



Government of the Republic of Trinidad and Tobago

THE NATIONAL COOLING STRATEGY OF TRINIDAD AND TOBAGO

Trinidad and Tobago's Sustainable and Efficient Cooling Strategy

FEBRUARY 2020

ABSTRACT

This 2020-2030 Policy sets the various initiatives to be undertaken nationally to address sustainable and environment friendly refrigeration and cooling in alignment with the Montreal Protocol and Kigali Amendment.

EXECUTIVE SUMMARY

Cooling is a critical element for the sustainability and development of the economy. It is required to ensure homes, offices, and cars are comfortable; industrial processes run safely and efficiently while ensuring societies have preserved foods and medicaments for consumption. Notwithstanding being identified as essential, cooling also has a significant adverse environmental impact, due to its contribution to global warming. The refrigeration and air-conditioning (RAC) sector (cooling sector) contributes to global warming both directly and indirectly. The demand for cooling is growing; thus, there is an urgent need to cut cooling related pollution and energy wastage. Without effective mitigating action, cooling may account for almost 20% of global greenhouse gas (GHG) emissions by 2050 (Peters, 2018).

The direct impact of cooling on the environment is due to the refrigerant emissions and depends on the global warming potential (GWP) of the refrigerant used, the refrigerant charge in the equipment and the leakage rates (annual and during maintenance and decommissioning) of the equipment. The cooling technology used for RAC mainly utilise synthetic refrigerants that can either deplete the ozone layer or have a high-GWP. Hydrofluorocarbon (HFC) refrigerants were introduced to replace their ozone-depleting counterparts but are greenhouse gases that can have a high-GWP. HFCs contribute to the increases in temperature currently experienced worldwide, and thus, the demand for cooling also increases.

The indirect influence of cooling technologies to climate change is due to the use of fossil fuels to generate electricity to power equipment. The burning of fossil fuels to generate electricity increases CO₂ emissions, which then contributes to global warming and increases the demand for cooling and cooling equipment.

To ensure that Trinidad and Tobago is prepared for the increased demand for cooling and ready to mitigate the identified threats to the environment and sustainability, the National Cooling Strategy of Trinidad and Tobago (NCSTT) has been developed. The NCSTT will support sustainable, energy-efficient, low-GWP cooling in Trinidad and Tobago, enhancing the phase-out and phase down targets under the Montreal Protocol and its recent Kigali Amendment.

BACKGROUND AND CONTEXT

Trinidad and Tobago as a producer of oil and gas, accounts for 0.1% of global absolute emissions (Government of the Republic of Trinidad and Tobago, 2011). Aside from the petrochemical and heavy industry sectors being the main contributors to GHG emissions, power generation and the transportation sector are also significant sources of emissions.

Trinidad and Tobago's emissions in the RAC, sector is directly related to the demand for cooling. It is likely that a warmer climate and the growing demand for RAC equipment increases the need for thermal power generation over the long term (IPCC, 2013). The demand for cooling is influenced by Trinidad and Tobago's location (proximity to the equator) and average temperature (26.5°C) (Trinidad and Tobago Meteorological Service, 2019), as well as the need for refrigeration and increased urban development on the island.

In Trinidad and Tobago, new RAC equipment, both to replace older ones and for new installations, tend to use high-GWP hydrochlorofluorocarbon (HCFC) and HFC refrigerants, which results in more direct CO₂ eq emissions when compared to existing low-GWP alternatives.

Trinidad and Tobago's RAC sector is responsible for producing **0.194 MtCO₂eq** of direct emissions and **1.11 MtCO₂eq** of indirect emissions which results in approximately 1.3 MtCO₂eq of total emissions into the atmosphere. Approximately 0.6 MtCO₂eq annually could be prevented from entering the atmosphere by the year 2030 if a path towards emission reduction is taken (Melville, 2017).

THE NATIONAL COOLING STRATEGY

The National Cooling Strategy of Trinidad and Tobago (NCSTT) provides a framework and a vision for transforming Trinidad and Tobago's RAC by outlining the strategies Trinidad and Tobago shall employ to realise sustainable and environmentally friendly cooling. The national approach to address the country's needs in the RAC sector, identifies policies to drive a rapid transition to high-performance cooling equipment, linking the ozone depleting substances (ODS) phase-out and HFC phase-down activities under the Montreal Protocol, to climate protection efforts. The implementation of the NCSTT will save residential consumers and businesses money on their utility bills, reduce electricity waste, enable greater comfort and productivity for building occupants, create employment, mitigate GHG emissions, and support Trinidad and Tobago's efforts to meet the Sustainable Development Goals (SDGs) and its obligations towards the Paris Agreement.

NCSTT INITIATIVES

The NCSTT tackles sustainable cooling through the four project initiatives which include the development of policy instruments, support for refrigerant replacement, capacity building, and partnership efforts, and monitoring, verification, and enforcement activities.

DEVELOPMENT OF POLICY INSTRUMENTS

The development of policy instruments is essential to creating the ecosystem within Trinidad and Tobago that would encourage and bring about the required paradigm shift towards low-GWP, energy efficient cooling technologies. The identified policy instruments are aimed at the key players in the sector (policy-makers, importers, retailers, installers, and consumers) are as follows:

- **The implementation of minimum energy performance standards (MEPS) and labelling programs** – This initiative would utilise MEPS and labels supported by testing facilities to enable the market to recognize energy efficient equipment and migrate towards the use of these products in the RAC sector.
- **Conduct a RAC sector market assessment** - This sub-project aims to acquire an in-depth understanding of the current technologies deployed on the twin island and identify appropriate technologies for the Trinidad and Tobago context. This information would strengthen the national policy, regulatory, and institutional frameworks to make the transition to more energy efficient, environmentally friendly RAC technologies.
- **Assessment of financial mechanisms and technical capacity to support market transition** - To execute the projects under the NCSTT financing would be required; thus, an essential aspect of the Strategy is the identification possible sources of necessary funding. There is also need to determine the readiness of the sector to support the transition.

- **Implementation of Minimum Energy Efficiency Standards (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 compulsory EE building standards (codes). MEES would increase EE and green building design, reducing the demand for cooling in residential and commercial buildings.
- **The implementation of public procurement measures and incentives** – This initiative is aimed at policies to support market migration through the development of financial and other incentives that would push the market toward the adoption of Energy Efficient, low-GWP RAC equipment.

SUPPORT FOR REFRIGERANT REPLACEMENT

Replacement of existing ozone depleting and high-GWP refrigerants is essential to Trinidad and Tobago's sustainable cooling path. The refrigerant replacement initiative would see existing refrigerants that are harmful to the environment, substituted with more environmentally friendly alternatives. This activity cannot be done in isolation and would include:

- **The development of an Alternative Refrigerants Implementation Strategy** - As Trinidad and Tobago moves toward a sustainable cooling future, mechanism shall be put in place to reduce the current consumption of high-GWP refrigerants. This would include the implementation of natural low-GWP refrigerants and the development of complementary and mandatory safety standards which are aligned with phase-out activities under the Montreal Protocol.
- **The introduction of not-in-kind technologies and services** – A barrier to the adoption of energy efficient RAC technology in Trinidad and Tobago is the high up-front cost to switch to more efficient technologies. Given the critical need to foster energy efficiency over the short to medium term to combat climate change and other environmental issues Trinidad and Tobago shall promote the introduction of not-in-kind technologies and services like district cooling and different business approaches to cooling such as Cooling as A Service. It is to noted that not-in-kind (NIK) cooling technologies refers to any alternative cooling systems other than the vapour compression cooling systems that are most commercially dominant today.
- **Mechanism for Recovery, recycling and safe disposal of refrigerants** – Under these initiatives, mechanisms to support commercially driven efforts for recovery, recycling, and disposal (RRRD) will be executed. These include building up entrepreneurial capacities (business modelling and planning), co-financing recovery and recycling facilities, and outreach activities. This would be followed by the development of instruments to effectively collect and track refrigerant usage, the development of training for technicians and companies in RRRD and mechanisms for environmentally friendly disposal of end of life refrigerants.

CAPACITY BUILDING AND PARTNERSHIP INITIATIVES

The capacity building and partnership initiatives are cross-cutting activities which are linked to or enhance other activities under the NCSTT. The development of the capacity building and partnership initiatives are core and involve National Ozone Unit's (NOU's), national policymakers, the service sector, importers and retailers, and consumers. These initiatives would include:

- **Training and capacity building** - Building institutional capacity and training are essential to strengthening the coordination between the National Ozone Unit (NOU), policymakers and energy groups to provide the needed conditions as required to integrate energy efficiency (EE) in

national policy and future HFC phasedown management plan. From the policy maker perspective, the capacity building will be geared towards the design and implementation of EE legislation, MEPS, labelling standards, data collection, monitoring and verification, and enforcement activities. For the service sector, EE technologies based on the use of low-GWP refrigerants require capacity building and training actions to address the specific knowledge gaps related to installation, operation, safety considerations and maintenance of low-GWP and flammable refrigerant-based equipment. Awareness sessions shall be provided to technicians and companies in the service sectors to equip them to adequately advise their respective clients on the importance and benefits for utilizing low-GWP, EE RAC technologies in their installations. For importers and retailers, technical capacity-building and training are vital so that they will be able to identify the best technology to procure and supply to the local RAC market. The actions will include information exchange and data sharing, analysis on design options and their costs, efficient component sourcing for maintaining or enhancing equipment energy performance, and for selection of low-GWP alternatives with significant energy efficiency benefits, and training for safety, mainly if importing flammable refrigerants.

- **Outreach and communication activities to sensitize, educate, and inform** – This initiative shall involve local and regional communication campaigns directed to consumers, manufacturers, service companies, and regional partners. These campaigns would also be a forum to educate the public about the financial and environmental benefits of utilizing technology that is low-GWP and EE, developed standards and codes, and fiscal incentives. The communication strategy would address the information needs of both the supply and demand side of the sector.
- **The Harnessing of opportunities for regional collaboration** – Trinidad and Tobago would seek to harmonise MEPS, labelling and measurement standards among countries within the Caribbean region with similar usage and energy cost conditions across the same product categories. Regional collaboration shall extend to regional market surveillance authorities creating recognition of test results and labelling. The partnership will also link regional activities to national initiatives, using the inclusions of national practitioners in regional training and information exchange activities, and via events in the participating countries directly targeting government policymakers. Trinidad and Tobago will take the initiative at the CARICOM level to establish a standard and harmonized approach to clean, sustainable cooling.

MARKET MONITORING, VERIFICATION, AND ENFORCEMENT

The development of data collection and analysis mechanisms for market monitoring, verification, and enforcement are essential to the success of the NCSTT. These mechanisms will include the information needed to evaluate performance over time, energy savings, compliance with the standards and labelling (S&L) regulations and levels of equipment sales as this is essential to the monitoring and evaluation of the effectiveness of activities undertaken. Data collected can also be used to incorporate EE into HCFC phase-out and HFC phase-down plan. These activities will also help to assess opportunities, identify mechanisms, inform prioritization of sectors and interventions, and develop strategies and roadmaps.

NCSTT IMPLEMENTATION FRAMEWORK

The implementation of the projects under the NCSTT shall be managed by a Cabinet appointed Committee over its ten (10) year implementation period. These initiatives can follow the timeline as identified in the project timeline diagram below.

NCPTT Timeline



The dynamic nature of the RAC sector requires the NCSTT to be continuously reviewed to adjust to changes in technology and the industry catalysed by shifts in both the local and international environments. The NCSTT takes into consideration the components needed for Trinidad and Tobago to chart a sustainable cooling path based on information that’s currently available. This may change as new challenges arise, and new information/data becomes available. The NCSTT would, therefore, be reviewed periodically to ensure that it remains relevant and to make necessary amendments.

