target MAC to reduce HFC-134a consumption. GHG emission reduction can be oriented toward alternative refrigerant applications in the sector and increase fuel efficiency to reduce direct GHG emissions. Passenger cars encompass the majority of MAC and can be targeted. Belize has no jurisdiction over vehicle manufacturing, so energy efficiency and refrigerant use in vehicles are out of Belize’s jurisdiction. However, the choice of vehicles imported into the country can be monitored relative to refrigerants and fuel energy efficiency.




Source: International Organization of Motor Vehicle Manufacturers (2021).

Figure 8: Registered Motor Vehicles in Belize.

Figure 8 depicts the number of registered motor vehicles in Belize between 2013-2020. Understanding the significance of registered motor vehicles is important since it allows decision-makers to understand the size of the subsector's market. The years 2013-2015 are based on actual data. The year 2016-2020 was projected to follow the previous year's trend, with an economy growing at a rate of 4% per year.

It is known that all of Belize's vehicles are imported. This implies no authority overusing specific technologies within the system. However, it is critical to encourage the importation of vehicles that use:

- **HFO-1234yf Systems:** Regarding system performance and fuel efficiency, HFO-1234yf systems can compete with HFC-134a systems. HFO-1234yf, on the other hand, has a significantly lower GWP than HFC-134a. As a result, it is a viable option for the MAC sector; however, the refrigerant is much more expensive.
- **Carbon Dioxide (R-744) Systems:** With proper system design and control, R-744 has been shown to be comparable to HFC-134a. Hence, it is a viable option that should be considered in the future. CO2 has a very low GWP, even lower than HFO-1234yf, emphasizing its advantages.

In Belize, it is important to transition toward hybrid/electric vehicles. The NCPP can provide incentives for importing these vehicles for market transformation in the RAC sector and reducing direct GHG emissions in the MAC sector.

### Refrigerant demand in Mobile Air Conditioning

Figure 9 below shows HFC refrigerant demand in Mobile Air Conditioning for business per usual scenario (BAU) and the intervention scenario induced by the Kigali Amendment.

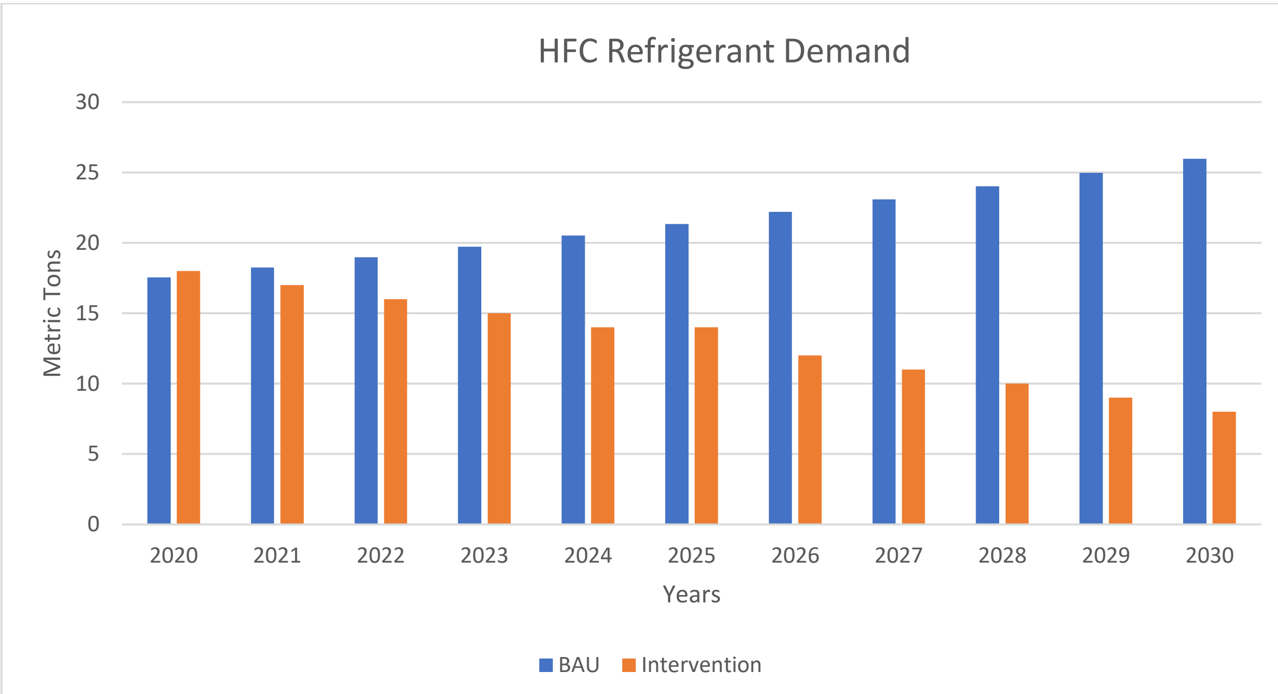



Figure 9: HFC refrigerant demand in Mobile Air Conditioning under BAU and Intervention scenarios.

Since most new motor vehicles entering Belize use the refrigerant HFO-1234yf, HFC consumption for transport refrigeration is expected to decrease. HFC-134a has a GWP of 1,430, while HFO-1234yf has a GWP of 4. This change will significantly impact accounting for carbon dioxide equivalent units.

### Recommendations

### Short-term recommendations:

- Consider the development of policies for the promotion of energy efficiency standards
- Incentivize the importation of vehicles that utilize HFO-1234yf and R-744 as refrigerants. This can be conducted through import tax reduction or repeal (line 1.4).
- Incentivize the importation of hybrid/electric vehicles in Belize. This can be conducted through import tax reduction or repeal (line 1.4)

- Recovery, Recycling, Disposal of Refrigerants & waste management of decommissioned equipment (line 2.6).
- Infrastructure for electric vehicles is also essential (charging ports etc.).
- Capacity building in the MAC service technicians (2.1)

#### Medium-term Recommendations

- Encourage public transportation to reduce cooling and refrigerant demand. Public transportation standards must be raised for this to be feasible in Belize.
- Encourage the usage of hybrid/electric vehicles in Belize

### 3.3.4 Research & Development

Research and development (R&D) are critical for achieving sustainable cooling in Belize. It should include industry participation, the scientific workforce, and the necessary academic and institutional capacities. R&D should include everything cooling-related, including refrigerant use and evolution, cooling equipment, building design interventions, and technology convergence. These are critical for preparing and advancing the RAC industry toward sustainable cooling. As a result, it must maximize societal benefits from cooling on a national scale.

R&D will drive innovation in the refrigeration and air conditioning industry sectors by selecting the best-suited component efficiencies within equipment and materials. Also, the NCPP will use R&D to map technologies and refrigerants best suited to the Belizean climate.

#### Short-term Recommendations

- Funding can be provided for these initiatives.
- It is important to research building design and materials, new molecule development in other countries, equipment, servicing, and refrigerant management.
    - The research shall be conducted by revising publications from renowned institutions and regional collaboration with CREEBC for building codes and materials, CROSQ for standards, and ARACT with regional consultants for equipment servicing and refrigerant management.
    - All cooling trends related to alternative refrigerants, equipment, and technologies must be assessed and selectively chosen for potential application relative to the Belizean standard.
- It is important to incorporate these initiatives in the NCPP steering committee and coordinate with the stakeholders viable for research and development.
    - Association of professional engineers, ARACT, Central Building Authority, Bureau of Standards, and Energy Unit, to name a few, are examples of entities to be considered.

    - It is essential to leverage the expertise available in academic and research institutes to conduct research in technology that will be in the best national interest and help address the country's cooling challenge.
        - Facilitate and encourage applied research for energy-efficient cooling technologies, including compressors, heat exchangers, pumps, electrical motors, and controls.
    - Vocational institutions and other relevant academic institutions must be engaged for this initiative to be successful to its greatest capacity.
- Quantifiable benefits imposed by R&D has to be assessed to develop prioritizations.
    - R&D should enable industry readiness for all emerging trends in the RAC sector, providing societal benefits such as increased energy efficiency and reduced GHG emissions.

#### Medium-term recommendations

- Demonstration and deployment of alternative equipment, materials, and technologies that can be applied and utilized in Belize.

#### Long-term recommendations

- Establish a research and development center where multi-stakeholder participation is encouraged.
    - This implies a centralized location where all the sector's R&D data and information is stored, revised, and disseminated.

### 3.3.5 Refrigeration & Air Conditioning Servicing sector

In Belize, the servicing sector is comprised of formal and informal. The formal servicing sector includes personnel or businesses that have obtained Belizean Association of Refrigeration and Air Conditioning Technicians (ARACT) licenses and, in some cases, may even be recognized as legitimate businesses that have been registered or incorporated by the country's Companies Act, 2020. All RAC technicians in Belize are required by law to hold an ARACT license. According to the ARACT licensing scheme, there were approximately 300 licensed technicians in 2021. The informal sector consists of organizations that do not have an ARACT license. It is important to note that most technicians are unlicensed and regarded as informal.

It is necessary to quantify the amount of servicing technicians in the country so that growth projections can be produced. Furthermore, it is essential to categorize the technicians based on their service sectors.

## Education and training of technicians

The only places where RAC training is offered in Belize are vocational schools, which have three primary branches. Training in the RAC sector in Belize has a structured and unstructured approach. While the unstructured approach takes the form of an apprenticeship, the structured approach is carried out in vocational institutes. The formal servicing industry includes systematic training. The unstructured approach is particularly prevalent in the informal service industries, where individual learning depends on the occupations the trainer meets. It is also known as ride-along training. RAC training institutions include Cayo Center for Employment Training (CET) and Institute for Technical and Vocational Education and Training (ITVET). It is worth noting that RAC technicians have received training from other Multilateral Fund-funded servicing sector projects. The training sessions focused on HFC refrigerants; however, training in HC refrigerants has been initiated.

Training is critical to service technicians for technical operation and servicing of systems, safety issues, and occupational hazards. The training landscape comprises private companies that train or facilitate training of their technicians, training conducted by ARACT, and other training financed by multilateral agencies.

The HCFC Phase-out Management Strategy (HPMP) ensured that best practices in the RAC sector were widespread at all training facilities. However, the Kigali Amendment drive makes it crucial to incorporate energy efficiency (EE) into the curricula. It is well acknowledged that EE is important and underrepresented in training institutions' curricula. Due to the change induced by the Kigali Amendment toward natural refrigerants, it is crucial to update training curriculums and implement all the changes necessary for technicians to be entirely relevant in a rapidly changing industry.

## Certification

Three leading vocational schools in Belize provide formal air conditioning and refrigeration programs. In Belize, ITVET and CET diplomas are regarded as formal training. Certifications are based on levels. The institutions offer level 1, level 2, and level 3 training; the levels provided correspond with the number of years the individual has received training. In such programs, 47 students were trained in 2018, 48 in 2019, and 12 in 2020. Levels 2, 3, and 4 of the International Standard Classification of Education (ISCED) apply to the vocational schools in Belize. The Belize Ministry of Education oversees the skill enhancement, vocational training, and certification training program.

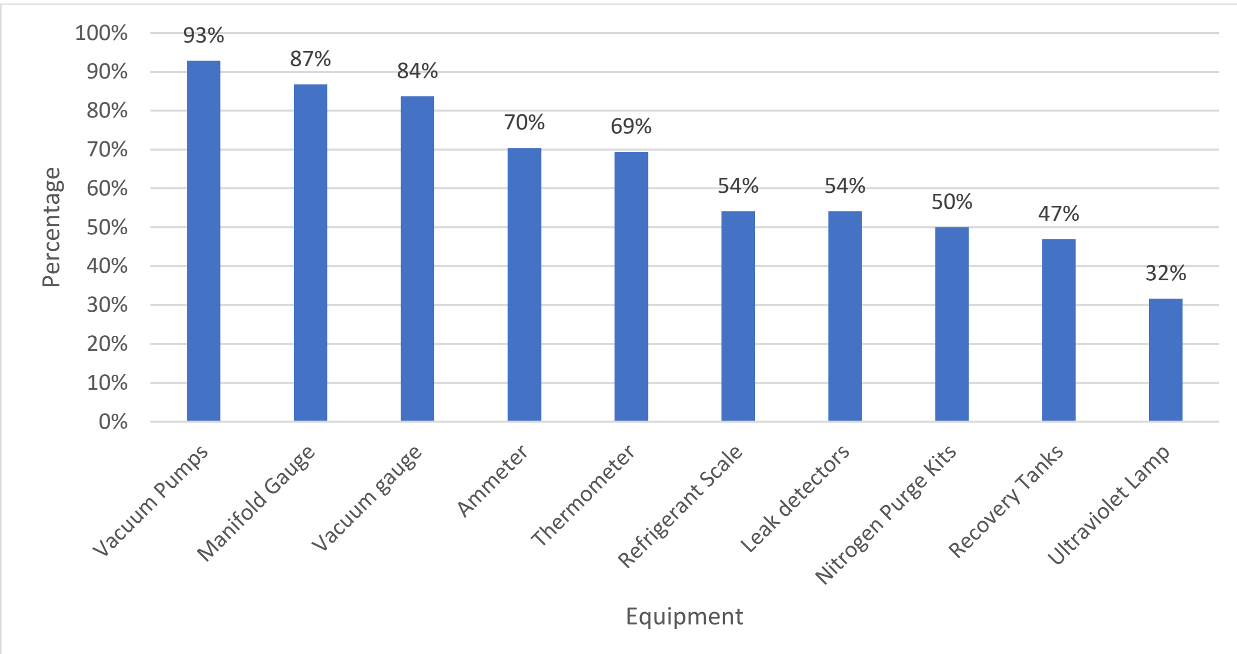
The vast majority of technicians in Belize are classified as informal and lack certification. As a result, it is critical to expand the certification/licensing scheme so that most RAC technicians are certified/licensed. The certification scheme must include updated curriculums that reflect all current trends in the RAC sector.

## Servicing Practices

This section focuses on refrigerant recovery and the tools owned by the technician. Furthermore, this hints at the potential servicing practices technicians can carry out based on the equipment they possess.

## Equipment owned by service stations & practices

Figure 10 below depicts the percentage of technicians that own specific equipment.




Source: Belize HCFC/HFC Consumption Survey Report 2018-2020

Figure 10: Percentage of technicians that own specific equipment.

The RAC sector has a significant deficiency of tools. The high cost of tools can contribute to this, as most technicians cannot afford them.