The cooling Strategy integrates current activity into a synergistic pathway for sustainable cooling. The Government of the Republic of Trinidad and Tobago hopes to realize the resulting energy cost savings and pollution reduction benefits by encouraging the use of high-efficiency, low-GWP equipment through market-transformation programs that include standards, labelling, procurement, performance assurance requirements for imports, and incentive programs. This integrated strategy replaces current refrigerants with climate-friendly alternatives while simultaneously improving the equipment’s energy efficiency and could double the climate benefits from the HFC phasedown alone, while also supporting development through enhanced energy security, reduced energy costs to the government and consumers.

TABLE OF CONTENTS

1	INTRODUCTION	11
1.1	THE TRINIDAD AND TOBAGO CONTEXT	12
1.1.1	Factors Affecting Cooling Demand	12
1.2	NATIONAL COOLING STRATEGY OF TRINIDAD AND TOBAGO	13
1.2.1	Objectives of the NCSTT.....	13
2	REFRIGERATION AND AIR CONDITIONING (RAC) SECTOR OVERVIEW	15
2.1	RAC EQUIPMENT SUPPLY CHAINS	15
2.2	RAC APPLICATIONS.....	16
2.2.1	Space Cooling: Residential, Commercial, and Mobile Air-conditioning.....	16
2.2.2	Refrigeration	17
2.2.3	Industrial Refrigeration	18
2.2.4	Demand and Projections.....	18
2.3	SERVICING SECTOR.....	19
2.4	EDUCATION AND TRAINING OF TECHNICIANS	19
2.4.1	Certification Scheme	21
2.5	MONTREAL PROTOCOL IMPLEMENTATION AND REGULATIONS.....	21
2.6	CLIMATE CHANGE ACTION PLAN	22
3	ELECTRICITY SECTOR OVERVIEW	23
3.1	ELECTRICITY MATRIX	24
3.2	REFRIGERATION AND AIR-CONDITIONING ELECTRICITY CONSUMPTION.....	25
3.2.1	Electricity Emission Factor	26
3.3	BARRIERS TO ENERGY EFFICIENCY IN THE RAC SECTOR	27
4	OVERVIEW OF ENERGY EFFICIENCY REGULATIONS IN THE RAC SECTOR.....	29
4.1	INTRODUCTION.....	29
4.2	ENERGY EFFICIENCY REGULATORY INITIATIVES	29
4.3	MINIMUM ENERGY PERFORMANCE STANDARDS	30
4.4	LABELLING STANDARDS AND TESTING	30
4.5	SUMMARY	31
5	NATIONAL COOLING STRATEGY PROJECTS.....	32
5.1	Policies to Guide Implementation	33
5.1.1	Implementation of Minimum Energy Performance Standards and Energy Efficiency Labelling Programme	33
5.1.2	Assessment of Financial Mechanisms to Support Market Transition	34

5.1.3	Refrigeration and Air Conditioning Sector Market Assessment	35
5.1.4	Implementation of Minimum Energy Efficiency Standards and Green Building Codes.....	36
5.1.5	Implementation of Public Procurement Measures and Incentives	37
5.2	SUPPORT FOR REFRIGERANT REPLACEMENT	38
5.2.1	Develop a Refrigerant Replacement Strategy.....	38
5.2.2	Introduction of NOT-IN-KIND (Any alternative cooling systems other than the vapour compression cooling systems)Technologies into the RAC market.....	39
5.2.3	Develop Mechanisms for Recovery, Recycling, and Disposal of Refrigerants	40
5.3	DEVELOP CAPACITY BUILDING AND PARTNERSHIP INITIATIVES.....	41
5.3.1	Outreach and Communications	42
5.4	MARKET MONITORING, VERIFICATION, AND ENFORCEMENT.....	43
6	<i>Implementation of NCSTT</i>	44
6.1	STAKEHOLDER GROUPS	44
6.2	NCSTT IMPLEMENTATION AND OVERSIGHT	47
7	REFERENCES	49

List of Figures

Figure 1: RAC Sector schematic chart	15
Figure 2: Showing industrial refrigeration refrigerant usage by year (mt).....	18
Figure 4: GHG Emissions By Sector, 2012	23
Figure 3: Trinidad & Tobago Electricity Consumption by Sector, 2011	25
Figure 5: Cooling Strategy initiatives relationship diagram	32
Figure 6: NCSTT Implementation timeline.....	47

List of Tables

Table 1: Usage of refrigerants in the Refrigerated Transport sub-sector/ mt.....	17
Table 2: OEC Import Data	18
Table 3: RAC Qualifications in Trinidad and Tobago.....	20
Table 4: Existing policy frameworks and controls.....	22
Table 6: Estimated End-use of Electricity for RAC Technologies (GWh, the year 2015).....	25
Table 5: Barriers to Energy Efficiency in the RAC Sector	27
Table 7: Status of Enforcement of Existing RAC Compulsory Standards	31
Table 8: List of Identified main stakeholders.....	44

List of Acronyms

AC	AIR CONDITIONING
ARIA	AIR CONDITIONING AND REFRIGERATION INDUSTRY ASSOCIATION
BAU	BUSINESS AS USUAL
BUR	BIENNIAL UPDATE REPORT
CAAS	COOLING AS A SERVICE
CARICOM	CARIBBEAN COMMUNITY
CFC	CHLOROFLUOROCARBON
CP	COUNTRY PROGRAMME
CROSQ	CARICOM REGIONAL ORGANISATION FOR STANDARDS AND QUALITY
CRS	CARBON REDUCTION STRATEGY
EE	ENERGY EFFICIENCY
EER	ENERGY EFFICIENCY RATIO
EPPD	ENVIRONMENTAL POLICY AND PLANNING DIVISION
GHG	GREEN HOUSE GAS
GORTT	GOVERNMENT OF THE REPUBLIC OF TRINIDAD AND TOBAGO
GIZ	THE DEUTSCHE GESELLSCHAFT FÜR INTERNATIONALE ZUSAMMENARBEIT
GWH	GIGAWATT HOUR
GWP	GLOBAL WARMING POTENTIAL
HCFC	HYDROCHLOROFLUOROCARBON
HFC	HYDROFLUOROCARBON
HPMP	HCFC PHASE OUT MANAGEMENT PLAN
IPCC	INTER-GOVERNMENTAL PANEL ON CLIMATE CHANGE
KBOE	KILOBARRELS OF PETROLEUM EQUIVALENT PER DAY
MAC	MOBILE AIR CONDITIONING
MEPS	MINIMUM ENERGY PERFORMANCE STANDARDS
MLF	MULTILATERAL FUND
MP	MONTREAL PROTOCOL
MPD	MINISTRY OF PLANNING & DEVELOPMENT
<i>MtCO₂eq</i>	METRIC TONS OF CARBON DIOXIDE EQUIVALENT
NCCP	NATIONAL CLIMATE CHANGE POLICY
NCSTT	NATIONAL COOLING STRATEGY TRINIDAD & TOBAGO
NDC	NATIONALLY DETERMINED CONTRIBUTION
NGO	NON-GOVERNMENTAL ORGANISATION

F-GAS	FLUORINATED GAS
NOU	NATIONAL OZONE UNIT
OBG	OXFORD BUSINESS GROUP
ODP	OZONE DEPLETING POTENTIAL
ODS	OZONE DEPLETING SUBSTANCES
OEC	OBSERVATORY OF ECONOMIC COMPLEXITY
PPG	PROJECT PREPARATION GRANT
PVOC	PRE-SHIPMENT VERIFICATION OF CONFORMITY
RRRD	REFRIGERANT RECOVERY, RECYCLING AND DISPOSAL
RAC	REFRIGERATION AND AIR-CONDITIONING
RACHP	REFRIGERATION AND AIR-CONDITIONING AND HEAT PUMPS
RIC	REGULATED INDUSTRIES COMMISSION
SEER	SEASONAL ENERGY EFFICIENCY RATIO
T&T	TRINIDAD AND TOBAGO
TTBS	TRINIDAD AND TOBAGO BUREAU OF STANDARDS
UNDP	UNITED NATIONS DEVELOPMENT PROGRAMME
UNEP	UNITED NATIONS ENVIRONMENT PROGRAMME
UNFCCC	UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE
UTT	THE UNIVERSITY OF TRINIDAD AND TOBAGO
UWI	THE UNIVERSITY OF THE WEST INDIES

1 INTRODUCTION

Cooling is a crucial element to health, prosperity, and sustainability, and support many of the Sustainable Development Goals (SDG's). According to the Green Cooling Initiative, as quoted in a University of Birmingham article (Peters, 2018), the future demand for cooling will increase, based on an estimate that there will be more than 9.5 billion cooling appliances worldwide by the year 2050, which is 2.5 times more than today's 3.6 billion. The need for cooling is growing, thus there is an urgent need to cut cooling related pollution and energy wastage. Without effective mitigating action, cooling may well account for almost 20% of global greenhouse gas emissions by 2050 (Peters, 2018).

An economy depends on cooling as a critical element for a variety of purposes—from industrial and commercial sectors to private use. Cooling is expected to make homes, offices, and cars more comfortable; while industries such as steel, chemicals, and plastics, depend on cooling for their processes, and if deprived of it, some economies could be at risk of collapse.

The commercial sector is also highly dependent on cooling due to the growing use of cold chain technology, servers, and data centres, especially in Trinidad and Tobago in recent times. Similarly, refrigeration is critical for the storage of medicines, including vaccines, and mortuaries. Despite being identified as essential, cooling also has a substantial adverse environmental impact. The primary cooling technology used for refrigeration and air conditioning (RAC) applications run mostly on synthetic refrigerants that can deplete the ozone layer and have a high global warming potential (GWP). The high-GWP of some refrigerants contributes to the rise in global temperatures and thus the demand for cooling also increases. Synthetic refrigerants used for cooling include hydrochlorofluorocarbons (HCFC), which is an ozone-depleting substance (ODS) and Hydrofluorocarbons (HFC). HFCs¹ also referred to as F gases, were primarily developed and promoted as alternatives to ODS and has been used in several sectors in the last 30 years, mainly as a refrigerant in refrigeration, air conditioning, and heat pumps (RACHP) applications. HFCs are greenhouse gases that can have high or very high-GWP, up to 14,800. (UNEP, 2016). Left unchecked, F-gases could account for nearly 20 percent of climate pollution by 2050 (EC, 2019).

The climate impact related to cooling applications consists of direct and indirect contributions. The direct result is due to the refrigerant emissions and depends on the GWP of the refrigerant, the refrigerant charge in the equipment and the leakage rates (annual and during maintenance and decommissioning) of the equipment. The indirect contribution of cooling technologies to climate change is due to the use of fossil fuels to generate electricity, which powers the increasing number of cooling equipment. The burning of fossil fuels to generate electricity increases CO₂ emissions, which will increase as the demand for cooling equipment increases, mainly if low-efficiency cooling technologies are utilised.

Globally, there is an increase in the development of more efficient cooling technologies. However, these technologies have not achieved the necessary market penetrations in developing countries, such as Trinidad and Tobago due to barriers described in Section 6.2. Thus, energy consumption is expected to increase over the next decade if no effort is made to adopt more efficient cooling technologies.

To ensure that Trinidad and Tobago is prepared for the increased demand for cooling and to mitigate the identified threats to the environment and sustainability, the National Cooling Strategy of Trinidad and Tobago (NCSTT) has been developed. This NCSTT will support energy-efficient, Low-Global Warming Potential (GWP) cooling in Trinidad and Tobago, enhancing phase out and phase down targets under the Montreal Protocol and the Kigali Amendment, which the country is a signatory.