## Table 3: Knowledge of Refrigerant Recovery from technicians

| Technicians | Number of Technicians | Percentage |
|---|---|---|
| Received training in the recovery & recycling of refrigerants | 83 | 85% |
| Own a recovery machine | 35 | 36% |

Source: Belize HCFC/HFC Consumption Survey Report 2018-2020

Surveys revealed that only 36% of all technicians own a recovery machine, and only a select few conducts recovery, recycling, and disposal of refrigerants.

### Training Infrastructure

It has been observed that the training infrastructure needs to be improved, requiring state-of-the-art equipment for more hands-on training. This points out the need to appropriately strengthen the training centers' infrastructure for the transitioning RAC sector. Industry collaboration in training, supporting infrastructure strengthening at training centers, and updating curriculum and trainers with international cooling trends, are among the critical focus areas.

### Characteristics of the Servicing sector

There are typically three channels through which servicing is conducted in the RAC sector. They comprise the following: Manufacturing companies:
Manufacturing companies have a formal servicing structure. Almost all original equipment manufacturers (OEMs) provide services and usually have a warranty period. There are no manufacturers in Belize; however, installation practices are conducted by technicians employed by the OEM's sale distributor/dealer. In Belize, companies such as LG and Carrier send technicians to get trained for the specific equipment the distributor/dealer carries.

Third-party Servicing Companies:
These can either be formally registered or unregistered, but no franchisee relationship exists with the OEM. Accordingly, this is ubiquitous for most RAC sectors in Belize.

Freelance Technicians:
It is estimated that freelance technicians make up most of the servicing sector in Belize. Technicians with experience in servicing air conditioning systems or refrigerators hire employees that train on the job. Consequently, this often results in technicians who aren't certified or licensed. As a result, it is difficult to estimate the number of technicians operating in this manner and their level of training.

### Recommendations

Most details can be found in Annex 6, line 2.1 of the general NCPP structure, for capacity building in servicing center and capacity building with trainers and vocational institutes.

### Short-term recommendations

- Market research to determine the total number of technicians in Belize, whether formal or informal. It is critical to compare the number of technicians available, the demand in the service sector, and the access to quality training institutions (line 3).
    - This is important as an initial guide toward implementing all recommendations.
- Include good practices for EE and low-GWP equipment.

- Conduct demand assessment of the RAC sector; focus on vocational institutions.
- Revision of vocational training curricula, including requirements for trainer qualification and infrastructure in the institution.
- Enhance the certification scheme
- The certification scheme must be standardized and run by a single entity. It is critical to consider vocational institutions.
- Mandatory adherence to standardized training curriculum by all vocational institutions
- Constantly update websites and social media outlets with information on training opportunities, cooling trends, and RAC sector innovations and changes (line 2.2).
- In the RAC sector, raising public awareness about the importance of regular servicing and good practices. In particular, it is essential to disseminate information about how regular servicing and good practices affect energy efficiency and GHG emissions reduction.
- Public awareness campaigns to promote the use of only licensed/certified technicians (line 2.2).
- Opportunities for the training of technical personnel regionally (lines 2.1 & 2.3)

### Mid-term recommendations

- Mandatory certification of all technicians.
- Develop a national database of RAC servicing technicians
- Upgrades based on demand assessment
    - Vocational institutions shall receive infrastructural upgrades
    - Potential increase of Institutions with RAC programmme.
        - Increase the network of training centers across the country.
    - Update on all cooling trends involving equipment and refrigerants.
- Certification of at least 50% service technicians.

### Long-term recommendations

- Mandatory Certification of all service technicians.
    - Provide incentivization for certification
    - National formalization of the servicing sector

## 3.4 Implementation Framework

### 3.4.1 Multi-stakeholder and collaborative development:

The coordinating entity will be comprised of the NOU. Through the NOU, mechanisms for effective inter-government and triple-sector engagement are vital. The triple sector includes researchers and analysts, government entities, the private sector, and industry. Therefore, this highlights the significance of a collaborative approach to the NCPP's cross-cutting nature. It incorporates interlinkages with all entities involved to achieve national and international priorities through the NCPP. The cooling agenda can be a critical tool for all relevant international commitments related to energy efficiency and GHG emissions reduction.

It is critical to include all initiatives that the relevant stakeholders have been working on that can synergize with the NCPP. The Belize Bureau of Standards (BBS) has initiated steps toward implementing MEPS and labeling schemes, while the Energy Unit, BEL, and PUC have begun work on energy efficiency. As other NCP-related initiatives are implemented, it is critical to collaborate with the NCPP.

### 3.4.2 Creation of Stakeholders Group

To ensure the success of the NCPB, it is crucial to involve all players in the RAC sector and energy landscape in a cooperative effort. The framework should encompass all pertinent players from government agencies, non-governmental organizations, service providers, industry associations, educational institutions, and the private sector.

Annex 1 contains a list of the stakeholders involved in the NCPP's development.

### 3.4.3 NCP steering committee

It is critical to have effective management and oversight of NCPB initiatives and implementation. As a result, it is proposed that a National Cooling Plan steering committee be formed. The NCPB structure proposed is as follows:

- The steering committee will lead the NCPB and report directly to the NOU.
- Three Working Groups will guide the committee, the members of which will be NCPP stakeholders.
- Group 1 is responsible for developing policy instruments and financing; Group 2 will be responsible for developing capacity-building and partnership initiatives; and Group 3 will monitor, verify, and enforce. The three working groups encompass the strategic guidelines for the National Cooling Plan Proposal.
- The NOU shall appoint key members of each working group to the NCP steering committee.
- In each working group and the committee, the NOU will appoint a chairperson, secretary, organizer, and other key members.
- Individual groups ensure that projects are implemented, evaluated, and validated.

Annex 1 shows the proposed implementation structure with roles and responsibilities by key institutions.

### 3.4.4 Meeting of the NCP steering committee working groups

The proposed meeting schedule is as follows:

- The NCP steering committee will meet semi-annually to track the progress of individual working groups.
- Working group executives will meet quarterly to discuss their progress and elaborate on their adherence to a set schedule.
- The NCP steering committee will review quarterly reports submitted by the working groups.
- The NCP steering committee will then report to the NOU semi-annually

A synergistic approach is required for ongoing initiatives by the relevant stakeholders. Synergies should also apply to financial instruments and current policies. Details for the financial mechanisms of the NCPP can be found in Annex 6, line 1.4.

The NCPP suggests examples for directional purposes throughout the document; however, the relevant stakeholders can implement initiatives however they see fit. Therefore, stakeholders within the NCPP can execute programs and other initiatives to achieve the NCPP goals. In an ever-changing industry, the objective is to find the most efficient approach to fulfill the NCPP.

Creating an institutional framework for tracking the NCPP's progress is vital. It is essential to identify the key success indicators that will help determine the efficacy of the proposed recommendations. However, since the NCPP is a living document, it is essential to develop an evaluation method. The NCPP should be reviewed and updated regularly. New technologies, for example, may become available and must be incorporated into the plan. Revisions will be carried out every 3-5 years. Maintaining and improving data collection and monitoring practices is therefore critical. Data collection and monitoring are significant for NCPP revisions because, as data becomes available, the steering committee must implement changes concerning the data acquired. These can be found on line 3 of the NCPP Annex 6. The NCPP must include the steering committee and relevant stakeholders in the intricacies of these processes to incorporate all of the expertise concerning the NCPP.

Figure 11 depicts the proposed NCPP implementation framework. The NOU serves as the nodal entity for these initiatives and is placed above the steering committee. The relationship, however, will remain collaborative.

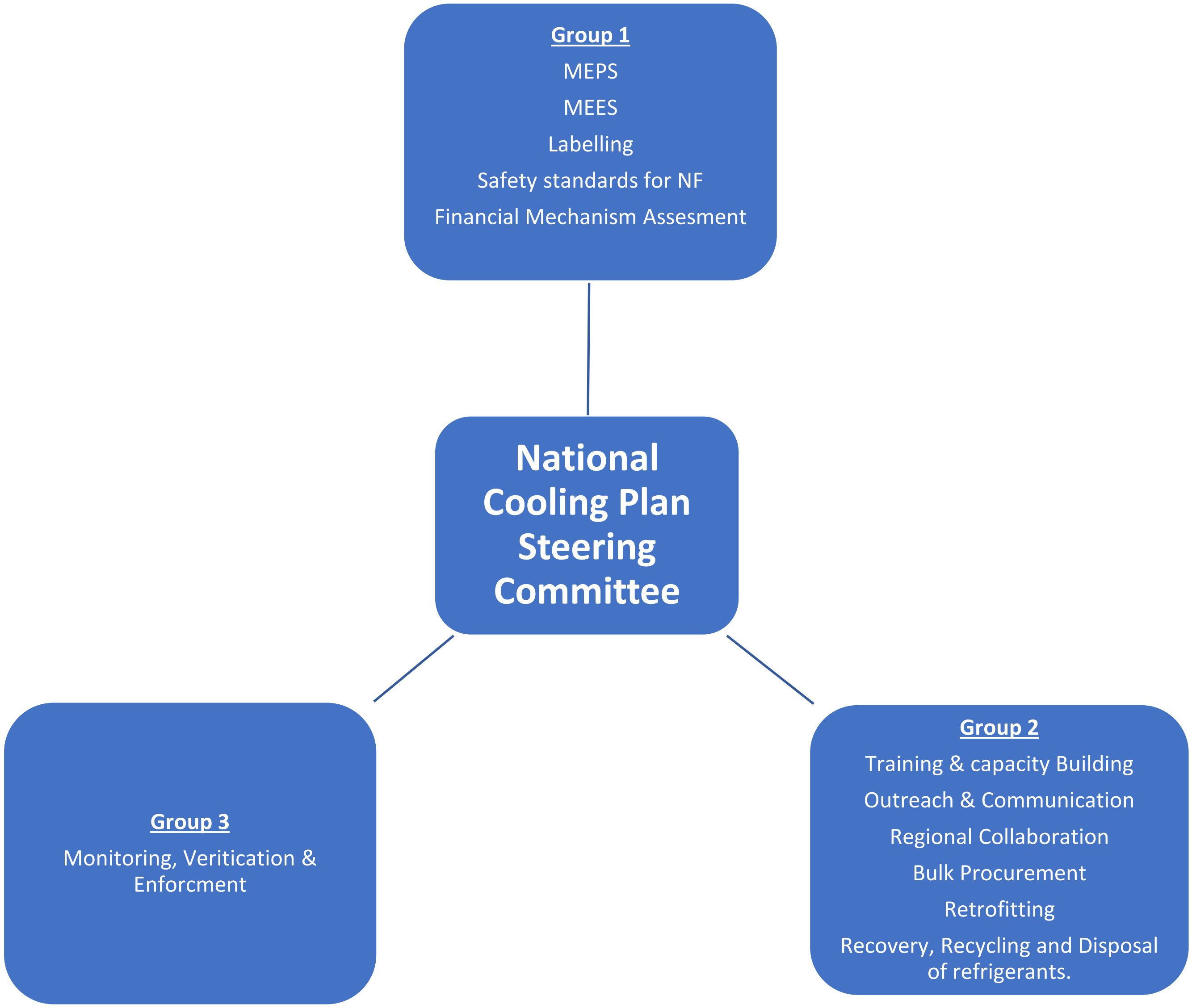



**Figure 11: NCPP Implementation framework**

Annex 1 lists the key stakeholders in each group. Figure 11 depicts each working group's functions and jurisdiction to which they will belong.

### 3.4.5 Road Map

The National Cooling Plan Steering Committee shall manage the projects under the NCPP over a 20-year implementation period. These initiatives can follow the timeline identified in figure 11 below.

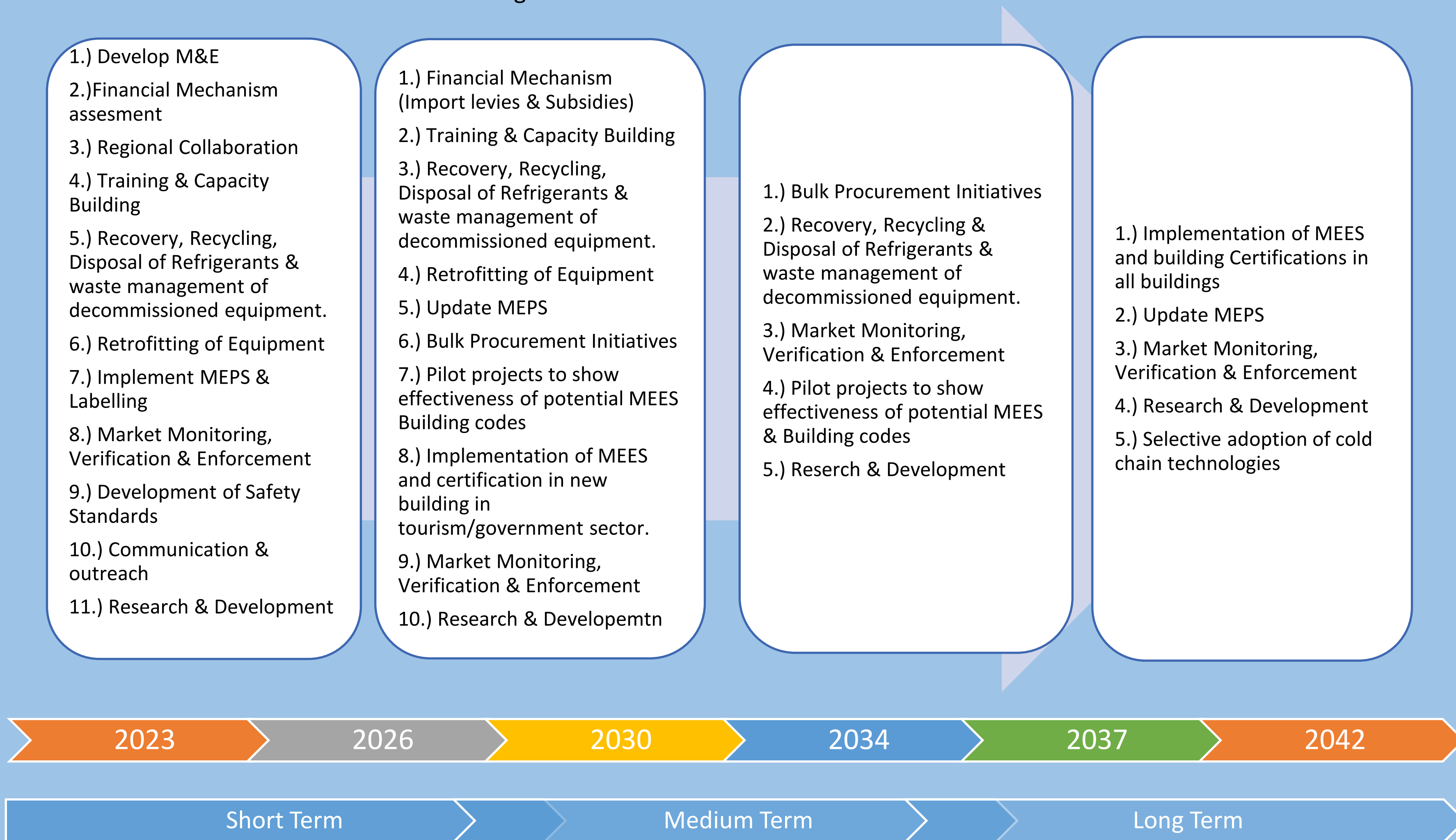


Figure 12 suggests a roadmap for the general NCPP initiatives, which also involve sector-wise analysis embedded within them. The NCPP is a living document; hence, in collaboration with relevant stakeholders, the steering committee can modify the roadmap to improve efficiency and practicality as the NCPP is implemented.