¹ HFCs are one type of F-gases, man-made gases that can stay in the atmosphere for centuries and contribute to a global greenhouse effect.

1.1 THE TRINIDAD AND TOBAGO CONTEXT

Trinidad and Tobago is a twin-island nation with a population of 1.3592 million (CSO, 2018) and with an extension of 5,128 square kilometres of land. The island of Trinidad is home to the nation's capital, Port of Spain, and is where most of the political and economic activity takes place. The island has a growing economy mostly influenced by the petro-chemical industry which is the pillar of national economic development; oil and gas account for about 33.7% (40%) of the Gross Domestic Product (GDP) and 80% of exports (GORTT, Review of the Economy: Changing the Paradigm, Putting the Economy on a Sustainable Path, 2017). The island of Tobago fosters the tourism sector, which plays a minor role in contributing to the nation's GDP; this is in contrast with most other Caribbean countries.

Trinidad and Tobago as a producer of oil and natural gas account for 0.1% of the global absolute GHG emissions (Government of the Republic of Trinidad and Tobago, 2011). The country has been moving towards the use of natural gas, as a cleaner fuel, as its primary means of meeting its growing energy demands. There has been growth of the local natural gas sector, which has achieved international and national prominence. Local energy production and consumption have grown significantly within the last few decades, despite the increase in the focus on natural gas, domestic emissions of GHGs such as carbon dioxide continues to grow. The petrochemical and heavy industry sectors are the main contributors to GHG emissions, followed by power generation and then the transportation sector. Emissions from power generation have increased from 1.74 *MtCO₂eq* to 2.49 *MtCO₂eq*, a growth of 43% over the period 1990-2006 (GORTT, 2011).

Preliminary research has suggested that Trinidad and Tobago's RAC sector contributes **0.194 *MtCO₂eq*** of direct GHG emissions and **1.11 *MtCO₂eq*** of indirect GHG emissions which results in approximately 1.3 *MtCO₂eq* of total GHG emissions into the atmosphere. Approximately **0.6 *MtCO₂eq*** annually could be prevented from entering the atmosphere by the year 2030 if a path towards emission reduction is taken (Melville, 2017).

Notwithstanding the continued importance of the country's petroleum resources, the Government recognizes that renewable energy, clean energy production and the maximization of energy efficiency are critical elements in the drive for sustainable development.

To this end, Trinidad and Tobago presented strategies for reducing global GHG emissions through the Nationally Determined Contributions (NDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris in 2015. The NDC was based on a Carbon Reduction Strategy (CRS) developed for the country's industrial, power generation, and transportation sectors. The NDC is also consistent with implementing the provisions stated in the National Climate Change Policy (July 2011). The country aims to achieve a reduction of 15% in overall emissions from the business as usual (BAU) scenario within these three sectors by 2030; which in absolute terms, is an equivalent of one hundred and three million (103,000,000) tons of CO₂eq (GORTT M. o., 2018).

1.1.1 Factors Affecting Cooling Demand

The national development policies in place in Trinidad and Tobago are directed towards the improved sustainable development of the country. This has fuelled expansion in infrastructure with ongoing plans for the construction of new homes, ports, schools, hospitals, office buildings, and business facilities, spurred by both public and private developers. This type of growth, especially in the construction sector, would increase the demand for cooling on the islands.

As global demand for cooling grows, so too does the need for RAC equipment. RAC equipment penetration and access to cooling technology continues to increase annually in developing countries and Trinidad and Tobago is following this international trend. The country's location in the tropical belt, its average temperature of 26.5°C (Trinidad and Tobago Meteorological Service, 2019) and humidity levels above 80% year-round, accounts for this demand for cooling.

Another factor affecting cooling demand is the need for refrigeration for cold and cargo chains, supermarkets, and hypermarkets². According to the UN Food and Agriculture Organisation (FAO), this country's top-10 import commodities by value were wheat, prepared foods, cheese, alcoholic beverages, refined sugar, maize, raw sugar, poultry, non-alcoholic beverages, and soybean oil (OBG, 2019), two of which are perishable items which require refrigeration. According to data from the Central Bank of Trinidad and Tobago (CBTT), total food imports in the first nine months of 2015 were worth close to TT\$4.2bn (USD\$646.8m), representing 9.3% of all imports. Additionally, CBTT statistics showed the nominal value of food imports more than doubled between 2006 and 2014. The importation of food continues to rise and results in an increased need for cooling for food preservation purposes. Cooling is also critical for the preservation of medicines, medical supplies and specimens in the medical industry, and mortuary services.

In Trinidad and Tobago, new RAC equipment, both to replace older ones and for new installations, tend to use high-GWP HCFC and HFC refrigerants, which results in more direct CO₂ eq emissions when compared to existing low-GWP alternatives.

1.2 NATIONAL COOLING STRATEGY OF TRINIDAD AND TOBAGO

The National Cooling Strategy of Trinidad and Tobago (NCSTT) **aims to provide a framework and a vision for transforming the country's market for cooling in the RAC sector**. The National Cooling Plan is a strategy for Trinidad and Tobago to deploy cooling initiatives that can be sustainable, whilst ensuring the preservation of the environment in a manner that is socially equitable. This includes the integration of the national HCFC phase-out programme whilst incorporating other national energy efficient projects and policies. The NCSTT plan will leverage the interlinkages between climate actions, energy conservation and development projects for greater resource and implementation efficiency. Key interventions for sustainable cooling are characterised by four transformative projects:

- Development of Policy Instruments
- Support for refrigerant replacement
- Develop Capacity Building and Partnerships initiatives
- Market monitoring, verification, and enforcement

1.2.1 Objectives of the NCSTT

The NCSTT aims to establish a national strategy to address the country's needs in the RAC sector, and to drive a rapid transition to high-performance cooling equipment, linking the ODSs phase-out activities under the Montreal Protocol, to climate protection efforts. The implementation of the NCSTT can:

- Reduce electricity wastage and consumer expenditures on utility bills;
- Create thermal comfort whilst reducing GHG emissions;

² A "hypermarket" (sometimes called a "supercentre" or "superstore") is a big-box store combining a supermarket and a department store. The result is an expansive retail facility carrying a wide range of products under one roof, including full groceries lines and general merchandise.

- Enhancing employment in conjunction with increasing the skillsets of RAC technicians;
- Contribute to synergistic actions with existing government programmes and global cooperation on sustainable development; SDGs, Montreal Protocol, Paris Agreement and the Kigali Amendment.

To reach these ambitious goals, the GORTT in collaboration with key stakeholders, developed the NCSTT, which takes into consideration, new technologies, technical market, financial resources, and enhanced capacity building frameworks to establish a sustainable and efficient cooling strategy for the country.

2 REFRIGERATION AND AIR CONDITIONING (RAC) SECTOR OVERVIEW

RAC applications in Trinidad and Tobago involves several sub-sectors which all are linked by the relevant RAC applications. It is critical to ensure that the NCSTT considers all individual components and their respective interrelations, as they must be synergized for Trinidad and Tobago to develop and achieve a sustainable cooling path. These sub-sectors include:

- RAC equipment supply chains
- Servicing sectors
- Education and training
- Regulatory framework

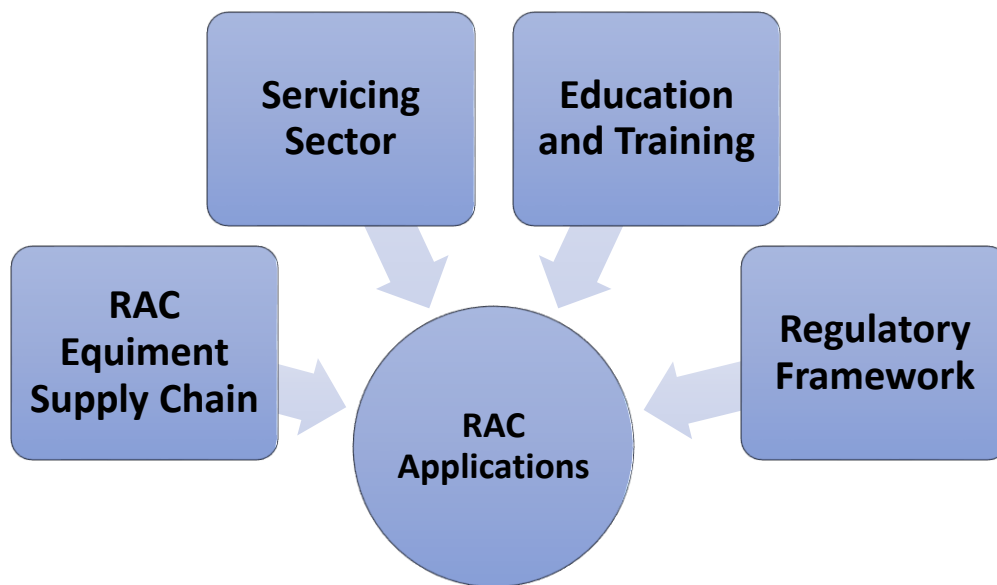


Figure 1: RAC Sector schematic chart

This chapter describes these components, the refrigerants used, and how the present context can be improved.

2.1 RAC EQUIPMENT SUPPLY CHAINS

The RAC sector supply chain is comprised and managed by many regulatory bodies. Trinidad and Tobago imports all their refrigerants for RAC application which includes the necessary ODS substitutes. Importers often seek out the most cost-effective equipment, which may render Trinidad and Tobago at risk of technology dumping. Trinidad and Tobago also does not produce refrigerants; therefore, all refrigerants used for RAC applications are imported, including ODS alternatives.

The importers typically retail the equipment and refrigerant on the local market, sell to other retailers, and export to neighbouring islands. Retailers of RAC equipment range from industry-specific suppliers, to the appliance and furniture stores; with no regulation of who can retail the equipment.

The types of refrigerant and equipment allowed into Trinidad and Tobago is strictly controlled at the ports of entry. Notably, no assembled equipment containing CFCs or HCFCs is allowed into the country, while only HCFC quota holders can import HCFC refrigerants. The import of CFC refrigerant and equipment has also been phased out.

2.2 RAC APPLICATIONS

The RAC Sector in Trinidad and Tobago has two primary applications. They are:

- Space cooling in residential, commercial and mobile, and
- Refrigeration in the residential, commercial (cold chain³, hypermarkets/supermarkets, and transportation) and industrial applications.

The primary HFC refrigerants imported are HFC-134a and HFC-410a, which are used predominantly for the servicing of RAC equipment. Other alternatives used, though on a small scale, are ammonia, hydrocarbons, and carbon dioxide.

2.2.1 Space Cooling: Residential, Commercial, and Mobile Air-conditioning

In Trinidad and Tobago, residential, commercial, and mobile air-conditioning provides thermal comfort, and is essential for maintaining psychological and physiological wellbeing from the external high ambient temperature.

The stationary air-conditioning categories consist primarily of three distinct types of equipment:

- Air-conditioning units predominantly split units with window units to the lesser extent;
- Chilled water and centralized systems, and
- Packaged air-conditioning units.

The average capacity of the air conditioning units is 18,000 BTU per hour, and utilize several refrigerants including HFC-410A. The chilled water systems in commercial applications are larger air-conditioning systems mainly installed in commercial and institutional buildings such as offices, malls, hotels, data centres, laboratories, and hospitals. The average capacity of the chillers used in those centralized systems are 300 tonnes of refrigerant (TR)⁴. They mostly use HFC-134a with some instances of HFC-410A as a refrigerant. The demand for space cooling is continuously on the rise as rural and urban sprawls continue to develop across the country.