### 3.5 Socioeconomic benefits of the NCPP

The NCP could optimize socioeconomic benefits such as sustenance and environmental benefits by coordinating actions in other sectors where cooling is required. Table 4 summarizes some of the essential socioeconomic benefits of each thematic area's activities.

**Table 4: Socioeconomic benefits of the NCP**

| Thematic Area | Socio-economic Benefits |
|---|---|
| Space Cooling in Buildings | • Thermal comfort for all<br>• Lower electricity consumption<br>• Lower operational costs to the user |
| Cold chain & Refrigeration | • Food security<br>• Vaccine security<br>• Lower electricity/energy consumption |
| Transport Air conditioning | • Lower fuel consumption<br>• Energy-efficient mobile air conditioning |
| Research & Development | • Enables market transitioning toward energy efficiency.<br>• Enhances the practices of R&D for research and innovation toward energy efficiency and reduction of GHGs. |
| Refrigeration & Air Conditioning Servicing sector | • Safer working environments<br>• Lower electricity/energy consumption |

## The Cooling Action Plan

All of the specifics of these initiatives are listed in Annex 6, which provides a broad overview of Belize’s efforts toward sustainable cooling.

## 4. Conclusion

The implementation of an NCPP will result in sustainable cooling throughout Belize. Sustainable cooling will be accomplished by lowering direct GHG emissions and increasing RAC energy efficiency. The main limitations of the NCPP were data gaps regarding energy consumption and GHG emissions in RAC sectors. The NCPP will address the data gaps throughout the NCPP's implementation.

Belize has not signed the Kigali Amendment; however, initiatives aligned with the amendment have commenced. Steps toward MEPS implementation and labeling preparations for non-ducted air-conditioning systems and refrigerators/freezers have begun. Also, capacity building and awareness campaigns have been proposed to aid in adopting low-GWP technologies.

A thorough review of primary and secondary data revealed obstacles to introducing low-GWP, energy-efficient equipment. These challenges include:

- There are no incentives for investing in EE, low-GWP equipment.
- Technical staff lacks knowledge of best practices for low-GWP, energy-efficient technologies.
- End-user ignorance about energy conservation and energy efficiency opportunities and benefits.
- The prevalence of obsolete technologies and practices regarding energy efficiency and refrigerant use.

Recommendations were listed outlining policy and regulatory measures to address these challenges and instill sustainable cooling in Belize. The Belize NCPP follows three general paths to achieve sustainable cooling. The three paths include the following:

1. Development of policy instruments and Finance
    1.1 Implementation of MEPS & labeling standards
    1.2 Implementation of MEES, Building codes
    1.3 Safety standards for Natural Refrigerants
    1.4 Assessment of Funding and Financial Mechanisms for Market Transformation
2. Capacity Building and Partnership Initiatives
    2.1 Training & Capacity Building
    2.2 Outreach and Communication
    2.3 Opportunities for Regional Collaboration
    2.4 Bulk Procurement
    2.5 Retrofitting equipment to use low-GWP equipment & to increase energy efficiency
    2.6 Mechanisms for Recovery, Recycling, Disposal of Refrigerants & waste management of decommissioned equipment.
3. Monitoring, Verification, and Enforcement
    Includes all the NCP standards to be established

### Monitoring and Evaluation of NCP implementation

The NCPP then incorporates the general pathways within the sector-specific analysis. The five sectors discussed were space cooling, cold chain & refrigeration, mobile air conditioning (MAC), the servicing sector, and research and development. Critical data gaps were identified in the sector-wise analysis. The data gaps include RAC sector-related GHG emission and energy consumption projections under the Business-as-Usual Scenario (BAU) and NCP implementation and mitigation data uncertainties related to the RAC sector. Furthermore, the time allotted was insufficient for developing the NCPP to include all requirements. Implementing these innovative policies and additional interventions will help Belize achieve sustainable cooling.

The NCPP initiatives were developed through a validation process with key stakeholders from the RAC and energy sectors. This was critical in developing a comprehensive proposal that accounted for Belize's national reality.

A steering committee shall aid in monitoring, verifying, and enforcing the Cooling Plan. The NCPP is a living document; the NCP will be open to new and emerging data and information. Hence, it is a document that evolves in response to technological advances. Moreover, this is critical since the RAC industry is constantly evolving, and changes to the NCPP are required to achieve the most effective outcomes with emerging technologies/trends.

The NCPP is designed to initiate the process toward sustainable cooling; however, further research and incorporation into the NCPP are necessary for successful implementation. The NCPP should significantly reduce direct/indirect GHG emissions from the RAC sector through increased energy efficiency and national deployment of low-GWP technologies.

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## Annex 1: List of Identified main stakeholders & Proposed implementation structure with roles and responsibilities by key institutions.

**List of Identified main stakeholders**

| Type | Stakeholder | Description |
|---|---|---|
| National Government | Energy Unit (Ministry of Public Utilities, Logistics, and E-governance) - | The Belize Energy Unit develops, promotes, and effectively manages energy production, delivery, and consumption for Belize's long-term development through interventions in Energy Efficiency, Renewable Energy, and Cleaner Production. |
| | Central Building Authority | A Statutory Body responsible for enforcing the Belize Building Act, the Central Building Authority oversees construction projects. |
| | Bureau of Standards | The national standards body for Belize, the Belize Bureau of Standards, is responsible for fostering effective and competitive production of goods and services. Quality Infrastructure is the cornerstone for achieving this goal. |
| | Ministry of Finance, Economic Development & Investment | Is responsible for guiding, coordinating, and carrying out the Government's fiscal and economic policies and programs, including the generation and distribution of financial resources for convenient public services to support Belize's overall growth. |
| | Ministry of Foreign Affairs | The Ministry carries out Belize's foreign policy to strengthen the country's sovereignty, uphold territorial integrity, and safeguard our national interests. |
| | Attorney General | To serve as the Government's primary legal advisor and provide legal services to Belize's government and citizens. |
| | Customs Department | Enforcing customs and excise laws, ensuring operational integrity, fostering legal trade, collecting and protecting revenue, protecting the environment, combating smuggling and illicit activities, and promoting and upholding fair trade practices through the effective use of modern tools and information are all required to ensure safety and security and contribute to Belize's economic development. |
| | Policy Unit (Ministry of Sustainable Development, Climate Change and Disaster Risk Management of Belize) | Responsible for drafting policies for the ministry. |
| | Ministry of Health | To create and maintain a healthy environment, the ministry of health is founded on equity, affordability, accessibility, quality, and sustainability in effective partnership with all government sectors and the general public. |

| | | |
|---|---|---|
| | Belize Tourism Board | The Belize Tourism Board (BTB) is the legally mandated organization responsible for directing, enhancing, and promoting Belize's tourism industry. To respond to the evolving needs of the tourism industry, BTB implements several strategic initiatives and policies. The organization aims to secure Belize's socioeconomic growth through responsible, open, and efficient governance. |
| | Public Utilities Commission (PUC) | The water, electricity, and telecommunication industries are governed by the Belize Public Utilities Commission (PUC), which also ensures that these services are available, of a good standard, sustainable, and reasonably priced for customers. |
| Public agencies | Belize Chamber of Commerce & Industry | Belize's social and economic growth through the development of all sectors of industry, trade, and services is one of the main goals of the Chamber of Commerce and Industry, which has constantly fought for the issues of its private sector constituency. |
| Private Sector | Industries | Industries that utilize RAC equipment or aids in the servicing, installing, and operating equipment. |
| | Importers | Importers of refrigerants and RAC equipment |
| Industry Associations/ Non-Profit Organizations | Association of Architects | The Association of Professional Architects of Belize is a nonprofit organization that supports Belize's responsible development by advocating the use of architecture to create safe, healthy communities and overseeing the practice of architecture. |
| | Association of professional engineers | The Association of Professional Engineers of Belize (APEB) is an organization devoted to advancing engineers in Belize. Members of international organizations include APEB. |
| | ARACT | Association of Refrigeration and Air Conditioning Technicians |
| | Belize Hotel Association | The Belize Hotel Association is a non-profit, non-governmental organization. Accommodation providers, such as hotels, resorts, lodges, condominiums, educational institutions, and homestays, make up most of its membership. Affiliated members include tour operators and ancillary companies that provide services to the hospitality sector. |
| Vocational Institutions with RAC curriculum | Orange Walk ITVET | Major vocational institutions in Belize have refrigeration and air conditioning programs. |
| | Belize City ITVET | |
| | Cayo CET | |

**Proposed implementation structure with roles and responsibilities by key institutions:**

| **NCP Steering Committee & Working Groups** | **Composition** | **Roles and Responsibilities** |
|---|---|---|
| NCP Steering Committee | Members of working groups | Oversee activities within the three work groups |
| Working Group 1 | Policy Unit, Attorney General, Energy Unit, Central Building Authority, Bureau of Standards, BEL, Chamber of Commerce, ARACT, Customs Department, Ministry of Finance, Association of professional engineers, Association of Architects, Economic Development & Investment, Ministry of Health | • Policy framework for MEPs, MEES, labeling, and Safety standards for NF.<br>• Financial mechanism assessment for market transformation. |
| Working Group 2 | Technicians & Engineers, Customs Department, Vocational institutions with RAC program, importers, Industries, Association of professional engineers, Association of Architects, ARACT, BTB, Belize Hotel Association, Ministry of Foreign Affairs | Capacity Building & partnership Initiatives:<br>• It engages important sectors of the Market to aid in adapting to the market transformation.<br>• Outreach & communication to disseminate all initiatives and regional collaboration toward policy, capacity building, and data sharing.<br>• Facilitate bulk procurement so sustainable equipment can enter the country at reasonable prices.<br>• Implement retrofitting projects for equipment using high-GWP refrigerants to low-GWP refrigerants and additional technical training. |

| | | |
|---|---|---|
| Working Group 3 | Customs Department, Energy Unit, Central Building Authority, Bureau of Standards, Public Utilities Commission, BEL | • Market Monitoring, Enforcement, and Verification and assessment or RAC technologies.<br>• It encompasses energy performance, energy savings, compliance with existing standards and policies (MEPS, labeling, building standards), and the type of equipment on the market<br>• Monitoring & Evaluation (M&E) of the NCPB |

## Annex 2: Main factors driving the future demand for RAC appliances in Belize.

### Demographic and socio-economic factors:

#### Rate of population growth

It is a known fact that as the population grows, so does the nation's need for cooling. Population growth significantly impacts economic expansion, another factor that drives cooling demand (Intentional Energy Agency, 2018).

Belize's population is predicted to be 441,471 as of July 2022, an increase of 2.55% from the preceding year. Belize's average rate of growth from 1961 to 2021 was 2.46%. (Statistical Institute of Belize, 2022). It has been noted that Belize's population is growing, and there is ample room for further growth. As a result, this increases the nation's potential for a significant rise in cooling demand.

#### Rate of economic growth/ purchasing power

The ability to meet cooling demand is strongly correlated with income and wealth. The economic environment, including the economy's structure, the cost of power, the price of air conditioners, and cultural preferences, all have a role in how a nation's cooling needs are satisfied (International Energy Agency,2018). According to reports, Belize's GDP increased by 9.8% in 2021, reaching USD 1.79 billion (World Bank, 2022). The economic growth experienced in Belize is indicative of the future development of cooling demand.

The main pillars of Belize's economy are agriculture, tourism, and services. Citrus, sugar, and bananas are Belize's three main exports. Belize's primary source of foreign exchange is tourism. With direct GDP contributions of 15% and overall contributions of 41% in 2017, it is the largest service subsector. In 2018, this number increased by 3.6% and was projected to increase by 4.6% by 2028. (Belize Chambers of Commerce & Industry, 2019). The tourism industry and all of its indirect economic effects are also accountable for the increase in demand for cooling.

It is well recognized that an economy's expansion is closely related to the size of its export market. Sugar, fresh bananas, frozen orange juice concentrate, petroleum oils, frozen rock lobster and other sea crawfish, conch, red kidney beans, molasses, brans, sharps, and other leftovers of maize (corn), and frozen lobster are Belize's top ten exports by value (Directorate General for Foreign Trade, Belize, 2020). Two or more of Belize's top ten exports are perishable and necessitate cooling.

#### Rate of urbanization

The majority of cooling is known to take place in towns and cities because of the higher income levels and heat islands brought on by the effects of urbanization (less vegetation, more building, and structures that trap heat, increased usage of appliances and machinery), and other factors (International Energy Agency, 2018).

Additionally, a study by Tewari *et al*. (2017) shows how urbanization and global warming affect near-surface air temperature. In conclusion, near-surface air temperatures rise as urbanization increases, increasing cooling and energy demand. 75% of the rise in near-surface air temperatures is ascribed to urban growth and 25% to global warming. This demonstrates how the demand for cooling can directly correlate to urbanization.

Larger towns and cities in Belize are home to about 46% of the population. Urbanization is a trend that is accelerating and growing at a 2.2% annual rate (World Bank,2022). The contribution of Belize's growing urbanization to future national cooling needs is significant.

### Growth of electrification

In Belize, 97.11% of the population had access to electricity as of 2020. Between 1991 and 2020, Belize saw a rise in the percentage of its population with access to electricity, from 67.1% in 1991 to 97.1% in 2020. This establishes a precedent for the country's increasing electrification (World Bank, 2022). The spread of electrification paves the way for a significant rise in cooling demand.

## Climate & Environmental Factors:

Air temperature and humidity are the two main meteorological variables directly affecting cooling demand.

### Temperature

It is well known that regions in the subtropics and tropics have the highest cooling needs. The Middle East, Africa, India, and the Caribbean are included in this region. (International Energy Agency, 2018). Since Belize is situated within these zones, it is clear that the region's high temperatures substantially impact Belize's cooling needs.

Belize's climate can be characterized as humid and tropical. The yearly temperature in Belize ranges from 23 to 27 °C, with coastal areas experiencing hotter weather than inland areas. Since 1960, Belize's average annual temperature has risen by 0.45 °C, or 0.10 °C each decade. The number of hot days and nights per year has increased by 67 days between 1960-2003. The number of cold days per year decreased by 21 days between 1960-2003. (Climate Change Knowledge Portal, 2022).

### Humidity

The average relative humidity in Belize is 90%, with November typically having the highest humidity (93%) and May typically having the lowest humidity (89%) (Climate & Weather, 2022). Belize has high relative humidity, which increases the need for cooling.

## Lack of access to cooling:

Access to cooling is one of the main societal problems worldwide. Only 8% of the 2.8 million people who reside in the hottest parts of the planet have access to cooling (International Energy Agency,2018). Even though Belize has a reasonably temperate climate, there are still a lot of unmet cooling demands. This could change, which would increase Belize's need for cooling.

## Cold chain supply:

Another factor affecting cooling demand is the need for refrigeration for cold and cargo chains and supermarkets. Many of the commodities distributed throughout the nation need to be refrigerated. The cold chain supply is regarded as crucial and necessary as the population grows, the tourism industry expands, and temperatures rise. The nation's population's well-being depends on utilizing the cold chain in and around supermarkets, the delivery of vaccines, etc.

## Annex 3: Policy instruments that address climate change in Belize.

### Climate Action Plan for Belize:

#### Belize National Climate change policy, strategy, and master plan

Belize ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994, the Kyoto Protocol in September 2003, and the Paris Agreement in 2016. As a result, Belize was required to create, enact, and implement laws and measures to mitigate the widespread effects of climate change.

The National Climate Change Policy, Strategy, and Action Plan (NCCPSAP) for 2015–2020 was subsequently created. In coordination with other sectoral policies, the document was essential in providing the policy that created an administrative and legal framework. This was crucial for the country's ability to achieve low carbon emissions in the future and for other profound impacts.

The NCCPSAP was revised for 2021-2025 and then referred to as the National Climate Change Master Plan. In essence, it's a five-year programme aimed at building the capacity resilience of Belize, reducing the emissions of greenhouse gasses, and adapting to the challenges of climate change while aligning with the country's sustainable development goals. Some of these goals include:

- Increasing citizen involvement to strengthen the political context for efficient policy execution.
- Enhancing educational opportunities and standards to support sustainable growth.
- Developing a robust economy with a critical emphasis on productive industries, including agriculture, fishing and aquaculture, and tourism, to enhance productivity and competitiveness while in alignment with environmental sustainability.
- Safeguarding Belize's natural environment and inhabitants' health as the cornerstones of its socioeconomic prosperity.

Some of the climate change mitigation initiatives under the NCCPSAP that will concentrate on lowering GHG emissions from energy generation and consumption include:

- Promote energy efficiency by establishing building codes, energy audits, minimum appliance standards, and market incentives in favor of energy-efficient technology.
- The expansion and diversification of the national renewable energy portfolio.

### Actors in the Belize National Climate change policy, strategy, and master plan are:

- National climate action plan Actors (ministries)
- Ministry of Sustainable Development, Climate Change & Disaster Risk Management
- Ministry of Finance, Economic Development & Investment

- Ministry of Agriculture, Food Security & Enterprise
- Ministry of Blue Economy & Civil Aviation
- Ministry of Natural Resources, Petroleum & Mining
- Ministry of Health & Wellness
- Ministry of Public Utilities, Energy and Logistics
- Ministry of Rural Transformation, Community Development, Labor & Local Government
- Ministry of Tourism & Diaspora Relations
- Ministry of Infrastructure Development & Housing
- Ministry of Human Development, Families & Indigenous Peoples' Affairs

## Other policy instruments to address climate change in Belize:

Long-term sustainable development policy documents integrating national commitments and priorities toward Climate Change mitigation and adaptation have been developed in Belize. These documents include the following:

- Updated Nationally Determined Contribution (NDC) (2021)
- Low Emission Development Strategy (LEDS) for Belize for the period 2020-2050 (2021)
- Technology Action Plan for Climate Change Adaptation and Mitigation (2018)
- Third National Communication to the UNFCCC (2016)
- Low Carbon Development Roadmap for Belize (2016)
- National Environmental Policy and Strategy for the period 2014-2024 (2014)
- National Climate Resilience Investment Plan (2013)
- Horizon 2030 – Long Term National Development Framework for Belize (2011)

### Updated Nationally Determined Contribution (NDC) (2021):

The Belize NDCs was filed in April 2016, and an updated NDC was submitted in 2021. This included the steps Belize took to reduce GHG emissions in the agricultural, forestry, and other land use (FOLU), energy, transport, and waste management sectors per the Paris Agreement. To adapt to the effects of rising temperatures, it also includes future initiatives to develop resilience in the FOLU, agriculture, coastal and marine, fisheries and aquaculture, health, tourism, infrastructure, and water resources sectors.

### Low Emission Development Strategy (LEDS) for Belize for the period 2020-2050:

Improves the nation's ability to incorporate NDCs into their context, long-term planning, and development priorities, offering direction for future development. Belize began using LEDs in 2021 to help attain low emissions and greener growth, aligning closer with Belize's sustainable development goals.

### Technology Action Plan for Climate Change Adaptation and Mitigation (2018):

This is crucial for ranking various technologies and project proposal notes to reduce GHG emissions. It offers a course of action for these high-priority technologies. The focus of the Technology Action Plan is to aid in disseminating these prioritized technologies for Climate Change adaptation and mitigation.

### Third National Communication to the UNFCCC (2016):

Belize's third national communication was submitted to the UNFCCC in 2016 after its first and second communications were introduced in 2002 and 2011, respectively. The sectoral overview of GHG emissions and sinks and their trends aims to elicit support for solutions for climate change mitigation initiatives and stimulate renewable energy. Additionally, vulnerability assessments and adaptations to strategies for Belize's major development sectors were conducted. The review of limitations, budget restrictions, and capacity building for the convention's execution were also addressed.

### Low Carbon Development Roadmap for Belize (2016):

A reduced carbon footprint and a more resilient Belize are goals of the roadmap. Depending on the magnitude or immediacy of action, it separates it into two basic categories. The roadmap will ultimately help Belize change its development course to one that can support the accomplishment of Belize's sustainable development goals by cultivating a low-carbon economy.

### National Environmental Policy and Strategy for the period 2014-2024 (2014):

This policy was created to prepare Belize for policy revisions and make it easier for the country to respond to various engagements and new environmental challenges. The achievement of a greener, more resilient, and stronger Belize is presented, along with strategic goals and targets.

### National Climate Resilience Investment Plan (2013):

This plan fosters a well-coordinated approach to national development by encouraging the participation of a broad range of stakeholders in planning procedures that are integrated across all economic sectors. As a result, it presents a framework for promoting societal and economic resilience that is efficient, strategic, and rigorous. All industries highly recommend improving disaster risk management capabilities and strengthening climate resilience.

### Horizon 2030 – Long Term National Development Framework for Belize (2011):

Details long-term, ongoing policy initiatives to promote environmental and sustainable development and economic resilience. The transformation of long-term vision, goals, and objectives into medium-term plans was also proposed. This allowed for targets to be set and implementation, monitoring, and evaluation processed to be defined. The heart of long-term development integrates environmental sustainability into the promotion of green energy and energy efficiency in a variety of other sectors.

## Policy instruments to address climate change specific to energy:

### Climate and Sustainability Goals

The Government of Belize (GOB) understands the vital function of the energy sector in mitigating climate change and its effects. Therefore, GOB has committed to a low-carbon, sustainable energy pathway. This is supported by numerous policy and strategic documents highlighting Belize's energy-related climate and sustainability goals. These documents are as follows:

### Ministry of Energy, Science & Technology and Public Utilities Strategic Plan for the period 2012-2017 (2012)

The Strategic Plan establishes a strategy that will lead to the economies and energy's evolution toward low-carbon development. It merges two of the three main areas of the Ministry's responsibilities—power and the sector of science, technology, and innovation (STI)—and offers a blueprint for the Sustainable Energy Strategy in the establishment of a low-carbon economy by 2033. Along with encouraging and advising the public and private sectors and the general populace to become more cognizant of the crucial energy issues. Additionally, to take corrective measures and preparedness, it strives to empower rural communities, particularly women and young people, to engage in income-generating endeavors.

### National Energy Policy Framework 2014-2030 (2011)

The strategy uses sensible laws and effective regulations to direct Belize toward efficient and sustainable energy over the next 30 years and improve energy supply chains. It discusses various policy tools to accomplish policy goals in the form of a suggested roadmap and offers policy recommendations to decision-makers. The four critical outputs of the policy framework are proposed goals and strategic objectives for Belize's energy sector; three energy plans to achieve the suggested strategic objectives; policy recommendations to direct the energy sector's growth, and a proposed organizational framework to carry out policy recommendations.

### Belize Sustainable Energy Strategy and Action Plan

To maximize the use of renewable energy sources and energy efficiency, the action plan considers Belize's economic, social, and environmental goals. There are six interrelated, linked measures offered to make this possible: Improve efficiency in homes, businesses, and government; increase access to renewable energy-powered electricity; promote these sources on a wide scale; create a utility that is effective and enabling; become prepared for distributed generation, and raise awareness and enhance skills.

### Sustainable Development Goal 7

The United Nations General Assembly adopted the 2030 Agenda for Sustainable Development, establishing the Sustainable Development Goals (SDG). Seven of the 17 SDGs—of which there are a total—are devoted to a stand-alone goal on energy. Affordable and clean energy is the target; there were five suggested energy-related targets.

### Nationally Determined Contributions (NDCs)

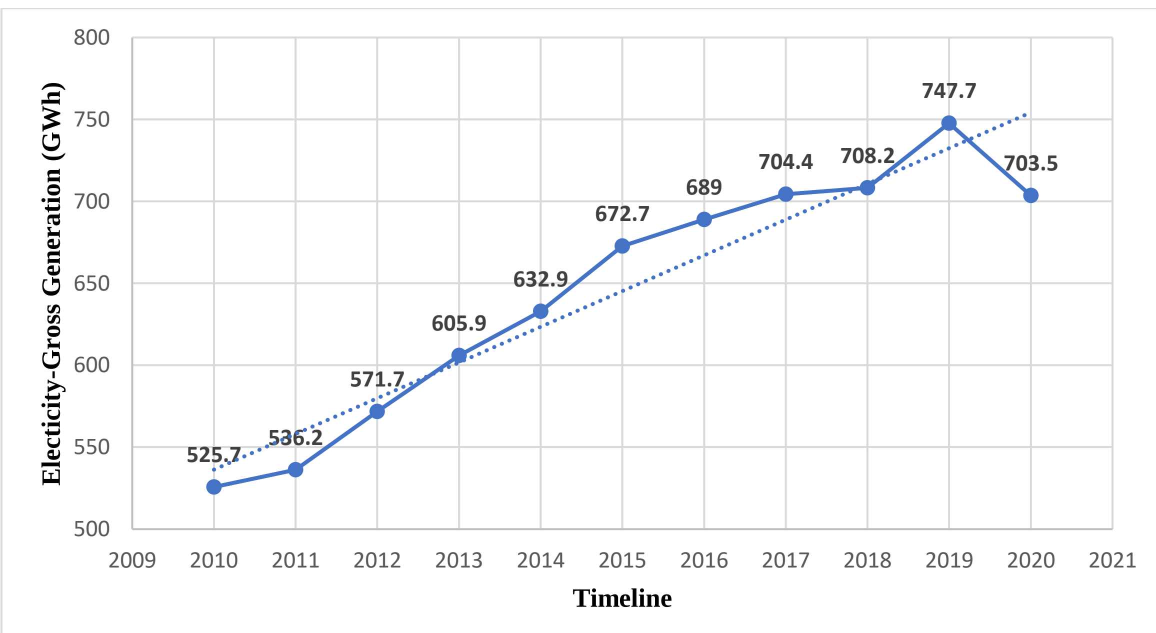
Under the Growth and Sustainable Development Strategy (GSDS), Belize published its first set of Nationally Determined Contributions (NDCs). Its objectives were to evolve into a low-carbon development economy while ensuring climate change mitigation and its effects. Plans and goals for mitigating emissions across several industries were included in the initial NDCs.

To comply with the Paris Agreement, Belize submitted and revised its NDC in 2021. This included efforts to reduce GHG emissions in forestry and other land use, agriculture, energy, transport, and waste management sectors. In addition, among the numerous suggested initiatives, steps involving infrastructure were identified to help society cope with the impacts of rising temperatures.

## Annex 4 Energy/Electricity Matrix, GHG emissions, and electricity rate.

### Gross Electricity Production

The gross electricity production in Belize has shown a general increase from 2011-2020. A general increase in electricity production is anticipated since it has an intimate relationship with the country's installed capacity and power demand.