The mobile air-conditioning sector encompasses all air conditioning for vehicles. The mobile sector mainly utilizes HFC-134a, and in Trinidad and Tobago has an extensive propagation of vehicle use with an estimate of 361,000 vehicles registered in the country, in 2010 (CEIC Data (SG) Pte Ltd, 2018). The number of vehicles registered increased to 397,000 by December 2015 (CEIC Data (SG) Pte Ltd, 2018) and has increased steadily from 2015. The growth in this sector is expected to continue causing the usage of refrigerant to triple by 2030.

³ Cold chain is sometimes referred only as refrigerated transportation in Trinidad and Tobago

⁴ Tons of refrigeration, equivalent to 1,055 kW

2.2.2 Refrigeration

Refrigeration in Trinidad and Tobago is used for preservation of food, medicines, chemicals, bodies and as part of industrial processes. Cooling is broken up into three categories residential, commercial, and industrial refrigeration.

2.2.2.1 Residential Refrigeration

Residential refrigerators consist of standalone units found in homes, like fridges and freezers used for food preservation. Residential refrigeration utilizes refrigerants R134a and R600a, but the refrigerant predominantly used is R134a, which accounts for approximately 86% usage within the residential sector.

2.2.2.2 Commercial Refrigeration

Commercial refrigeration includes refrigerated transportation, hotels, supermarket and hypermarkets, where there are installed bottle chillers, cold rooms, and refrigerators, display cool cabinets and ice making machines. Based on the ODS Alternatives Survey, 2017, the following are the four primary refrigerants used in refrigeration; R-134a, R-404A, R-407C & R410A.

Refrigerated transportation is used to ensure the shelf life of products, such as fresh agricultural produce, seafood, frozen food, chemicals, and pharmaceutical drugs. Global data suggest that currently, cold chains account for roughly 1% of CO₂ production in the world (Kashav, 2018), which is likely to increase if global temperatures rise. Employing the use of energy efficient refrigeration technologies would substantially extend and improve the cold chains without any increase in CO₂, and possibly even cause a decrease (James & James, 2010).

The refrigeration transport subsector primarily utilizes HFC-134a, R-404A, with R-507C and R-407C accounting for the remaining usage. HFC-134a is the main ODS alternative and accounts for roughly 50% of the categories' usage based on the last ODS Alternative Survey Report 2017. Table 1 shows the quantity of the refrigerant gases used in cold chain applications.

Table 1: Usage of refrigerants in the Refrigerated Transport sub-sector/ mt

ODS Alternative	2012	2013	2014	2015
HFC-134a	98.3	91.02	44.98	48.9
R-404A	35.45	54.18	22.45	23.9
R-407C	1.24	2.25	1.3	1.59
R-410A	27.7	29.1	44.01	23.7
R-507C	0.95	0.36	1.5	1.5

Ref: 2017 Trinidad and Tobago ODS Alternatives Survey Report

2.2.3 Industrial Refrigeration

Industrial refrigeration involves cooling of equipment in manufacturing or processing applications. For example, cooling is required for gas separating, crystallization of substances, releasing of reaction heat, along with other processes; all of which are important to petroleum-based economies, like Trinidad and Tobago.

In Trinidad and Tobago, industrial refrigeration mainly utilizes R-404A and R-410A, with R-404A representing approximately 75% of the total usage. The overall usage in this subsector has almost halved between 2013 and 2014 (NOU, 2017), which correlates to the decrease in oil prices. The reduction in oil prices led to a drop in industrial activity, as well as, a decline in the deployment of new projects in the industrial sector. Figure 2 shows the refrigerant used in industrial refrigeration by year.

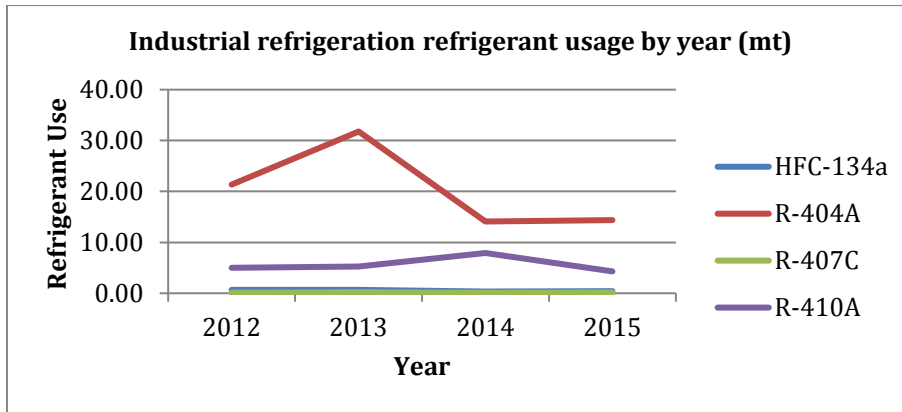


Figure 2: Showing industrial refrigeration refrigerant usage by year (mt)

2.2.4 Demand and Projections

The overall market for space cooling and refrigeration is projected to increase over the next five years based on data and estimations from the Observatory of Economic Complexity's Trinidad and Tobago Import / Export Report 2017. Table 2 shows OEC RAC related import data, including the dollar value and % of total imports for the items, and a 5-year growth value based on the recorded total value of imports into Trinidad and Tobago in 2016, US\$5.75B (OEC, 2017).

Table 2: OEC Import Data

Item	Value / % of total imports	Projected 5-year growth in imports (%)	Related Application
Air-conditioners	US\$27M (0.47%)	6.6%	Space Cooling
Cars	US\$263M (4.6%)	2.6%	
Perishable Foods	US\$422.95M (7.5%)	0.3%	Refrigeration
Refrigerators	US\$26.6M (0.46%)	2%	
Packaged Medicaments	US\$112M (2.0%)	0.7%	
Blood	US\$12.3M(0.21%)	-0.7%	

Source: Extrapolated from data provided by the Observatory for Economic Complexity (OEC, 2017)

An increase in the demand for refrigerants is also expected because of the rise in imports of vehicles, refrigerators and air conditioning units, as used for the servicing of RAC equipment. With these projected increases there would be an inherent increase in the demand for power to drive cooling equipment which reinforces the need to push the market toward the use of energy efficient (EE) RAC equipment based on low-GWP refrigerants.

The use of disaggregated data on RAC equipment import and export would strengthen the assessment of the demand for cooling, but at this stage, it was not available.

2.3 SERVICING SECTOR

The servicing sector for RAC comprises of two main segments, the formal and informal sectors. The formal sector represents those service that are recognized legal entities registered or incorporated under the Companies Act, 1997 of Trinidad and Tobago. The informal sector, however, is made up of those entities that do not possess legal recognition and perform services as an unregistered freelancer or self-employed technician.

For the service sector, capacity building in low-GWP, EE RAC technologies is essential to addressing the specific issues related to installation, operation, maintenance and safety of low-GWP refrigerants, and the requisite equipment. There is a need for capacity development for technicians in both the formal and informal sectors, public officers, and companies, and it should be conducted to equip them with the knowledge required to make informed decisions and to provide accurate advice to stakeholders and clients. This would increase the capacity to adequately explain the importance and benefits of utilizing low-GWP, EE RAC technologies to their stakeholders and clients.

2.4 EDUCATION AND TRAINING OF TECHNICIANS

In Trinidad and Tobago, RAC training at post-secondary level focuses on the individuals who handle RAC equipment on a day-to-day basis. Thus, they are responsible for the provision of quality work, correct advice and safety, to customers who would require their services. Undertaking the installation of new technology, retrofits and repairs, with individuals that lack the required capacities can result in high costs to customers due to the need to re-do work. As such, proper training is critical to avoiding time and money wastage throughout the RAC sector.

Training in the RAC sector currently can have a structured, semi-structured, or unstructured approach. Unstructured training takes place during ad-hoc apprenticeships (ride-along training) that is prevalent in the informal servicing sector. This training is dependent upon the specific jobs and situations that the trainer and apprentice encounter. Alternatively, semi-structured training takes on a combination of structured and unstructured forms as employers hire based on a pre-requisite level of knowledge and experience, and then conduct specific in-house training (brand or project related) for their staff to upskill them.

The structured training applies to private and public schools and technical institutes, as well as formal apprenticeships and on-the-job training. Various RAC programmes are offered through structured training, and they are either accredited or approved by local or international institutions, with different curriculum and qualification structures. Table 3 shows twelve of the common RAC qualifications available in Trinidad and Tobago.

Table 3: RAC Qualifications in Trinidad and Tobago

Item	Qualification
1	CVQ Level 1 & 2 – Refrigeration & Air Conditioning
2	TTNVQ Level 1 – Refrigeration & Air Conditioning
3	City and Guilds IVQ – Refrigeration & Air Conditioning
4	UWI Extramural – Refrigeration & Air Conditioning
5	ARIA – Refrigeration & Air Conditioning (RAC) Level 1, 2 and 3
6	NEC – UTT John S. Donaldson Campus– Refrigeration and Air Conditioning
7	St. Kevin’s – (200hours)- Certificate in Air conditioning and Refrigeration
8	International Correspondence School – Refrigeration and Air Conditioning Certificate.
9	International Correspondence Schools – Air-conditioning, Heating, and Refrigeration Mechanic Diploma
10	Oklahoma State Tech – Associate of Technology in Refrigeration and Air-conditioning
11	San Fernando Technical Institute – certificate in Domestic Refrigeration and Air Conditioning (150 hours)

Other institutions that also offer RAC training include: The School of Business and Computer Science, CTS College of Business and Computer Science Limited, the MIC Institute of Technology, the School of Refrigeration and Air Conditioning, and the Youth Training and Employment Partnership Programme (YTEPP).

An equivalence assessment of these programmes should be conducted to gauge levels and content with the aim of standardization of the qualifications offered, and integration into the existing Professional Certification Scheme for the RAC industry. The local accrediting body is the Accreditation Council of Trinidad and Tobago (ACTT), along with the National Training Agency (NTA). The NTA also sets occupational standards that are used to develop the curriculum for locally and regionally recognized RAC programmes. The formalization of training in the RAC sector can be further enhanced through the amendment of regional and national occupational standards to include content to support the NCSTT activities.

The increased demand for cooling and the growth of the RAC sector in Trinidad and Tobago requires a large cadre of technicians with a high quality of service delivery. Many technicians are still adjusting to the rapidly changing global industry, the phase-out and phase-down of refrigerants, and the new accompanying technologies. The training on good refrigeration practices under the HCFC Phase-out Management Strategy (HPMP), has achieved significant levels of success but needs to be extended to cover more technicians. Most RAC training in Trinidad and Tobago does not take into consideration EE measures, and in the case of the semi-structured and unstructured training, professionalism is also not

considered. Hence, there is a need for more education, training and re-training and revision of the curriculum to ensure that technicians can provide quality service and support a market change toward EE within the sector.

A flexible skills development approach, using a web-based multi-platform mode of delivery for training, can be considered to reach more service technicians, especially with the massive proliferation of internet applications and mobile technologies.

Data is essential to the success of a multiplatform approach to training and would allow for adequate planning for future activities, trends, and projections. Unfortunately, updated data on the number of persons in the formal and informal service sectors are not available, nor is data regarding the specific skill level of technicians.

2.4.1 Certification Scheme

The country's first certification award scheme for technicians in the RAC sector was launched in April 2017.

The Professional Certification Scheme for the RAC Industry was developed through joint efforts between various stakeholders. The scheme is aimed at:

- The establishment of a system for certification of personnel within the Refrigeration and Air-conditioning sector
- The promotion of the enforcement of proper installation, servicing, handling, maintenance, and containment strategies within the RAC sector
- The enhancement of the level of professionalism within the RAC
- Trinidad and Tobago meeting its commitments to the Montreal Protocol.

The Professional Certification Scheme for the RAC Industry examines three scopes: residential, commercial, and mobile. Candidates must meet stipulated requirements for admission to the certification examination. The Certification Scheme has been a vehicle to recognize personnel in the industry with the required skill level and competence.

2.5 MONTREAL PROTOCOL IMPLEMENTATION AND REGULATIONS

The Government of the Republic of Trinidad and Tobago acceded to the Vienna Convention and the Montreal Protocol on Substances that Deplete the Ozone Layer in 1989, to become the first country of the Caribbean Commonwealth to be a party to this multilateral environmental agreement. Trinidad and Tobago operates under Article V (1) of the Montreal Protocol and has ratified all amendments to the Protocol, including the Kigali Amendment which was signed in 2017. The Kigali Amendment strengthened the Montreal Protocol by linking ozone protection to climate protection efforts, through the setting of HFC phase-down targets. The collective effort of the Kigali Amendment aims to reduce global greenhouse gas emissions and will ultimately support the country's SDGs.

From the regulatory standpoint, current activities related to the phase-out of ODS and phase-down of HFCs under the Montreal Protocol are driven by the National Ozone Unit.

Several legislative works embody the country's commitment to the Montreal Protocol; one of which is the 2018 National Environmental Policy, as it defines the overall policy and legal framework to support the Protocol. The National Import and Export Control Regulations, which was adopted in 1941, was amended in 2014 to include ODSs and mixtures containing ODSs, also to support the Protocol (UNDP, 2011). Based on the revised Regulations, a quota system for HCFC imports has been established. Despite such a legislative framework, the effort is still required to transform policy instruments and energy saving targets into action.

Table 4 shows a summary of the existing policy frameworks and controls implemented by Trinidad and Tobago under the Montreal protocol.

Table 4: Existing policy frameworks and controls

TYPE OF ACTION / LEGISLATION	Ongoing (Yes/No)	Since when (Date)
1. Regulations		
Import and Export Control Regulations (1941)	Yes	1999
2. Enforcement of HCFC/ ODS Alternatives Import/Export controls		
ODS Licensing System	Yes	1999
National annual quota established	Yes	1999
Registration of importers	Yes	1999
Imports controls/imports license	Yes	2014
3. Strategies policies, legislation, and regulations		
Control of Trade in all ODS Blends	Yes	2014

2.6 CLIMATE CHANGE ACTION PLAN

Trinidad and Tobago as a producer of oil and natural gas account for 0.1% of the global absolute GHG emissions (Government of the Republic of Trinidad and Tobago, 2011). The country has been moving rapidly towards the use of natural gas, as a cleaner fuel, as its primary means of meeting its growing energy demands. The petrochemical and heavy industry sectors are the main contributors to GHG emissions, followed by power generation and then the transportation sector. Figure 4 shows the percentage of contribution from the main emitting sectors.

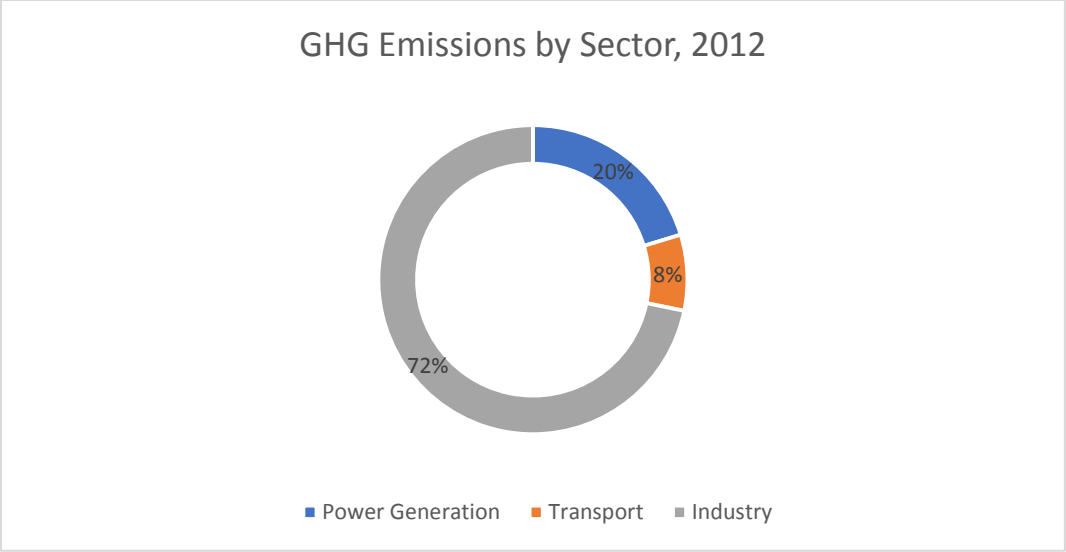


Figure 3: GHG Emissions By Sector, 2012

Trinidad and Tobago has started mainstreaming climate change considerations through the development and implementation of a national policy framework for climate change, which includes the National Climate Change Policy (NCCP), Carbon Reduction Strategy (CRS) and Nationally Determined Contribution (NDC). The CRS is a tool, to create the necessary conditions and capacities for multidisciplinary implementation of the NCCP, specifically for the reduction of GHG emissions in the power sector, industry and transport sectors over the 2013-2040 horizon. The CRS recognizes the decline of the energy consumption in the housing, commercial and institutional sectors as a critical measure composing the national strategy for GHG mitigation (GORTT, Strategy for Reduction of Carbon Emissions in Trinidad and Tobago, 2015).

One of the initiatives identified under the NCCP, which is aimed at reducing the GHG emissions from the energy sector, is increasing energy efficiency in commercial and residential buildings. This can be achieved by:

- developing a Green Building Code that will seek to maximize renewable energy and energy efficiency and
- formulating and adopting minimum energy efficiency standards (MEES) through the Trinidad and Tobago Bureau of Standards

Based on the NDC 2015, the objective is to reduce overall cumulative emissions from the three main emitting sectors (Industry, Power Generation and Transportation) by 15% by 2030 from Business as Usual (BAU) equivalent to 103 MtCO_{2e}.

3 ELECTRICITY SECTOR OVERVIEW

Trinidad and Tobago is an oil and gas-producing country, where the total energy supply depends mostly on its domestic production of natural gas (71%) and crude oil (27%). Final energy consumption in the country stands at 269 kboe/day⁵. The industrial sector accounts for 45 kboe/day, followed by transport

⁵ Kilo barrels of petroleum equivalent per day.

with 21 kboe/day, residential with 7 kboe/day, and commercial with 2 kboe/day. The remaining other sectors, including public facilities, account for most of the consumption with 194 kboe/day (Humpert & Ramon, 2016).

The country has a total large thermal power capacity of 2,428 MW. This capacity is split between four electricity producers the Trinidad and Tobago Electricity Commission (T&TEC), PowerGen, Trinity Power and Trinidad Power Generation Unlimited (Humpert & Ramon, 2016). T&TEC is the entity solely responsible for power distribution in both islands by law. T&TEC's customer base is expected to grow from 468,906 customers in 2016 to 550,303 customers in 2025, with an average annual compounded growth rate of 1.8%. Total energy sales are forecasted to grow by 41% from 9,363 GWh in 2016 to 13,215 GWh in 2025 at an average annual compounded rate of 3.9 %, with small and medium industrial energy are expected to grow at an average annually compounded rate of 3.5 %. System peak demand for 2016 was 1.434 MW and is expected to be 2044 MW in 2025, with an average annually compounded growth rate of 4.0% (Humpert & Ramon, 2016).

3.1 ELECTRICITY MATRIX

Due to the country's energy-intensive industries, annual per capita consumption of electricity is among the highest in the Caribbean at over 6,500 kWh (Humpert & Ramon, 2016). The industrial sector represents the largest consumer of electricity, accounting for 60 % of sales (4,825 GWh). The residential sector consumed 29 % (2,412 GWh) with an average annual compounded growth rate of 3.6 %. The commercial area is the third largest consumer, with 10% (773 GWh), with an average growth rate of about 7% per year (Humpert & Ramon, 2016). Other end-uses, primarily street lighting, accounted for sales of 109 GWh, representing around one percent Trinidad and Tobago's electricity consumption. Electricity pricing is controlled by the Regulated Industries Commission (RIC); however, it is heavily subsidized with an average price in the commercial sector to the order of USD \$0.06 per kWh being kept since 2011 and at USD \$0.04 per kWh for the residential usage -the lowest electricity prices throughout the Caribbean where the range is USD \$0.30 – USD \$0.40 per kWh- a significant challenge in promoting the enabling environment and implementation of energy efficiency programs.

Electricity consumption by sector is summarised in Figure 3.

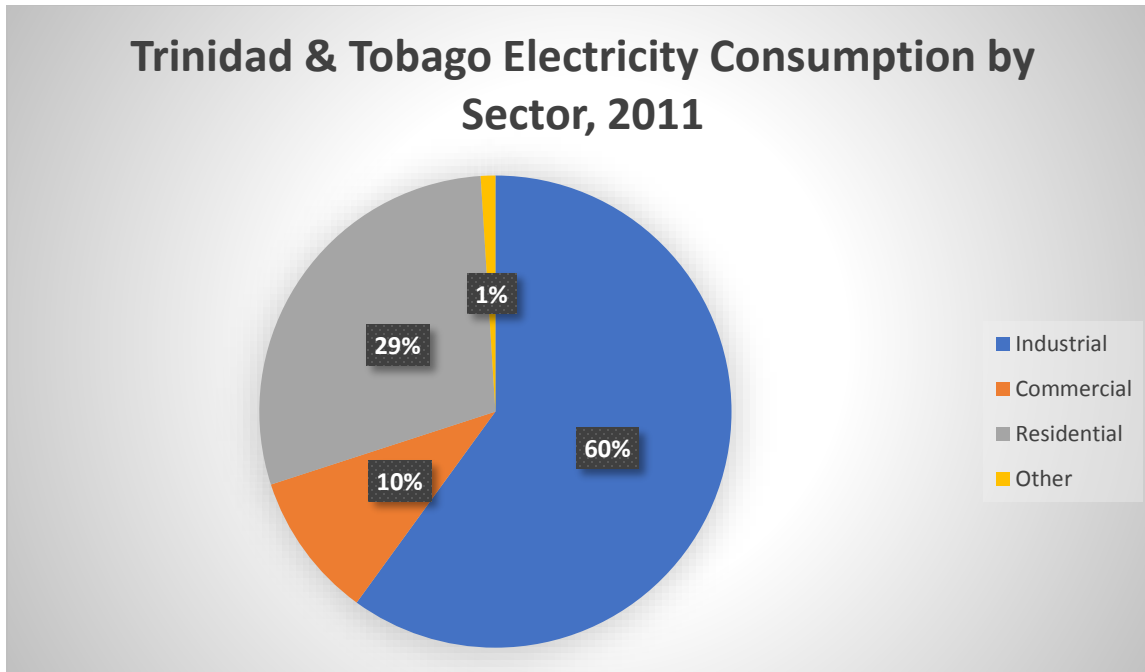


Figure 4: Trinidad & Tobago Electricity Consumption by Sector, 2011

3.2 REFRIGERATION AND AIR-CONDITIONING ELECTRICITY CONSUMPTION

Information related to electricity consumption for air conditioning and refrigeration equipment is not officially available. The following calculation was approached on the most demanding sectors, residential and commercial, as shown in Table 6. T&TEC in 2015 sold approximately 8,900 GWh of electricity (Commission, 2017). Based on the distribution in figure 3, approximately 39% of electricity consumption can be utilised by the residential and commercial sectors totalling 3,471 GWh. Using an assumption that 43% of the total electricity usage of the residential and commercial sectors is used for cooling application the value 1479 GWh is extrapolated. For the estimated total consumption of electricity for the RAC sector, it is assumed that commercial would account for 70% of this value while residential accounts for 30%. For commercial systems light would refer to split units in the case of air-conditioning, while small refrigerators, freezers and drink chillers (10 – 28 cubic feet) in the case of refrigeration.