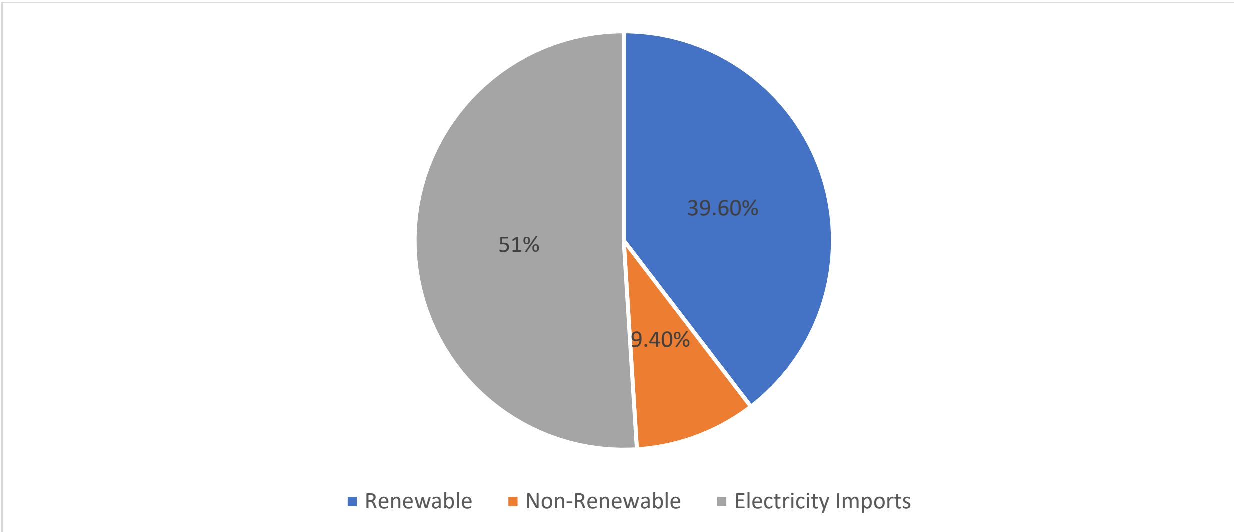



Source: Energy Unit. (2021). 2020 Annual Energy Report. Ministry of Public Utilities, Energy & Logistics, Belmopan City, Belize.

Figure: Historical timeline of Gross Electricity Generation in Belize.

### Electricity Production by Fuel and Technology Share in 2021

Indigenous renewable energy (RE), imported electricity, and non-RE each comprised 39.6%, 51%, and 9.4% of the total electricity generation by supply type. It's important to remember that Belize's production of fossil fuels is extremely minimal when compared to other sources. The growing importance of renewable energy in Belize's electrical mix is congruent with the strategic and policy commitments Belize made as part of its transition to a sustainable energy future.

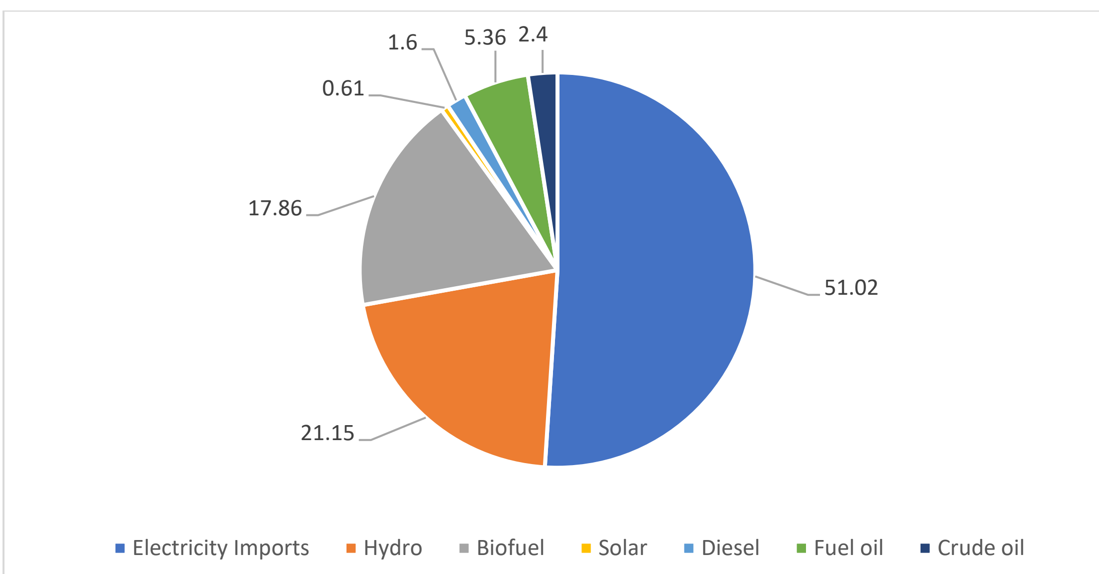



Source: Energy Unit (2022).

Figure: Electricity Generation mix by supply type in 2021.

### Electricity Generation mix by supply technology in 2021.

The figure below displays renewable energy sources, fossil fuel sources, and electricity imports. Renewable energy sources are as follows: hydro (21.5%), biofuel (17.86%), and solar (0.61%). Fossil fuel sources include Crude oil (2.4%), fuel oil (5.36%), and diesel (1.6%). Lastly, electricity is imported from Mexico and constitutes 51.02% of Belize's electricity mix by supply technology in 2021.



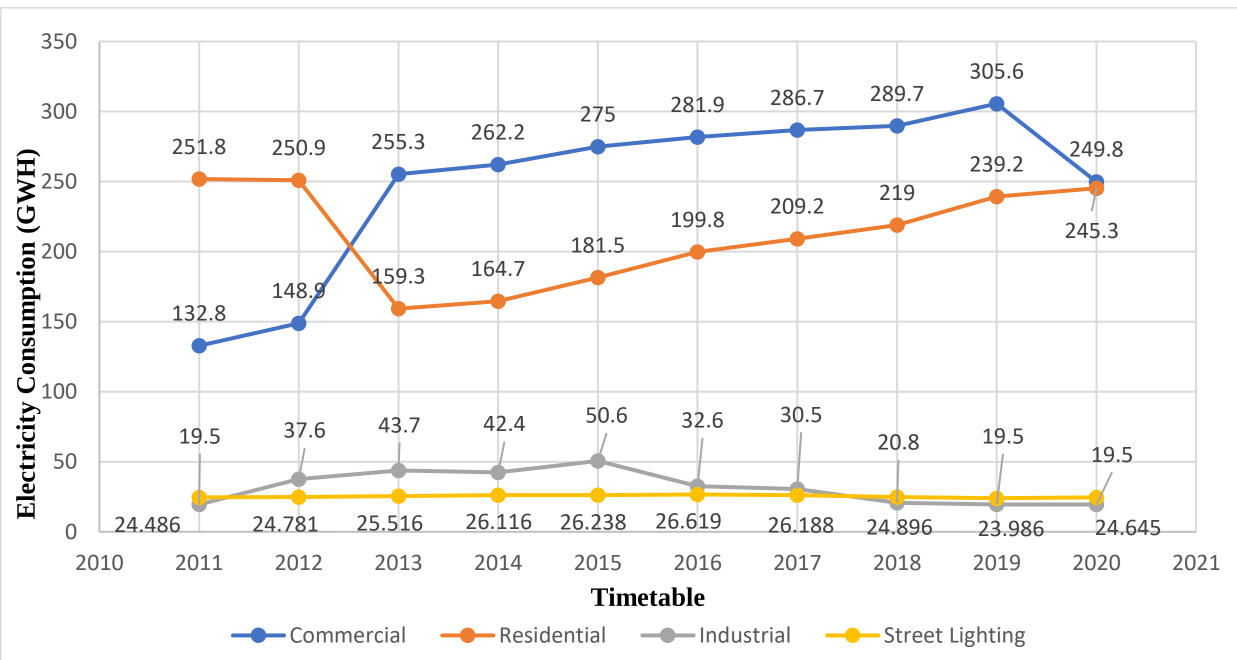
Source: Energy Unit (2022).

Figure: Electricity Generation mix by supply technology in 2021.

### Gross electricity consumption by Sector

The consumption of electricity in the commercial, industrial, residential, and street lighting sectors is shown in the figure below. As stipulated by Belize Electricity Limited, such values were extracted from client tariff categories. In Belize, the commercial sector, comprising businesses, manufacturers, and hospitality services, had the highest gross electricity consumption in 2020, with 249.8 GWH. With 245.5 GWG of gross electricity consumption, the residential sector followed closely behind. Thereafter, with 24.645 and 19.5 GWG in 2020, the industrial and street lighting sectors displayed substantially lower levels of gross energy consumption. In general, while the street lighting industry is experiencing very modest growth, the residential and commercial sectors are expanding significantly. Lastly, the industrial sector is experiencing a decrease in gross electricity consumption (Belize Electricity Limited Annual Report, 2021).

It is worth noting that the RAC sector accounts for a significant share of energy consumption in the commercial and residential sectors. Therefore, it emphasizes the significance of increasing EE in the RAC sector.

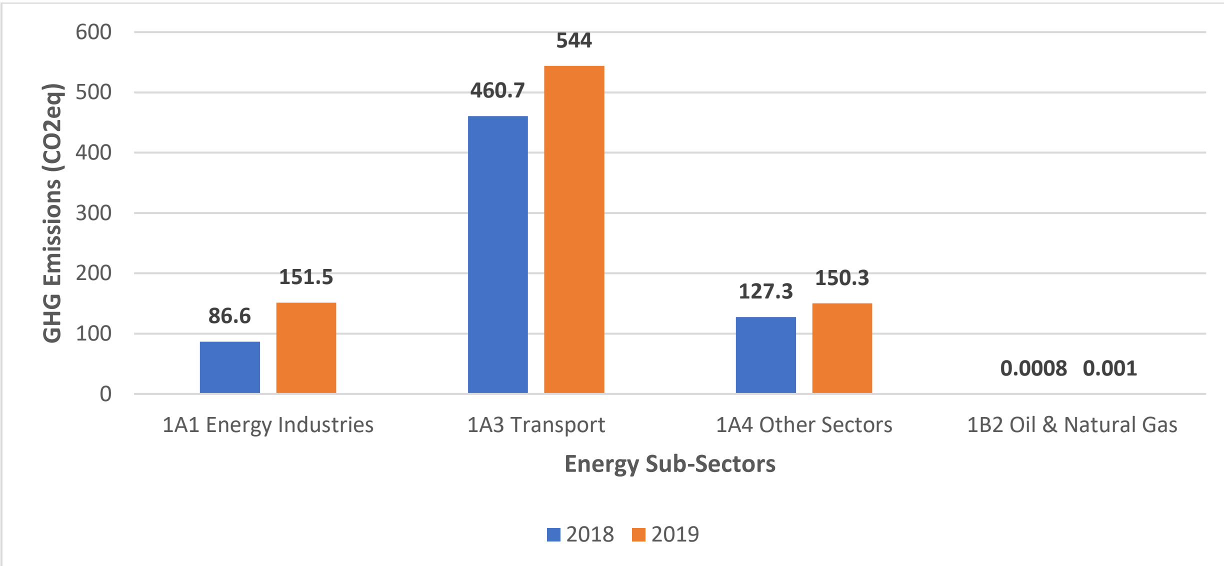



Source: Energy Unit (2021).

Figure: Historical timeline of Electricity Consumption by Sector.

### Total GHG Emission by Energy Sub-Sectors

Belize's overall emissions (Gg CO2 eq) by subsector in 2018 and 2019 are displayed below. The transportation subcategory accounts for the most significant portion of Belize's overall GHG emissions, with 460 and 544 (Gg CO2 eq) in 2018 and 2019, respectively. Then followed emissions from other industries, including the energy industry. Oil and natural gas emissions were minimal compared to the other sub-sectors.

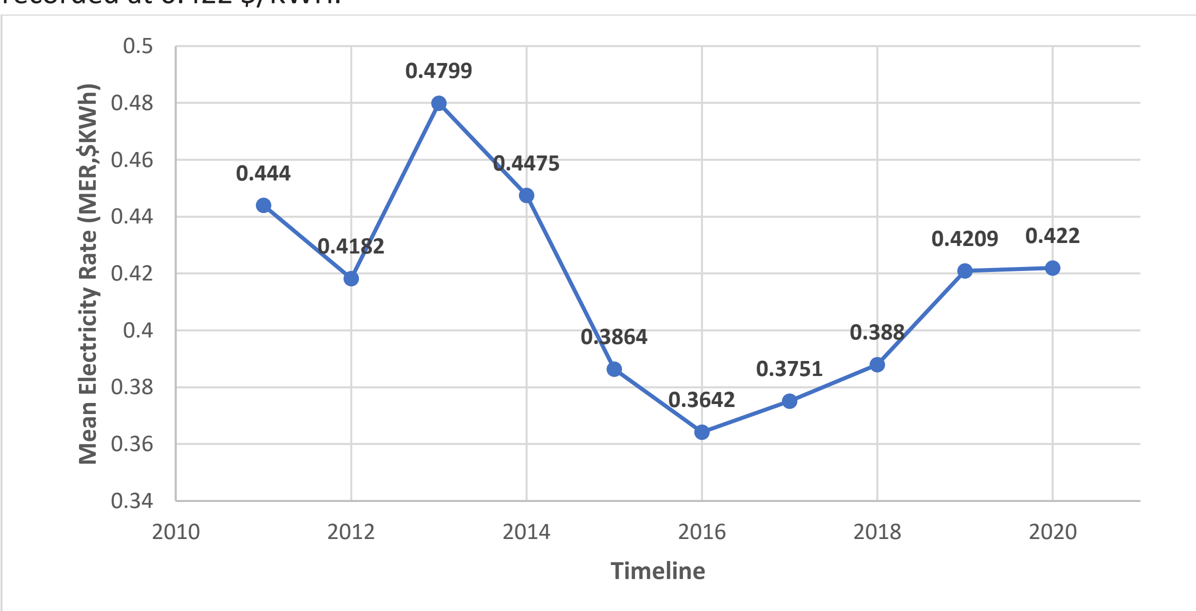



Source: Energy Unit (2021).

Figure: Total GHG emissions (Gg CO2 eq) by sub-sectors in 2018 and 2019.

### Mean Electricity Rate

The mean electricity rate (MER) was obtained from the Public Utilities Commission's tariff review procedure. From 2012 to 2014, the MER increased; however, from 2013 to 2016, the MER decreased. The MER gradually increased from 2016 to 2020; in particular, the MER for 2020 was recorded at 0.422 $/KWH.



Source: Energy Unit (2021).

Figure: Historical timeline of Mean Electricity Rate (MER, $/KWh) in Belize.

## Annex 5: Energy sector policy and legislative framework

**2000 – Electricity Act:** Describes the duties and legislative authority of BEL, as well as citizens' rights and reparations.

**2003 – Electricity Subsidiary Act:**
States the rights and liabilities of the Public Utilities Commission (PUC) over the rates, revenue recovery, and licensing of technicians. The placement of power lines along the roads and public spaces was also included.

**2012 – National Energy Policy Framework:**
It elaborates on the potential for energy growth in all conceivable societal sectors; it describes and maps out energy scenarios across these areas. This strategy includes experimental technologies, such as using industrial waste from nearby businesses that could be used as a source of energy (i.e., bagasse). Even though the National Energy Policy Framework contains several targets viewed as out-of-date, it nonetheless directs the country on the right path for mitigating energy issues.