Table 5: Estimated End-use of Electricity for RAC Technologies (GWh, the year 2015)

Sector/RAC System	Refrigeration	Air Conditioning	Total
Commercial (Rates A1 and B1)			
Light	248	166	414
Centralized	373	248	621

Residential (Rates A and B)			
Light	177.6	266.4	444
Total			1479
Source: Review of the Status of the Trinidad & Tobago Electricity Commission 2010-2015, and assumptions.			

Within the commercial sector (49,000 customers), the highest end-users of electricity include hotels and restaurants, services facilities (mainly hospitals and offices), and retail stores. Electricity for refrigeration with light systems is made up primarily of medium and small enterprises with an average monthly consumption of 20.66 GWh, for a total consumption of 248 GWh, while centralized units are commonly used in large facilities with areas larger than 500 square meters (373 GWh) and are imported in parts to be installed on-site. The average monthly consumption in these types of facilities – for example, large retail stores and supermarkets – account for 621 GWh and operate either with HCFC-22 or HFCs. Both uses also have in operation self-contained units for medium and low refrigeration, which are assembled locally or imported as single (packaged) units. Additionally, the commercial also has installed air conditioning units for acclimatization ranging from 7 ton of capacity up to 50 tonnes, depending on the size and use of the facility, with an estimated annual consumption of 414 GWh, for the reference year 2015, as indicated in Table 6.

In the residential sector (408,000 customers), electricity end-use for refrigeration with light systems depends on the operation of standard self-contained household single units, with an average size of 25 cubic feet and a household penetration rate of 18% (Loy, Klein, Casado Cañeque, & Marzolf, 2015) nationwide. This consumption represented 177.6 GWh for the year 2016. In addition, there is a growing penetration of air conditioning light units in this sector (the conventional split-type with quite ample ranges of energy efficiency), which are imported with an average cooling capacity of 12000 - 18000 BTU per hour, and a consumption of 266.4 GWh for the reference year, as indicated in Table 6.

Power generation continues to be one of the most significant contributors to GHGs in the country, and its demand is projected to continue to increase. Cooling has a substantial role to play primarily in the residential and commercial sectors of Trinidad and Tobago as there is an increased need for space cooling and refrigeration. In considering mitigation activities, several factors need to be considered. The elements are the culture of the users, technology improvements and availability, the provision of financial incentives, and a mechanism to measure and evaluate the effectiveness of the proposed initiatives.

3.2.1 Electricity Emission Factor

Greenhouse gas accounting involves quantifying the greenhouse gas emissions associated with a country’s economy or activities, including the consumption of grid electricity. Electricity consumption in Trinidad and Tobago is one of the highest sources of emissions; thus, it is, therefore, essential that the measurement of these emissions is as accurate as possible. This can be done with the use of the respective emissions factor.

An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the mass of pollutant divided by a unit mass, volume, distance, or duration of the activity emitting the pollutant (EPA, 2016). For climate purposes, the emission factor will consider GHG emissions measured in the mass of CO₂ or CO₂ eq.

For Trinidad and Tobago, the estimated electricity grid GHG emission factor is 0.687 kgCO₂/kWh as published by the International Energy Agency, 2015.

3.3 BARRIERS TO ENERGY EFFICIENCY IN THE RAC SECTOR

The GIZ⁶, in a 2016 presentation entitled, “Energy Efficiency in the RAC Sector,” identified key barriers for the introduction of EE in the RAC sector. These barriers, as described in Table 5, were confirmed to exist in the Trinidad and Tobago context by a baseline study done during the Project Preparation Grant (PPG) phase of the GEF-6 project. These barriers were considered when developing strategies under NCSTT.

Table 6: Barriers to Energy Efficiency in the RAC Sector

Actors	Barriers	Description
Institutions	Information	Lack of reliable and clear indication of RAC energy performance, lack of direct information about the sector which affects effective decision-making on the part of regulators, service technicians, and consumers
	Tariff distortion	Subsidized electricity tariffs distort the market, causing energy efficiency to be undervalued
	Regulatory frameworks and policy development synergies	Currently the Trinidad and Tobago Electrical Commission Act does not allow for wheeling or the feeding of electricity from independent operators into the grid without consent from the state owned utility. Therefore there must be legislative reform to facilitate the use of renewable energy so that it can be financially attractive to potential users.
Consumers	Information	<ul style="list-style-type: none"> • Lack of understanding of energy-efficiency benefits • Lack of information about the value of equipment energy performance • Lack of information on the applicability of the use of renewable energy in providing services such as air conditioning /cooling • Uncertainties about energy savings as energy savings are not directly measurable but can only be inferred
	Affordability	High up-front costs for retrofits and new installations
	Principal-agent problem	Occurs when the people who are purchasing RAC equipment are not the ones paying for the electricity to operate them. This is frequent in rental homes.
Manufacturers /Retailers	Availability of products	<ul style="list-style-type: none"> • Lack of energy-efficient products available on the market • Lack of available capital for investment in product upgrades
	Financial barriers	Energy-efficiency projects considered high risk by financial institutions
	Technical barriers	A large gap in professional capacity to produce efficient equipment exists in developing countries

⁶ The Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH, or GIZ in short, is a German development agency headquartered in Bonn and Eschborn that provides services in the field of international development cooperation.

It is to be noted that for the barriers identified that activities cited within this Strategy is intended to act as facilitators to overcome these barriers.

4 OVERVIEW OF ENERGY EFFICIENCY REGULATIONS IN THE RAC SECTOR

4.1 INTRODUCTION

The development of energy efficiency in Trinidad and Tobago is still at a rudimentary stage. A few initiatives including fiscal incentives, draft public policies, and research projects have been undertaken, such as energy efficiency and green design into new residential and commercial developments and the Renewable Energy and Energy Efficiency Fiscal Incentive Program (2011). There is also ongoing capacity building in the tertiary education sector through the incorporation of renewable energy and energy efficiency into the academic programs of institutions such as the University of Trinidad and Tobago (UTT) and the University of the West Indies (UWI).

The 2011 National Climate Change Policy aims to provide policy guidance for the development of an appropriate administrative and legislative framework, in harmony with other sectoral policies to reduce GHG emissions. This policy looks at appropriate strategies and actions to address climate change, such as increasing energy efficiency measures in the commercial and residential sectors, to reduce the carbon footprint of the country.

Energy efficiency regulations should also form part of the country's commitment to reduce carbon emissions and reduce power demand. In the Trinidad and Tobago context energy efficiency actions need to be developed, putting in place the necessary legislation, government policies, and public awareness programmes.

4.2 ENERGY EFFICIENCY REGULATORY INITIATIVES

The Ministry of Energy and Energy Industries (MEEI) is the leading entity concerning policy making in the energy sector. MEEI's focus is to create innovations and partnerships that support a self-reliant and resilient energy sector. Through its Renewable Energy Division, the MEEI provides guidance on drafting local legislation on renewable energy and energy efficiency policies. This Ministry has developed several fiscal incentives to promote RE and EE in collaboration with the Ministry of Finance, which are included in the Finance Act No. 13 of 2010 and effected on January 1, 2011. The fiscal incentives are as follows (MEEI, 2011):

- import duty exemptions are granted for "machinery, equipment, materials and parts for the manufacture or assembly of solar water heaters."
- 0-Rated VAT granted for solar water heaters, solar PV panels, and wind turbines.
- tax credit for Solar Water Heaters: Where an individual, in a year of income commencing 1st January 2011, purchases solar water heating equipment for household use, that individual shall be entitled to a tax credit of twenty-five per cent of the cost of the solar water heating equipment up to a maximum of ten thousand dollars (maximum tax credit of TT \$2500.00).
- wear and tear allowance on 150% of the expenditure incurred on:
 - a. the acquisition of plant, machinery, parts, and materials for use in the manufacture of solar water heaters and
 - b. the purchase of wind turbines and supporting equipment; solar photovoltaic systems & supporting equipment; and solar water heaters.

It is the intention to introduce fiscal incentives for Energy Service Companies (ESCOs) to influence the local private sector to form ESCOs and become Government certified to offer services such as the design of energy saving solutions, installation of the energy savings systems and perform energy audits, for the public.

4.3 MINIMUM ENERGY PERFORMANCE STANDARDS

Globally, interest in improving the energy efficiency of household appliances is widespread and growing. Methods for reducing energy consumption include energy labelling, energy efficiency standards, and other drivers to adjust market demand and conditions. The implementation of energy standards started with the industrial sector in the global context and then was introduced in commercial and domestic applications. Energy-efficiency labels and standards can be applied to any product that consumes energy, directly or indirectly, as it provides its services.

Minimum Energy Performance Standards (MEPS) and energy labelling are recognized by this country's energy and environmental policymakers as one of the most important ways to impact the market for equipment and appliances being imported into Trinidad and Tobago. MEPS establish limits for the energy efficiency that products must meet or exceed before they can be imported or sold. MEPS are an effective regulatory instrument, especially when paired with energy labelling, to drive the increase of product efficiencies and can be either mandatory or voluntary. They are very effective policy measures, especially for small RAC appliances, such as refrigerators and air conditioners.

Currently, in the Trinidad and Tobago regulatory landscape, there are no MEPSs, however, the development of a MEPS for the RAC is being considered at the national level.

4.4 LABELLING STANDARDS AND TESTING

The Trinidad and Tobago Bureau of Standards (TTBS), is the regulatory body under the Ministry of Trade and Industry, responsible for standards development and implementation in the country. In Trinidad and Tobago, there are no national EE standards for any sector. In terms of the energy efficiency standards and labelling aspects of RAC equipment, the TTBS has some technical capacity for standardization, verification, and certification of energy efficient RAC systems. There exist label standards for RAC equipment and refrigerants. However, they are not related to energy efficiency. Table 7 shows the existing labelling standards and their respective status of enforcement.

Table 7: Status of Enforcement of Existing RAC Compulsory Standards

Compulsory Standards related to RAC Sector	Status of Enforcement
TTS 76: Part 2: 1994 – Requirements for Labelling – Part 2: Labelling of Pre-packaged Goods	Currently Enforced
TTS 76: Part 20: 2015 – Requirements for Labelling – Part 20: Labelling of Refrigerant Containers	Currently Enforced (under ISO/IEC 17020 Accreditation)
TTS 76: Part 13: 2016 – Requirements for Labelling – Part 13: Labelling for Electrical Appliances (3 rd Revision)	Currently Enforced
TTS/UL 984: 2008 – Hermetic Refrigerant Motor-Compressors	Partially Enforced (Labelling)
TTS/UL 250: 2009 – Household Refrigerators and Freezers	Partially Enforced (Labelling)

Ref.: TTBS, Implementation Division, Pre-Packaged Good Unit.

The TTBS, however, is exploring ways to handle a new generation of low-carbon, EE RAC technologies, and their environmentally-friendly refrigerants through regional partnerships with bodies such as the CARICOM Regional Organisation for Standards and Quality (CROSQ). Through CROSQ the TTBS has been able to contribute to the development of regional EE labelling standards which can be adopted by Trinidad and Tobago once finalised and approved.

4.5 SUMMARY

Given that the global environmental benefits of energy efficiency and renewable energy development far outweigh the barriers to its implementation, it is prudent to foster energy efficiency over the short to medium term. Increasing energy efficiency would have a spill over effect on savings in power generation and utility costs and contribute to the reduction of GHG emissions by the RAC sector. To achieve this, several actions are proposed as projects described in the next chapter.