**2015 – Belize Sustainable Energy Strategy and Action Plan:**
Examines Belize's potential for energy efficiency and renewable sources of power. Concerning the electrical sub-sector, it details the methods Belize could employ to achieve its sustainable energy goals. It elaborates on the institutional and sectoral hurdles to accomplishing the specified objectives, identifies specific implementation activities and their costs, and evaluates how to overcome them.

**2018 – Belize Consolidated Project Plan:**
It focuses on the electricity sector with the explicit goal of boosting renewable energy generation and resilience. Scenario mapping and sensitivity analysis would be used to accomplish this. To achieve energy efficiency, distributed generation, and clean fuels, incentives were put forth for several industries.

## Annex 6: National Cooling Plan general structure

### 1. Development of policy instruments and Finance

Policymakers are responsible for developing and enacting EE laws, MEPs, MEES, labeling standards, monitoring and verification, and enforcement. The NCPB's policy instruments will address the nation's cooling demands while enhancing energy efficiency and lowering emissions. Therefore, it demands a comprehensive approach to develop concise policy efforts for achieving energy and environmental objectives.

Regarding EE-low GWP RAC technologies, their infiltration into the Belizean market should emerge in the short term and persist throughout the foreseeable future. The impact of building codes and innovative construction technologies is expected to be gradual and on the long-term NCPB spectrum. Private actors and entities will continue to exert the most significant influence over market trends; consequently, policy and regulatory framework are critical in inciting desired changes in Belize's RAC sector. Policies should also consider all opportunities for developing digital technologies that augment EE and building-related energy services.

Market trends are often driven by economic viability. Unfortunately, most new EE-low GWP technologies and new building standards, such as those demanding efficient construction materials, are costly. As a result, financing is an integral part of a strategy to assess and implement to stimulate previously unviable advances.

It is also critical to update the existing regulatory, fiscal, or local planning policies and ensure that regulations are enforceable and enforcement strategies are adequately funded. Due to these modifications, the NCPB initiatives should be facilitated coherently. It is also vital to synergize the NCPB with international commitments. For example, the Kigali Amendment to the Montreal Protocol, the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC), NDCs under UNFCCC, the 2030 Agenda for Sustainable Development, and green building designs such as SDGs all interrelate on sustainable cooling.

### 1.1 Implementation of MEPS & labeling standards

Minimum energy performance standards (MEPS) delineate energy efficiency standards that equipment must adhere to or exceed before they can be imported or sold. MEPS has proven to be a highly effective policy measure for increasing RAC equipment's energy efficiency. In summary, an increase in energy efficiency implies that the maximum amount of energy used by equipment during operation reduces. To implement MEPS, policymakers must consider the energy efficiency of RAC equipment on the market and use accurate energy performance measurement standards, protocols, and testing procedures. It is critical to determine where to set the bar concerning the MEPS. As a result, market surveillance is vital. It is also crucial to cross-cut policies in NCPB with MEPS implementation and encourage synergies. Such policies include labeling, market incentives, and the development of a system for regular monitoring, to name a few. International cooperation among governments, industries, and partners should be encouraged for MEPS development.

For equipment labeling, energy efficiency metrics are an essential component. The following constitute the most popularly used metrics around the world:

- Coefficient of performance (CoP)
- Energy efficiency ratio or rating (EER)
- Seasonal energy efficiency ratio (SEER)

Because of global climatic differences, several EE metrics have been developed and are used in specific regions. It is not recommended to convert from one metric to another for various reasons. For example, one piece of equipment may have a higher EER but a lower SEER than another. This emphasizes the significance of incorporating a single metric system for the country of Belize.

Recommendations:

- Examine national and international regulatory mechanisms for developing MEPs and EE Labeling systems.
    - The National Methods Manual- Belize, 2021, Caribbean Region Regulations 57 and 59, outline the procedures and directions Belize will follow in adopting MEPS and labeling standards. The BBS has undertaken these actions, and additional development is ongoing.
        - Throughout the process, CARICOM Regional Organization Standards and Quality (CROSQ) served as a guide.
    - With regards to labeling, ENERGY STAR in the United States, Top Runner in Japan, and energy labeling in the European Union are examples of successful labeling programs that can also serve as a guide. Reviewing the CARICOM Energy Efficiency (CEE) labeling scheme can be helpful.
- It is critical that MEPS be implemented in stages. For example, an AC rated five stars in 2022 could be rated two stars in 2032. In essence, the MEPS must gradually increase energy efficiency and evolve in tandem with the evolution of EE technology.
    - With that said, it is essential to reviewing of MEPS every 3-5 years
- Determine which RAC technologies will be liable to Belize's MEPS and EE labeling programs.
    - As per the Caribbean Regional Standards 57 and 59, refrigerators, freezers, and non-ducted air conditioners with a single interior unit shall be targeted in the RAC industry.
- To ensure the success of MEPS implementation, a system for regularly monitoring the market must be established.
    - Methodologies are stated within the National Procedures Manual- Belize, 2021.

- Designate a single metric for the labeling program, preferably EER, SEER, or CoP.
    - Metrics were assigned in the CARICOM Regional Standards (CRS) 57 and 59.

- Labeling implementation would then require a testing and verification process. It is critical to ensure that the values on the labels are accurate and adequately verified.
    - Develop the necessary product testing, compliance verification services, and certification procedures for MEPS.
    - Regional collaboration initiatives can be utilized to conduct product testing and verification through the BBS. Given the magnitude of the Belizean market, creating an EE testing facility would be unfeasible. The BBS has partnered with Mexico's Association of Normalization and Certification (ANCE) to assist with these objectives.

The Belize Bureau of Standards (BBS) is the regulatory body under the Ministry of Agriculture, Food security & enterprise responsible for standards development and implementation in the country. The BBS has taken action concerning examining national and international regulatory structures for developing MEPs and EE Labeling systems. It is crucial that the MEPs and Labelling within the BBS synergize with the NCPP. The initiatives undertaken by the BBS are as follows:

### The National Procedures Manual- Belize, 2021:

The National Procedures Manual Belize outlines the procedures followed when the Pilot Energy Efficiency Labeling Scheme (EELS) is implemented in the latter part of 2022. It shall be carried out through the Physikalisch-Technische Bundesanstalt (PTB), the CARICOM Regional Organization for Standards and Quality (CROSQ), and the Instituto Dominicano por la Calidad (INDOCAL).

The manual includes methods for complying with the CARICOM Harmonized Regional Energy Efficiency Labelling Scheme (CHREELS). Its compliance would then extend from the port of entry into the Belizean market. All the actions that all the essential actors must take are detailed in the manual. It is focused on registering imported equipment and its monitoring, verification, and enforcement. The actions are divided into six steps: product declaration, registration application, compliance verification, label issuance, monitoring and enforcement, marketing, and information.

Details of the steps are as follows:

- Step 1- Product Declaration
- Step 2- Application for registration
    - Application procedure
    - Application vetting
- Step 3 – Compliance Verification
    - Information required for compliance assessment
        - For products registered in equivalent programmes
        - For products tested in Regional Testing Facilities
        - For products tested in international laboratories

    - Registration of the product
    - Registration rejection
    - Data protection
    - Appeals
- Step 4- Arrival and Issuance of Labels
    - Registered products
    - Nonregistered products
- Step 5- Monitoring and Enforcement
    - Introduction
    - Market surveillance
        - During the voluntary application of the programme
        - During the mandatory application of the programme
    - Check-testing
- Step 6- Marketing and Information
    - Communication
    - Marketing

CARICOM Regional Standards (CRS) 57 and 59 are the reference standards for executing the EELS program. The launch will be carried out as a pilot program. During the pilot program's execution, significant consideration will be given to regional collaboration with other standards and schemes such as Mexican EE standards, Central America, energy star, etc. The implementation will initiate as a voluntary program and gradually become mandatory. Essentially, the goal is to make these standards mandatory nationally.

**CRS57**

This standard defines the minimum energy performance standards (MEPs) for refrigerating appliances and the appropriate test procedure for determining the energy label. Moreover, it outlines the specifications for the energy label.

The standard was developed under the jurisdiction of the CARICOM Regional Organization for Standards and Quality (CROSQ). This criterion is consistent with CARICOM's Energy Policy.

**CRS 59**

The standard was developed under the jurisdiction of the CARICOM Regional Organization for Standards and Quality (CROSQ).

CRS 59 is intended to improve the energy performance of air conditioners. The document provides the energy labeling standards and the Minimum Energy Performance (MEPS) standards for non-ducted air conditioners with a single interior unit, whether single-package or split-system. The parameters employed are the Energy efficiency ratio (EER) and the Performance Coefficient (COP).

The standard was created with the support of the Collaborative Labelling Appliance and Standards Programme, which is part of the CARICOM Regional S&L Policy and the Pan American Standards Organization.

### 1.2 Implementation of MEES, Building codes

Another standardization path that shall be implemented alongside MEPS is minimum energy efficiency standards (MEES) for buildings, which would establish a minimum energy rating for buildings and a certification scheme supported by the introduction of EE building standards (codes). MEES would increase EE and green building design, reducing the demand for cooling in residential and commercial buildings. MEES must be implemented concurrently with MEPS because both are critical to achieving higher energy efficiency in the RAC sector. This would entail establishing a minimum energy rating for buildings and a certification scheme, which would eventually be supported by implementing mandatory EE building standards (codes). This will raise the demand for sustainable building designs, resulting in greater energy efficiency in space cooling.

Amongst the most important drivers of demand for space cooling is the energy performance of buildings. Energy efficiency is highly dependent on space design. The design of a building, and the materials and construction approaches used for its envelope, are crucial. In particular, the building aspect ratio, which is the ratio of interior space to the surface area, directly impacts the heat transfer rate. The roof, ceilings, exterior walls, windows, doors, floors, and foundation are all part of the building envelope. It is well established that the materials used in building envelopes significantly impact the need for space cooling. Thermal mass is an essential factor to consider when evaluating building envelopes. Essentially, the greater the thermal mass, the longer the material holds on to external temperatures. The materials used in construction create a barrier between indoor and outdoor temperatures, leading to the conclusion that it is critical to use materials with low thermal mass. It is essential to ensure that the materials used maintain structural integrity and don’t compromise the building's stability compared to conventional materials. It is also important to consider reducing airflow and leaks that enter the building to avoid heat exchange from the external environment, which reduces heat load even further. In terms of finance, building envelope technologies must consider the affordability and lifecycle costs of materials and building methods of construction.

Recommendations:

- Adopt building codes and performance standards. It is critical to emulate existing standards such as the CARICOM Regional Energy Efficiency Building Code (CREEBC), codes from the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), the Chartered Institute of Building (CIOB), and the International Energy Conservation Code (IECC).
    - It is essential to note that initiatives for Belizean building codes have been launched in tandem with the CREEBC.
    - Belize shall work closely with the CREEBC to accomplish energy retrofit policies for existing buildings.

- It is essential that the building codes and standards:
    - Reduce heat entering a building by using materials with a high thermal resistance (low thermal mass), such as fiberglass insulation and high-performance windows; organic mass, such as green roofs and rammed earth walls; air sealing, such as air-tight envelopes with no uncontrollable vents; and solar protection, such as low-emissivity window films, shutters and overhangs, and green shading.
    - Engage with industry organizations such as the Association of Professional Engineers, the Association of Architects, and other private organizations to formulate MEES.
    - Use comfort-based set-point for air conditioning operation. This can be included in building codes. An example is a set point of 24$^{o}$C implemented in other countries.
- Building Codes and performance standards can be exhibited during the construction of new government and commercial buildings and demonstrated as pilot projects.
    - Implement (MEES) for commercial buildings by requiring environmental clearance to be provided if the building design implementation corresponds to the building codes.
- Green Building Codes and performance standards can be first exhibited during the construction of government buildings and demonstrated as pilot projects.
- Implement the building certifications along with building codes.
    - Green building certifications can be quite advantageous for the hospitality and tourism sectors. It is common knowledge that consumer behavior in tourism is influenced by environmental consciousness and awareness. Hotels and other accommodation facilities that have received "green" certification instantly gain more appeal among guests. As a result, it can be suggested that building certifications may initially be applied to the tourism and hospitality industry.
- Several construction industry certifications can be emulated to improve the energy and environmental performance of RAC equipment and systems used in buildings and houses, including Sustainable Building Certification (SBC), Sustainable Housing Certification (SHC), Green Building Council (GBC) certification, and House and Public Building Energy Rating (HER).
- Establish a proper institutional framework to control, enforce, monitor, and evaluate MEES for buildings implementation.

### CARICOM Regional Energy Efficiency Building Code (CREEBC):

Building codes will be implemented in Belize following the standards outlined in the 2018 CARICOM Regional Energy Efficiency Building Code (CREEBC). It is based on the International

Energy Conservation Code 2018 Edition and ANSI/ASHRAE/IES Standard 90.1-2016. The CREEBC is a design document. For example, per the CREEBC, the minimum insulation R-values and fenestration U-values for the building's exterior envelope must be established before construction.

Exterior envelope insulation, window and door U-factors, Solar Heat Gain Coefficient (SHGC), duct insulation, lighting, power efficiency, and water distribution are the essential criteria for residential and commercial buildings.

To be specific, the CREEBC code contains the following:

- Scope and administration
- Definitions
- General requirements
    - For climate zones
    - Design conditions
    - Materials system equipment
    - For example, the general requirements encompass the following:
        - Roof solar reflectance and thermal emittance.
            - Calculations are included
        - Opaque portions of buildings
        - Fenestration
        - Air leakage of buildings
- Commercial energy efficiency
- Residential energy efficiency
- Requirements for existing building
- Referenced standards

### 1.3 Safety standards for Natural Refrigerants

Unlike synthetic refrigerants, natural refrigerants are typically more environmentally sustainable (low-GWP). Natural refrigerants, such as ammonia (NH3), carbon dioxide (CO2), and hydrocarbons (HC), are now commonly utilized in equipment. Natural refrigerants must be cautiously handled due to safety concerns such as high working pressures, flammability, and toxicity.

Under the Kigali Amendment, the NCPB is geared toward reducing emissions of substances with high GWP, such as HFCs and HCFCs. HCFCs will be phased out, while HFCs will be phased down. As a result, equipment that uses high-GWP refrigerants will be less prevalent on the market, while those that use low-GWP refrigerants (natural refrigerants) will become more common. Working pressures, flammability, and toxicity of natural refrigerants are all hurdles to overcome in the RAC sector. This emphasizes the significance of developing safety standards for using equipment that employs natural refrigerants.

Recommendations:

- Refrigerant safety classification (flammability, toxicity);
- Types of occupancy, refrigerant charge size limits, and room sizes;
- Safe design and testing of components and pipes (e.g., pressures),
- Safe design and testing of assemblies (systems);
- Electrical safety, ignition sources;
- Installation areas, positioning, pipework, mechanical ventilation, gas detection;
- Instructions, manuals, name plates;
- Servicing, maintenance, and refrigeration handling practices.
- Installation of refrigerant detectors to warn of leakages
- Safety standards for the transportation and storage of NF and NF-containing equipment.

### 1.4 Assessment of Funding and Financial Mechanisms for Market Transformation

To support the market competitiveness of alternative systems, the NCP finance working group must assess existing funding and financial mechanisms and develop and implement new funding and financial support measures. The funding and incentive system aims for a quick and long-term transition, the development of sustainable national funding streams, and the market introduction of more efficient, low-GWP appliances. Financing is essential for the implementation and the NCP for Belize. Accessing funding opportunities locally, regionally, and internationally is vital to support market transformation in alignment with the NCP.

Recommendations:

#### Assess International Cooperation Funds:

- To kickstart the process, international climate finance can be used, including contingent international funding.
    - It is essential to synergize the NCPB with international commitments. For example, the Kigali Amendment to the Montreal Protocol, the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC), NDCs under UNFCCC, the 2030 Agenda for Sustainable Development, and green building designs such as SDGs all interrelate on sustainable cooling. These can all aid in funding mechanisms for the implementation of the NCPB.
        - A significant portion of the NDC GHG emission reductions can be realized with the implementation of the NCPB. With that said, international finance can be activated for the NCPB by collaborating with the NDC of Belize.
    - It is also essential to evaluate other possible international funding that would support the initiatives of energy efficient cooling and the reduction of GHG

emissions, such as Green Fund, GIZ, Kigali Cooling Efficiency Programme (K-CEP), GEF, and Green Climate Fund (GCF), and the Paris Agreement amongst others.

        - According to Article 6 of the Paris Agreement, a country can transfer carbon credits earned from GHG emission reductions to help meet climate targets.
            - It is essential to monitor energy consumption reductions (per capita) caused by EE technologies, convert the reduction in energy consumption to a reduction in GHG emissions, and receive carbon credits.
            - As high-GWP equipment is decommissioned, it is critical to recover and destroy the refrigerants so that the amount can be quantified and transferred into carbon credits.
    - The Belize Chambers of Commerce and the Ministry of Finance & Economic development can assist in accessing foreign funds, for example, funds from the Green Climate Fund (GCF).
- Assess how other countries accessed funding and relate the international experiences to the Belizean perspective.

**Public Finance:**

- Analysis of import taxes, sales tax, and other incentives for the procurement of equipment with high EE, low GWP RAC equipment with natural refrigerants, and to reduce costs and improve access to energy efficiency measures in the building sector for MEES.
- Disincentives for low EE RAC and high GWP equipment where applicable.
    - Financial mechanism to phase out least efficient, high-GWP products and encourage the introduction of EE, low-GWP products.
        - Taxation (higher import duties) of low EE, high-GWP equipment and using those funds to subsidize high EE, low-GWP equipment.
            - Tariff reduction or repeal for EE, Low-GWP equipment imports. Solar air conditioning systems can be prioritized.
- It is essential also to analyze all the national alternatives for the financing.

    - For the transformation of the RAC market, such as training, equipment bulk procurement, market monitoring, enforcement, verification, outreach and communication, and all other aspects of the NCP.

**Private Finance:**

Private financing can be sourced from:

- Intergovernmental organizations

- ESCOs
  - Customers can choose from a wide variety of distributed generation, renewable energy, and energy efficiency measures through the Energy Performance Contracting (EPC) service. It is typically backed with guarantees that the savings generated by a project will be adequate to cover the project's entire cost, and it is sometimes compared to design/build construction contracts. The following elements comprise a typical EPC project delivered by an Energy Service Company (ESCO). ESCOs typically concentrate on public buildings, including hospitals, colleges, and universities. ESCOs obtain long-term project finance via a third-party financial provider. Ordinarily, the funding takes the form of municipal or operational leases.
  - ESCOs propose, implement, and help clients finance energy management projects that can result in significant electricity cost savings and mitigate GHG and refrigerant emissions.

## 2. Capacity Building and Partnership Initiatives

One of the most significant barriers to introducing new RAC technology is the insufficient technical capacity for its installation and maintenance. As a result, updating and training technical staff, teachers, and students regarding recent cooling trends based on alternative refrigerants and EE criteria is critical. The NCP's other initiatives are inextricably linked to training and capacity building. Capacity building is aimed at national policymakers, the service sector, government officers and departments/agencies, importers and retailers, and consumers.

Outreach, communication, and regional collaboration are critical for RAC sector capacity building. Other partnership initiatives are also essential to the NCP's implementation. This should stimulate and drive the cross-sectoral partnerships between the public, private, and multi-stakeholder sectors for the NCPB's long-term development. Bulk equipment procurement, retrofitting equipment to use low-GWP refrigerants, and mechanisms for refrigerant recovery, recycling, and safe disposal are all important partnership initiatives that must be incorporated.

### 2.1 Training and capacity building

Inadequate technical capacity for installation and maintenance is one of the most significant barriers to introducing new RAC equipment. Capacity building is fundamental for the NCPB because it enhances the RAC sector's performance and capacity to function and remain viable in a rapidly changing industry. As a result, it is essential to update and train technical staff, teachers, and students on new cooling trends based on alternative refrigerants and EE criteria. Training and capacity building is intricately bound to the NCP's other initiatives. National policymakers, the service sector, government officers and departments/agencies, importers and retailers, and consumers are all targeted for capacity building. Capacity building for MEPS has been outlined in the National Procedures Manual 2018 and the CREEBC for MEES.

Recommendations:

- Capacity building in the servicing sector:
    - Focus on the safety and handling of alternative refrigerants and the installation, operation, maintenance, and safety considerations of EE, low-GWP equipment in space cooling, cold chain refrigeration, and MAC sectors.
        - Capacity building activities based on safety standards for natural refrigerants and equipment that utilize natural refrigerants.
    - The significance of using low-GWP alternative refrigerants and EE, low-GWP equipment; discussing how installations, MEPS, and building codes affect energy efficiency.
    - Retrofitting HFC AC units to use low-GWP refrigerants.
    - Training for technicians and companies in the recovery, recycling, and disposal of refrigerants
    - Incentivization and grants/funds regarding equipment.
    - It is essential to enhance the licensing scheme.
        - Vetting and confirming that technicians know and meet the standards for handling refrigerants appropriately; installing, servicing, and operating all required equipment; proper approach to refrigerant recovery, recycling, and disposal, etc.
        - It’s beneficial to continue with the apprenticeship license for 1-2 years.
    - Introduce solar and desiccant AC units as viable, sustainable technology.
        - Provide training sessions concerning the installation and servicing of such equipment.
- Capacity building with importers and retailers should:
    - For importers and retailers’ capacity building would be geared toward sensitization sessions on Energy Efficiency labels, MEPS, Low-GWP equipment, and safety training.
    - Introduce solar AC units and desiccant AC units as viable, sustainable technology and encourage importation.
- Capacity building with trainers and vocational institutes should:
    - Due to the market transformation induced by the Kigali Amendment and NCPB, modifications to the training curricula within the vocational institutes have to be implemented.
        - The change will be directed toward theoretical and practical knowledge of good practices in the installation and servicing of equipment, constantly updating cooling trends with low GWP refrigerants, and the inclusion of energy efficiency.
            - Training in recovery, recycling, and disposal of refrigerants for HCFC, HFC, and HC.

            - Dissemination of the potential policies that can be implemented, such as MEPs, EE labeling, building codes, etc.
            - It is essential to introduce awareness toward international environmental commitments such as the Montreal Protocol and the Kigali Amendment in vocational institutes.
            - Introduce requirements for trainer qualification and infrastructure in the institution.
                - Introducing machinery or models to enhance capacity for servicing, maintaining, and installing alternative machinery that utilizes low GWP refrigerants.
            - Encourage the update of curriculum every 3-5 years, addressing new market trends
        - Focus capacity-building initiatives to aid in the introduction of new curriculum updates.
        - Students' school fees are very high, and it would be advantageous if stipends or subsidies were provided as assistance.
        - Introduce solar AC units and desiccant AC units as viable, sustainable technology and potentially include them in the curriculum
- Capacity building with governmental departments, officials, and practitioners in public and private institutions involved with monitoring, verification, and enforcement:
    - Introduce the importance and implications of energy efficiency in the RAC sector
    - Monitor equipment procurement, handling procedures, and monitoring performance operation of equipment
    - Conduct training on personnel in charge of monitoring, verification, and enforcement of MEPS, and labeling
        - Disseminate the potential policies that can be implemented, such as MEPs, EE labeling, building codes, etc.
- Capacity building for architects and engineers:
    - Introduce new policies such as MEPS, MEES, certification, and labeling standards.
    - Training for Architects and engineers to include the use of EE low-GWP equipment in their design
    - Discuss solar and desiccant AC units as viable, sustainable alternatives.

### 2.2 Outreach and Communication

Consumers, service companies, technicians, and importers/retailers will be targeted for outreach and communication. The campaigns will disseminate the advantages of using EE low-GWP equipment, developed policies and standards, and the financial benefits of using EE equipment. Communications and outreach are critical to the NCP's success. It is worth noting that outreach and communication are inextricably linked with all of the NCP initiatives.

Recommendations:

- It is vital that a communication and outreach strategy is developed.
- Campaigns should prepare the RAC industry for compliance with the standards and policies proposed in the NCP, such as MEPS, MEES, labeling standards, safety standards, and their benefits.
    - It is important to promote all policies and standards relating to sustainable building designs, energy-efficient equipment, and safety approaches for alternative equipment.
- Outreach and communication campaigns should instill user awareness and the benefits of energy-efficient, low-GWP equipment.
- Support information and capacity-building efforts that encourage consumers to opt for energy-efficient products and services.
- The campaigns should promote the importance of hiring only certified technicians
- New technology available and its benefits
    - Promote EE in such a way as to convince the consumer of its financial feasibility. The upfront cost of the alternative technology might be more expensive; however, the energy savings by utilizing EE low-GWP equipment is significant compared to the initial upfront cost.
    - It is also important to instill environmental consciousness and elaborate on the environmental implications of utilizing new technologies available, EE and low-GWP.
        - Other viable alternatives are photovoltaic ACs and desiccant ACs.
    - Encourage using energy-efficient cooling systems like cooling towers and evaporative condensers.
    - Promote renewable and alternative energy technologies in tandem with the international market.

- Dissemination of the metric systems used for MEPS, such as the EER/SEER metric fund and their relationship with EE.
- Disseminate on labels a how to interpret the information portrayed.
- The NCP is designed and parallel to the Kigali Amendment, so it is essential to include the phase-out of HCFCs and the phase-down of HFCs in all campaigns.
- Guidelines for new cooling projects and retrofits
- Good practice manuals for installation, maintenance, and operation of equipment.
- Update the website and social media pages with details regarding the new standards that will be implemented and other market trends.
- All campaigns should disseminate sector-wise analysis, including space cooling, cold chain & refrigeration, mobile air conditioning, research & development, and the servicing sector.
- Project public campaigns should be conducted through TV and Radio talk shows, social media, presentations, and write-ups on the NCP in the Print Media

## 2.3 Opportunities for Regional Collaboration

Belize has the potential for regional collaboration with its CARICOM and North American counterparts. This is possible, particularly in the Caribbean, because Belize has similar demographics, energy usage, and energy costs. Regional collaboration must include implemented policies, standards, monitoring, verification, enforcement, regional training opportunities, outreach and communication, and financial mechanisms.

Regional cooperation among nations with comparable energy usage and pricing conditions for the same product categories is crucial. This strategy makes it possible to harmonize MEPS & MEES with CARICOM nations and other regional peers. It would also be advantageous to imitate labeling requirements and their verification, monitoring, and enforcement practices. Harmonization with other countries is beneficial because it enables us to take already-in-use resources from different countries and apply them to the Belizean aspect.

Recommendations:

- Harmonize MEPS in the RAC Sector across the Caribbean and Americas
- Harness all possible opportunities for regional collaboration
- Develop strategies for regional collaboration and recognition of MEPs, MEES, and labeling systems. It is essential to harmonize policies and regulations within the Caribbean.
    - Increase international cooperation in cooling-related research
        - Integrate with international agencies such as the international energy agency (IEA) collaboration programmes.
        - Integrate policies with regional policies such as The CARICOM Regional Energy Efficiency Building Code (CREEBC), CARICOM Regional Organization for Standards and Quality (CROSQ), The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), Energy star labeling, The CARICOM Regional Energy Efficiency Labelling Scheme (CREELS), Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE).
        - In particular, through the joint leadership of the CARICOM Secretariat and CROSQ and the strategic support of their development partners, CREEBC, energy efficiency labeling of refrigerators, energy efficiency labeling for air conditioners, MEPS for refrigerators and freezers, and MEES for buildings are all developed/ or to be developed. These initiatives are to be conducted through the BBS.
            - In collaboration with the BBS, a regional partnership will be established with the Mexican EE standards, Central American Standards, and Energy Star.
            - Research all the regional policies and incorporate them into the NCPB where feasible.
- Regional collaboration initiatives can be utilized to conduct product testing and verification through the BBS. Given the magnitude of the Belizean market, creating an EE

testing facility would be unfeasible. The BBS has partnered with Mexico's Association of Normalization and Certification (ANCE) to assist with these objectives.
- Establish a framework for data sharing, mutual recognition of product testing results, market monitoring, verification, and enforcement.
- Opportunities for the training of technical personnel regionally.

### 2.4 Bulk Procurement

The cost of replacing low EE, high GWP equipment with high EE, low GWP equipment is one of the significant impediments to RAC market transformation. However, bulk procurement can help reduce prices for such equipment.

They achieve this by pooling technological demand and creating a competitive market for participating producers, which causes prices to fall quickly. When purchasing equipment in bulk from manufacturers, prices experience a natural reduction because it is more cost-effective to produce large quantities of equipment than smaller ones.