5 NATIONAL COOLING STRATEGY PROJECTS

The National Cooling Strategy of Trinidad and Tobago (NCSTT) focuses on the development of clean, sustainable, and efficient cooling that would contribute to the reduction of global warming and climate change. The cooling Strategy looks at the following four (4) major areas to be addressed to achieve them. These areas are:

- Development of Policy Instruments
- Support for refrigerant replacement
- Develop Capacity Building and Partnerships initiatives
- Market monitoring, verification, and enforcement

These project factors are acted on by several identified initiatives as summaries in figure 5. These projects shall enable Trinidad and Tobago to realise the important global environmental benefits linked to sustainable cooling. The NCSTT is not a detached initiative but seeks to synergise existing plans and projects and develop others to fill any gaps identified, to create a holistic Strategy for the cooling sector. Figure 5 shows the interactions between the thematic areas and the proposed project initiatives. This chapter presents the initiatives to be undertaken under the NCSTT.

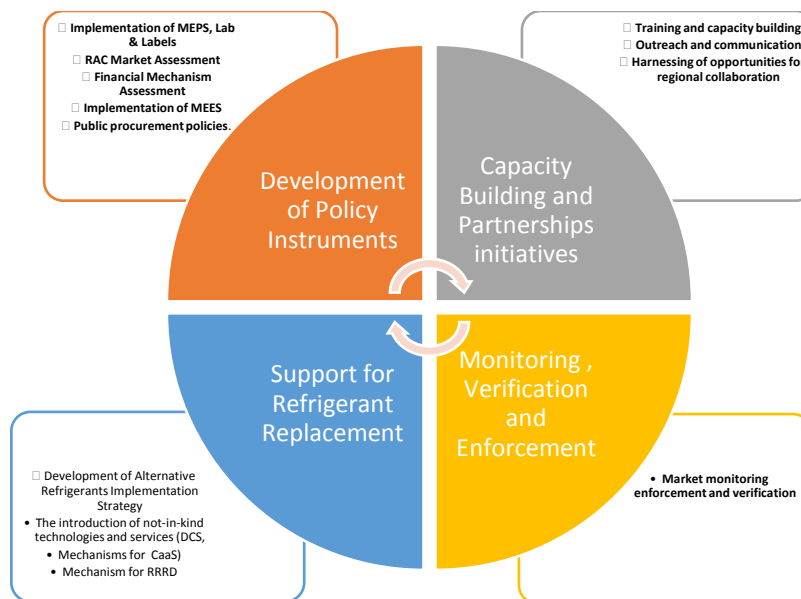


Figure 5: Cooling Strategy initiatives relationship diagram

5.1 POLICIES TO GUIDE IMPLEMENTATION

5.1.1 Implementation of Minimum Energy Performance Standards and Energy Efficiency Labelling Programme

Minimum Energy Performance Standards (MEPS) are a set of procedures and regulations that prescribe the minimum energy performance of manufactured products and are an effective regulatory instrument to drive the increase of product efficiencies. MEPSs are useful in many countries, and markets have been transformed toward the offer and utilization of energy efficient products while removing inefficient equipment. MEPS are even more essential to increase the adoption rate of energy efficient products, in countries such as Trinidad and Tobago where the energy costs are low, and the financial savings on energy bills from energy efficient equipment is insufficient to promote their widespread adoption. It also safeguards against old inefficient products from flooding the local market (technology dumping).

The use of energy efficiency metrics that rate product performance independent of the technology used is preferable, as consumers or policymakers can directly evaluate the benefits of the more efficient options. For instance, countries using a Seasonal Energy Efficiency Ratio (SEER) can have single energy performance requirements for fixed speed and inverter RAC product categories, rewarding designs that achieve higher efficiency levels independent of the technology used.

Trinidad and Tobago currently has no MEPS established but needs to consider it as a vehicle for the market change towards energy efficient technologies in the RAC and other sectors.

Energy efficiency labels are informative labels indicating the products' energy performance and efficiency in a way that allows for comparison or endorses the products' use. Energy Efficiency Standards and Labels (S&L) are complementary regulatory tools that are instrumental in promoting a sustainable energy path. MEPS and labels are meant to help enable the market to recognize energy efficiency and migrate towards the use of these products in the RAC sector. In the absence of the information provided by labels, consumers and other end-users would be unable to make an informed decision about the actual value of products. Manufacturers, suppliers, and retailers will also lack the incentive to improve the energy performance of their product offering, as there is no way for the market to recognise and value EE equipment. Energy labelling of products and MEPS increase the general product quality and make consumers aware of the differences between similar products on the market.

Energy Efficiency Labelling Programme and MEPS should be implemented together as push and pull market strategies maximizing the impact towards transitioning the air conditioning market to high efficiency. One of the challenges of energy labelling is the testing and verification process to ensure that the stated levels are accurate and have been verified. It is therefore crucial for Trinidad and Tobago to generate the appropriate infrastructure for product testing and confirmation on product compliance. However this can be overcome with the establishment of existing regional accredited testing facilities. The main barrier to these partnerships, however, would be the cost of transportation of equipment for testing; therefore, a study of the feasibility of in-country testing versus external testing would have to be performed.

To this end, the GORTT in collaboration with relevant stakeholders shall:

- Review regulatory mechanisms, nationally and internationally, to establish benchmarks and industry best practice for the development of MEPS and EE Labelling systems
- Identify and define the RAC applications that will be targeted in MEPS and EE Labelling Programme in Trinidad and Tobago.
- Establish through the MEPS a mandatory efficiency minimum that all equipment manufactured and sold in that country must meet or exceed.

- Introduce MEPS concessions (less stringent requirements) for air conditioners that use low-GWP and non-ODS refrigerants given that MEPS can also vary depending on the air-conditioners cooling capacity (size of the units).
- Establish a system to regularly monitor the market when MEPS are implemented to identify when policy revisions are economically justified.
- Align efficiency policies with programs that promote low-GWP equipment and other systems that restrict usage of high-GWP refrigerants in air conditioners, as well as with the phase-out of ozone-depleting and phase-down of high GWP refrigerants
- Promote data collection in the energy performance of equipment in kWh of energy consumption per 24 hours, or kWh per year per adjusted volume.
- Develop a national product labelling programme for the RAC Sector which includes inclusion of energy efficiency ratings (EER or SEER), refrigerants used and cooling capacity
- Ensure that Trinidad and Tobago’s RAC minimum efficiency standards and labelling programme bases product performance rating on Energy Efficiency Ratio (EER) or Seasonal Energy Efficiency Ratio (SEER) metrics, which enable direct comparison of performance between fixed speed (non-inverter) and variable speed (inverter) air conditioners when using a combined product category for both types⁷.
- Develop energy efficiency programs for the adoption of high-efficiency RAC systems by providing rebates and other incentives to consumers to help offset the high initial purchase cost for high-performance equipment.
- Conduct an awareness campaign for the MEPS and labelling programmes highlighting the benefits of and requirements for appliance and equipment energy efficiency
- Develop national testing and certification procedures
- Establish EE testing laboratory in Trinidad and Tobago
- Conduct training of inspectors (regulators) responsible for implementation of MEPS and Labelling system on monitoring proper labelling, coordination, and enforcement.
- Develop strategies for regional collaboration and recognition of MEPS and Labelling systems.

5.1.2 Assessment of Financial Mechanisms to Support Market Transition

To support the market competitiveness of alternative systems, it is essential to assess existing funding and financial mechanisms and to develop and implement new measures for funding and financial support. This includes funding and financing schemes to bridge higher upfront costs of alternative systems with lower operating costs due to energy savings. Global and local funding, resources and guidance to be assessed include the Green Fund of Trinidad and Tobago, GIZ, Kigali Cooling Efficiency Programme (K-CEP), GEF, Green Climate Fund (GCF), and Caribbean Basin Sustainable Energy Fund (CABEF) among others.

To this end, the GORTT in collaboration with relevant stakeholders shall:

⁷ “Most countries have adopted part-load assessment test standards such as ISO 16358, EN 14825 and ASHRAE 116 in addition to the conventional ISO 5151 full-load test standard. However, many countries in the Middle East and South America still adhere to ISO 5151 standard for policy or high temperature environment reasons” (Myung et al, 2018)

- Analyse the current tax system (such as import, value-added and sale taxes) and on-going incentives for infrastructure retrofit and electro-mechanical reconversion, in the commercial and industrial sectors
- Develop financial instruments and economic incentives for the import of high EE, low GWP RAC equipment with natural or alternative refrigerants, and disincentives for low EE RAC, high GWP equipment where applicable,
- Access funding opportunities locally regionally and internationally to support market transformation

5.1.3 Refrigeration and Air Conditioning Sector Market Assessment

An important activity that is required for market adoption of energy efficient cooling technologies is the undertaking of a RAC market assessment. This would be necessary to understand the current technologies deployed on the twin island and identify appropriate technologies for the Trinidad and Tobago context. It would also strengthen the national policy, regulatory, and institutional frameworks to make the transition to more energy efficient, environmentally friendly RAC technologies. To effectively chart a way forward for the incorporation of EE technologies in the RAC sector, it is important to identify the availability of these technologies and future market trends. Another consideration is combining low-GWP refrigerants and efficient performance while assessing benefits and barriers. This integrated approach to RAC equipment selection and design will foster opportunities to improve energy efficiency.

To this end, the GORTT in collaboration with relevant stakeholders shall:

- Develop strategies to ensure minimisation of cooling/heating loads.
- Promote the selection of appropriate low GWP and non-ODS refrigerant.
- Ensure the use of high efficiency components and system design.
- Ensure proper installation, optimised control and operation, under all common operating conditions.
- Promote design features that will support servicing and maintenance.
- Facilitate the market penetration of energy efficient and sustainable technologies (R&D, market introduction incentives).
- Develop and execute marketing assessment strategy, and monitoring systems for RAC EE Technologies
- Incorporate behavioural and gender considerations in market assessments
- Establish an inventory of current and available energy efficient and sustainable technologies and required R&D, deployment, and technology transfer activities.
- Conduct a feasibility study regarding the use of alternative or not-in-kind technologies like District Cooling as an alternative to high GWP, low energy efficient technologies.
- Formulate a strategy for diffusion, acceleration of innovation, technology transfer, and dissemination of low-GWP and energy efficient technologies-based equipment.
- Develop a detailed model for the future use of EE technologies in the RAC markets between now and 2030, and the assessment of the cost impact of using the same.
- Assess the opportunities to reduce cooling needs (e.g. shading, natural ventilation, coatings, dress codes), right-sizing equipment, proper installation and maintenance considerations, and alternative cooling solutions.
- Facilitate the reduction of cooling needs presently and in the future.

5.1.4 Implementation of Minimum Energy Efficiency Standards and Green Building Codes

Another standardization path considered alongside MEPS is minimum energy efficiency standards (MEES) for buildings, which would establish a minimum energy rating for buildings and a certification scheme. The MEES requires the review of existing building codes to incorporate energy efficiency and clean energy into the high-performance design of buildings and homes, which would, directly and indirectly, reduce cooling demand. Introduction of EE building standards (codes) for social housing projects are a good starting point as most of these buildings are not adapted to tropical climates leading to a low comfort and high electricity costs if occupants purchase air-conditioning systems to lower high room temperatures. Innovative to high-performance building design approaches like insulation of roofs and sun exposed walls coupled with improved ventilation and the use of EE RAC technologies and EE glass can leverage substantial increases in comfort and energy savings.

5.1.4.1 *High-Performance Building Design to reduce cooling requirements (Passive Energy Efficiency) and Certification of Energy Service Companies (ESCOs)*

High-performance building designs can reduce the heat transfer from the outside through the building envelope (walls, roof, windows, and doors) to the inside of the building, thereby reducing the need for or a load of an A/C system to reject this heat from the conditioned space. Also, increasing the energy efficiency of lighting and other appliances that give off heat have the compound benefit of reducing cooling demand as well as direct energy consumption. The inclusion of trees into the design of buildings and their surrounding area can also reduce cooling demand as trees provide shade and cooling via transpiration⁸.