Bulk procurement has demonstrated the ability to reduce costs by up to 30%, enticing the feasibility and benefit of bulk procurement (The Energy and Resources Institute, 2019).

Solar cooling and desiccant technologies are appealing alternatives to space cooling because they can contribute to little or no emissions from refrigerants used (low-GWP) and indirect emissions from grid energy consumption. Solar PV AC units, in particular, are emerging and very effective, but the cost of such technologies is high. Bulk procurement can mitigate this disadvantage and encourage market adoption.

Recommendations:

- Collaborate with RAC equipment importers to procure EE, low-GWP RAC equipment.
    - It is essential to provide financial incentives for bulk procurement of such equipment
    - It is also essential to establish technical specifications for the equipment that will be procured concerning EE and low-GWP-containing equipment.
    - According to market research, AC split units, domestic and commercial refrigerators, are commonly imported. This provides the opportunity of targeting such equipment first in bulk procurement initiatives.
        - Due to the dominance of AC split units in the RAC import market, bulk procurement can also focus on solar PV AC units. This is critical in potentially diversifying the electricity mix associated with space cooling to more energy-renewable resources.
        - Desiccant AC systems can also be bulk procured and introduced into the country through pilot projects.

### 2.5 Retrofitting equipment to use low-GWP equipment and to increase energy efficiency

Retrofitting RAC equipment is one of the most cost-effective ways of complying with the Kigali amendment regarding direct GHG emissions. Retrofitting equipment with a long life is crucial, as consumers will naturally replace older equipment sooner. It must be replaced by low-GWP EE equipment.

Recommendations:

- Facilitate the elaboration of funding opportunities among the decision and policymakers
- Establish the type of equipment that will be subject to retrofitting and the specific sectors to be targeted.
- AC split units are known to be the most common and typically utilize HFC-410A.
    - Establish a mechanism for retrofitting HFC equipment with low-GWP refrigerants.
    - This can be implemented as pilot projects within governmental institutions and then into the domestic and commercial sectors.
- Training exercises and demonstrations shall be conducted with technical personnel for retrofitting.
    - The Kigali Amendment compliance campaign will include these training sessions as a component.

**To increase energy efficiency:**

- Retrofit cold storage equipment. This could include improving insulation and switching to the more energy-efficient cooling equipment.
- Belize shall work closely with the CREEBC to accomplish energy retrofit policies for existing buildings.

### 2.6 Mechanisms for Recovery, Recycling, Disposal of Refrigerants & waste management of decommissioned equipment.

To reduce GHG emissions in the RAC sector, mechanisms for refrigerant recovery, recycling, and disposal must be established. Most HFC/HCFC-containing equipment is expected to be decommissioned in the coming years. When the inevitable happens, recovery and disposal of these refrigerants will be critical. Although low-GWP refrigerants do not pose an environmental threat, recycling these refrigerants is economically beneficial. Components within refrigeration and air conditioning units can be classified as hazardous and pose a waste management issue when decommissioned. Consequently, it is crucial to establish waste management mechanisms for such equipment.

As a result, it's critical to build capacities for refrigerant recovery, recycling, and disposal and financial support for such initiatives.

Recommendations:

- Develop mechanisms to support initiatives for refrigerant recovery, recycling, disposal, and waste management of decommissioned equipment.
    - Partnership initiatives between the NOU and other private entities in the RAC sector can be established to realize this critical initiative.
    - Develop mechanisms to establish recovery, recycling, disposal, and decommissioning centers.
        - This would require collaboration between NOU, technicians, and other relevant stakeholders.
        - Bounty programs can be implemented to encourage the collection of decommissioned equipment for refrigerant recovery, recycling, and environmentally friendly refrigerant and equipment disposal.
        - Determine a method for disposing of refrigerants and related equipment in an environmentally friendly manner.
            - It is critical to quantify the amount of disposed of/destroyed refrigerants used to obtain carbon credits.
- Develop training for technicians and companies on recovery, recycling, and disposal of refrigerants.
    - This will also be conducted in all the vocational institutions with programs focused on the MAC, space cooling, and cold chain & refrigeration sector.

- It is crucial to design ways to increase the availability of a recovery machine for all technicians.
    - Recovery equipment is usually costly. Therefore, it's crucial to secure funds for recovery equipment or provide incentives for businesses and technicians to buy this equipment.
    - The availability of recovery cylinders is required in conjunction with the recovery, recycling, and disposal of refrigerants. It will be crucial to provide funding or other incentives to promote the availability of these cylinders.

### 3. Market Monitoring, Verification, and Enforcement

Market monitoring, verification, and enforcement are essential for the implementation of the NCPB. It is, in essence, the driving force behind all policies and regulations put in place. Without them, policies and regulations are rendered ineffective in their intended purpose. All of the policies have the potential to be very effective, provided they are well-thought-out and adequately enforced.

A data collection mechanism is essential for market monitoring, verification, and enforcement. The data should cover energy performance, energy savings, compliance with existing standards and policies (MEPS, labeling, building standards), and the type of equipment on the market. It is critical to monitor market transition because specific mechanisms may be implemented within the NCP in response to market changes. Monitoring, verification, and enforcement can be coordinated with the Montreal Protocol and the Kigali Amendment initiatives.

Recommendations:

- First, compile an inventory of the current and available energy-efficient and sustainable cooling systems before MEPS and labeling are established.
- Create a data collection and statistics system.
    - Monitor, track and report market transformation
        - Import data can be used to monitor, track, and report market transformation
    - Monitor, evaluate and report energy savings
    - Monitor, evaluate and report HFC phase-down
        - Import data can be used to monitor, track, and report HFC phase-down based on refrigerant imports.
    - Track and report on all relevant data corresponding to policy and regulations implemented (MEPS, MEES, Safety standards, labeling, etc.).
        - Throughout the implementation, it is critical that this data be shared with decision-makers and policymakers.
    - RAC servicing facilities must register and record refrigerant recovery, load, and recycling details. This initiative is also essential for the Kigali amendment in Belize.
        - Establish a database for RAC facilities and technicians and record data.
- It is critical to creating monitoring, verification, and enforcement mechanism to ensure proper installation and servicing practices in the RAC sector.
    - For MEPS, it’s highlighted in the National Procedures Manual-2021.
    - For MEES it’s highlighted in the 2018 CARICOM Regional Energy Efficiency Building Code.
- Create a system to enforce MEPS, MEES, and labeling when implemented.
    - Create a market surveillance system, including an effective fining system for non-compliance.
- Propose methods that should enforce the use of only licensed technicians to encourage good practices and refrigerant handling, as well as proper installation and servicing of equipment by certified personnel.
- It is also critical to monitor, verify, and enforce natural refrigerant safety standards.
- The testing and verification process to ensure that the stated EE is accurate and verified is one of the challenges of energy labeling. As a result, Belize needs to develop the necessary infrastructure for product testing and compliance verification.
    - Equipping NOU/Customs officers with HC, HFC, and HCFC refrigerant identifier kits
    - Given the magnitude of the Belizean market, creating an EE testing facility would be unfeasible. The BBS has partnered with Mexico's Association of Normalization and Certification (ANCE) to assist with these objectives.

- Research methods to calculate and verify emissions before NCP is initiated and after.
- It is essential to monitor and report on all NCP initiatives and their progress and conduct monitoring and evaluation (M&E). It is essential that the National Cooling Plan Steering Committee and the NOU collaboratively develop an M&E matrix.
    - When the NCPB is initiated, it is essential to establish baselines and monitor all the proposed initiatives.
    - Creating a monitoring protocol and, ideally, creating an institutional framework to track the progress of NCAP implementation.
    - Identifying the major success indicators that will aid in determining the effectiveness of the proposed recommendations
    - Since the NCPB is a living document, it is critical to design a method for -evaluation. The NCPB should be revised and updated at regular intervals. For example, new technologies may become available, which must be incorporated into the plan.
        - It is important to incorporate all the data gaps stated within the NCP's limitations when available.

# Annex 7: Cold chain data

## Food cold chain equipment systems, stocks, imports & cold chain equipment and systems characteristics

| Cold Chain equipment and systems stocks and imports | | | | | | | | | | | Cold Chain equipment and systems characteristics | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stock (number of units) | | | | | Imported and/or installed (number of units) | | | | | Average refrigerant charge (kg) | Average emission factor | Average lifetime | Average cooling capacity | The average coefficient of performance (COP) | Average runtime hours |
| **Application** | **2017** | **2018** | **2019** | **2020** | **2021** | **2017** | **2018** | **2019** | **2020** | **2021** | | (% initial charge) | (years) | (kW) | | (h/day) |
| **Domestic refrigeration** | | | | | | | | | | | | | | | | |
| HFC-134a | 62519 | 70818 | 70506 | 79164 | 75802 | 12,934 | 8,369 | 12,299 | 2,398 | 10,533 | 0.0801 | | 10 | 0.215 | | |
| HC-600a | 7100 | 8569 | 9524 | 10984 | 11364 | 1,469 | 955 | 1,460 | 380 | 1,571 | 0.0736 | | 5 | 0.13 | | |
| **Commercial refrigeration** | | | | | | | | | | | | | | | | |
| R-404A | 2,277 | 5,019 | 5,137 | 5,662 | 5,448 | 362 | 334 | 204 | 471 | 622 | 0.48 | | 10 | 586 | | |
| HFC-134a | 21,918 | 17,071 | 17,477 | 19,261 | 18,754 | 3,484 | 1,136 | 694 | 1,602 | 2,141 | 0.21 | | 10 | 320 | | |
| HCFC-22 | 13 | 8 | 2 | - | - | 2 | 0 | 0 | 0 | 0 | | | 10 | | | |
| R-600a | 1,730 | 3,441 | 3,525 | 3,883 | 5,982 | 275 | 229 | 140 | 323 | 683 | 0.08 | | 4-5 | 188.3 | | |
| R-290 | 1,006 | 1,442 | 1,460 | 1,623 | 1,785 | 160 | 96 | 58 | 135 | 93 | 0.12 | | 4-5 | 145 | | |
| **Condensing units** | | | | | | | | | | | | | | | | |
| R-404A | | | | | 338 | | | | | | | | | | | |
| HFC-134a | | | | | 68 | | | | | | | | | | | |
| HCFC-22 | | | | | 45 | | | | | | | | | | | |
| **Supermarket central systems (compressor racks)** | | | | | | | | | | | | | | | | |
| R-404A | | | | | 176 | | | | | | | | | | | |
| HFC-134a | | | | | 0 | | | | | | | | | | | |
| HCFC-22 | | | | | 44 | | | | | | | | | | | |
| R-744 | | | | | 0 | | | | | | | | | | | |
| **Industrial refrigeration** | | | | | | | | | | | | | | | | |
| R-717 | | | | | | | 1 | | | | 23 | | 10 | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HFC-134a | | | | | | | 2 | 1 | 1 | | 11.36 | | 13.5 | 19.5 | | |
| R-404A | | | | | | | 1 | 2 | 2 | | 13 | | 13.5 | 22.86 | | |
| HCFC-22 | | | | | | | 1 | 1 | 1 | | 18.2 | | 20 | 22 | | |
| **Refrigerated transport** | | | | | | | | | | | | | | | | |
| R-404A | 101 | 103 | 105 | 107 | 109 | | | | | | 38.5 | 20% | 20 | 9 | | 4 |
| HFC-134a | NA | NA | NA | NA | NA | | | | | | | | | | | |
| HCFC-22 | 21 | 21 | 20 | 20 | 20 | | | | | | | 20% | 20 | | | 4 |

## Cold Chain food imports (2017-2021, in kg)

| Product | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|
| Dairy | 2,570,311 | 4,471,968 | 6,526,519 | 8,360,430 | NA |
| Meat | 999,201 | 1,015,593 | 726,707 | 693,629 | NA |
| Marine | 114,351 | 164,326 | 87,655 | 166,900 | NA |
| Fruits & Vegetables | 10,240 | 13,148 | 5,706 | 8,890 | NA |

Note 1:2/3 of the local consumption of these products is produced internally, and the production regions are at a similar distance to the main towns and cities than the main customs.

Note 2: Total quantity of dairy products includes powder and liquid, the powder milk does not need the same refrigeration system as liquid milk.

## Refrigerated transport Fuel Consumption

| Estimate the number of refrigerated trucks | Estimate of average travel distance of refrigerated trucks | Estimation of average refrigerated truck cooling capacity | Calculation of average diesel consumption |
|---|---|---|---|
| | (km/day) | (kW) | (l/km) |
| 109 | 250 | 9 | 0.33 |

## Vaccines & pharmaceutical cold chain equipment systems, stocks, imports & cold chain equipment and systems characteristics

| **Table 4 Vaccines and pharmaceutical products cold chain equipment and systems stocks and imports** | | | | | | | | | | | **Table 5 Vaccines and pharmaceutical products cold chain equipment and systems characteristics** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Stock (number of units)** | | | | | **Imported and/or installed (number of units)** | | | | | **Average refrigerant charge (kg)** | **Average emission factor** | **Average lifetime** | **Average cooling capacity** | **The average coefficient of performance (COP)** | **Average runtime hours** |
| **Application** | **2017** | **2018** | **2019** | **2020** | **2021** | **2017** | **2018** | **2019** | **2020** | **2021** | | **(% initial charge)** | **(years)** | **(kW)** | | **(h/day)** |
| **<u>Refrigerators</u>** | | | | | | | | | | | | | | | | |
| R-404A | | | | | NA | | | | | | | | | | | |
| HFC-134a | | | | | NA | | | | | | | | | | | |
| HCFC-22 | | | | | NA | | | | | | | | | | | |
| Others (please specify) | | | | | NA | | | | | | | | | | | |
| The blowing agent used in equipment foam | | | | | NA | | | | | | | | | | | |
| **<u>Refrigerated transport</u>** | | | | | | | | | | | | | | | | |
| **R-404A** | | | | | **6** | | | | | | | | | | | |
| **HFC-134a** | | | | | **NA** | | | | | | | | | | | |
| **HCFC-22** | | | | | **NA** | | | | | | | | | | | |
| **Others (please specify)** | | | | | **NA** | | | | | | | | | | | |

## Vaccines and pharmaceutical products cold chain - Refrigerated transport Fuel Consumption

| Estimate the number of refrigerated trucks | Estimate of average travel distance of refrigerated trucks | Estimation of average refrigerated truck cooling capacity | Calculation of average diesel consumption |
|---|---|---|---|
| | (km/day) | (kW) | (l/km) |
| | | | |
| 6 | 25 | 9 | 0.33 |