To support the move toward high-performance building design and the implementation of the MEES for building it is essential to have companies that are effectively able to establish a baseline for the energy consumption of buildings and effectively report and advise on energy saving strategies. The role of an ESCO is to carry out energy audits to determine if air conditioning units are performing at optimum efficiency or if they should be replaced with more cost-effective energy efficient alternatives. ESCOs can also propose, implement, and help clients finance energy management projects that can result in significant electricity cost savings and mitigate GHG and refrigerant emissions.

To this end, the GORTT in collaboration with relevant stakeholders shall:

- Adopt Green Building Codes in municipal buildings by law for compliance in all new construction to bring about an overall shift towards energy efficient building practices.
- Adopt Building codes and performance standards such as but not limited to ASHRAE and the Chartered Institute of Building (CIOB) for commercial and residential buildings and the International Energy Conservation Code (IECC) to substantially reduce cooling demand and subsequent energy consumption relative to non-compliant structures.
- Promote the introduction of EE building standards (codes) for social housing projects and all public and government buildings in the first instance
- Promote High-Performance Building Design in Building practices

⁸ TRANSPIRATION. When water vapour is transpired from leaves into the atmosphere, the plant and surrounding air is cooled down. When sitting in the shade of trees the air temperature can be 5 degrees centigrade cooler than in the sun. The shade of the tree will cool you down and transpiration **cooling** will lower the air temperature.

- Promote Innovative to high-performance building design such as insulation of roofs and sun exposed walls coupled with improved ventilation and the use of EE RAC technologies and EE glass can leverage substantial increases in comfort and energy savings
- Promote market awareness campaigns to sensitize both the construction community as well as the consumers towards the multiple benefits of efficient buildings – reduced operational costs, improved health and comfort, environmental and societal benefits.
- Engage with industry associations such as the Association of Professional Engineers (APETT) and other private associations to promote high-performance building design
- Promote Sustainable Building Design courses at the post-secondary institutions (construction curriculum) to support the market / cultural change.
- Implement a system for the certification of ESCOs as this initiative would also contribute to existing fiscal policy measures.

5.1.5 Implementation of Public Procurement Measures and Incentives

New equipment purchases generally occur at the time of new construction and equipment failure/end of life, and consumers are limited to products that are readily available through their local distributor channels or RAC contractor. The consumer may not consider the lifetime energy savings from high-efficiency equipment when they need to make a purchase, due to lack of information by which to make an informed decision.

In selecting new equipment, thermal comfort, noise level, price, and other non-energy factors constitute the most significant influence on buying decisions. Education and awareness programmes for energy efficiency in refrigeration and air-conditioning should specifically target RAC wholesale and retail sales professionals, procurement officers, and consumers.

A potential concern during the transition to more energy efficient non-HFC appliances is the possibility that manufacturers will export less-efficient HFC-containing machines to countries not yet subject to the Kigali Amendment's requirements or have the systems in place to regulate these types of imports. These items would include new, second-hand, recycled, repaired, or refurbished appliances.

To this end, the GORTT in collaboration with relevant stakeholders shall:

- a) Guard against the importation of low-efficiency products and product components by implementing strong national efficiency policies for imported new, imported second-hand/ recycled/ repaired/ refurbished cooling appliances, and any such domestically manufactured or reconditioned second-hand appliances
- b) Ensure that relevant national policies include MEPS, mandatory and voluntary labelling, prior notification of product imports, and pre-shipment verification of product conformity mechanisms be applied to all import of appliances and effectively implemented.
- c) Promote energy efficiency by mandating it in tendering processes during the public procurement of RAC equipment (installation and maintenance) for state-owned buildings in either new building construction or Retrofitting and retro-commissioning existing buildings to reduce cooling requirement and energy consumption.
- d) Drive widespread adoption of energy efficient traditional and alternative cooling equipment in new and existing public buildings as articulated in the GORTT Office Outfitting Policy 2012 and implement campaigns to encourage the private sector and consumers to do the same.

- e) Issue public procurement guidelines for trained and certified RAC service technicians for public buildings.
- f) Develop and implement procedure for commissioning of new RAC equipment above a specified size
- g) Implement pre-shipment verification of conformity (PVoC) process, to ensure products destined for import meet all importing-country standards and requirements.
- h) Improve energy efficiency through trade-related incentives or government procurement specifications that encourage the importation of high-efficiency equipment.
- i) Review and revise tariffs to encourage high-efficiency products in the RAC Sector.
- j) Train sales professionals to be able to offer solutions rather than merely a price by communicating to consumers that high-efficiency RAC equipment can incorporate these additional benefits, as well as save money on monthly electricity bills, to achieve substantial and rapid market adoption.

5.2 SUPPORT FOR REFRIGERANT REPLACEMENT

5.2.1 Develop a Refrigerant Replacement Strategy

As Trinidad and Tobago moves toward a sustainable cooling future, mechanisms must be put in place to reduce the current consumption of high-GWP refrigerants as well as ODS refrigerant. Natural refrigerants such as hydrocarbons, carbon dioxide, and ammonia are some of the low GWP refrigerant options available other than synthetic refrigerants. There is also the need to have safety standards for new alternative refrigerants, including natural refrigerants. It is also necessary to develop refrigerant safety standards for room air conditioners, especially for the natural refrigerants which are generally toxic and flammable. These considerations shall be incorporated into a refrigeration replacement Strategy.

To this end, the GORTT in collaboration with relevant stakeholders shall:

- a) Promote the use of low GWP and non-ODS Refrigerants
- b) Conduct a RAC market assessment for refrigerant
- c) Identify the most feasible refrigerant replacement to be used in the Trinidad and Tobago
- d) Development a RAC Sector Code of Practice supported by refrigerant safety handling standards, which include a procedure for a safe recovery, recycling, and disposal
- e) Develop and implement a national phase-out programme for remaining sectoral hydrochlorofluorocarbons (HCFCs) usage
- f) Develop a national phase-down programme for hydrofluorocarbons (HFCs) that link to requirements of the Montreal Protocol, and incorporate into an Implementation Strategy for environmentally friendly Alternative Refrigerants
- g) Develop a refrigerant safety and handling standard which includes:
 - a. the steps required for safe implementation of marginally flammable refrigerants and hazardous refrigerants.
 - b. A list of possible, plausible, and most common scenarios in which a refrigerant- air mixture might be ignited so that the risk and consequences can be determined.

- c. The ignition properties of marginally flammable refrigerants with air.
- d. Accurate, validated correlations and modelling capabilities for specifying venting requirements to prevent overpressure from flames of marginally-flammable refrigerants.
- e. Sensors for detection of refrigerant gases or their decomposition by-products.
- h) Integrate refrigerant replacement initiatives into existing and upcoming refrigerant phase out / down programmes
- i) Develop a system to control the sale of refrigerant, equipment, and parts
- j) Develop a licensing system for RAC technicians promotes the use of low GWP and non-ODS Refrigerants
- k) Develop a Refrigeration Code for the Refrigeration and Air Conditioning Sector

5.2.2 Introduction of NOT-IN-KIND (Any alternative cooling systems other than the vapour compression cooling systems)Technologies into the RAC market

One of the barriers to the adoption of energy efficient technology in Trinidad and Tobago is the high up-front cost to switch to more efficient technologies. Given the critical need to foster energy efficiency over the short to medium term to combat climate change and other environmental issues the introduction of not-in-kind (any alternative cooling systems other than the vapour compression cooling systems)⁹ technologies like district cooling and different business approaches to cooling such as ‘Cooling as A Service’ is required.

These initiatives would increase energy efficiency uptake and have a spill over effect on environmental sustainability, savings in power generation, and utility costs. Not-in-kind technologies will substantially improve energy efficiency gains (Suxin Qian, 2016), using District Cooling technology, which can use local sources for cooling such as groundwater, seawater, waste heat or solar heat.

The advantages of district cooling include:

- energy efficiency; reduction of power generation infrastructure, ability to use an alternative, renewable and cheaper fuels, 50% reduction in power consumption, no need for refrigerants, reduced greenhouse gas emissions, the flexibility of cooling load
- Lower life-cycle costs; less maintenance on machinery, the longer life cycle of the plant, ability to expand and distribute to more buildings so less construction of new operational machinery
- Reliability; availability 24 hours a day, unaffected by peak loading, backup systems available, operated at the external site to building thus can be responded to immediately
- Decreased building costs, architectural flexibility;

To this end, the GORTT in collaboration with relevant stakeholders shall:

- a) Promote the introduction of not-in-kind technologies and services

⁹ The term of **not-in-kind (NIK) cooling technologies** refers to any alternative **cooling** systems other than the vapour compression **cooling** systems that are most commercially dominant today. An example is absorption/adsorption **cooling** which uses the heat to drive the cycle instead of compressors in vapour compression systems. – International journal of refrigeration 62 (2016) 177–192

5.2.2.1 Introduction of Cooling as a Service (CaaS) into the RAC market

Cooling as a Service interrupts the standard business model for delivery of cooling, which involves the manufacture, sale, use, and disposal of equipment. Increase in cooling demand translates into increased production, more sales, and more profits. This, however, would lead to an increased need for electricity to power these products, increasing the production of GHG indirectly. The potential from profit discourages manufacturers from voluntarily focusing on minimizing the energy and resource needs of cooling products. CaaS is an alternative business model which can promote much more energy and resource efficient technologies.

CaaS involves end customers paying for the cooling they receive, rather than the physical product or infrastructure that delivers the cooling, which can contribute to a reduction in the demand for cooling products and would increase access to cooling. District cooling is an example of CaaS where customers do not own the cooling infrastructure and use a pay-per-service model, where a technology provider installs and maintains the cooling equipment and recovers costs through periodic payments made by the customer. These payments are based on actual usage and are usually fixed /unit. The payment is not dependent on the savings (as with an ESCO model) but agreed in advance as a function of actual usage.

Not-in-kind technologies such as district cooling as a CAAS can benefit Trinidad and Tobago from a financial standpoint through overall cost savings, from an environmental standpoint in the reduction of the power requirements and the usage of natural refrigerants, and the social perspective with respect to the increased access to cooling that CaaS has the potential to provide, and the capacity building opportunities and job creation.

To this end, the GORTT in collaboration with relevant stakeholders shall:

- a) Promote Cooling as a Service (CaaS)
- b) Provide financial incentives to encourage Cooling as a Service (CaaS)

5.2.3 Develop Mechanisms for Recovery, Recycling, and Disposal of Refrigerants

The market migration from high-GWP, energy-intensive RAC equipment to the use of EE and low-GWP technology would see an increase in technology replacement. This replacement would increase the need for containment, recycling, and disposal of replaced refrigerants to minimise the possibilities of leakage into the atmosphere. The development of mechanisms for refrigerant recovery, recycling, and disposal (RRRD) is essential to the successful refrigerant replacement initiatives under the NCSTT. Given the newness of this sector, there would be a need to generate business interest in this area.

To this end, GORTT in collaboration with relevant stakeholders shall:

- Develop mechanisms to support commercially driven initiatives for RRRD, such as improving entrepreneurial capacities (business modelling and planning), co-financing recovery and recycling facilities, and outreach activities.
- Develop mechanisms for effective collection and tracking refrigerant usage
- Develop a mechanism to promote RAC systems where components incorporate ability to recycle
- Develop training for technicians and companies on RRRD and include in RAC training curricula
- Identified a mechanism for the environmentally friendly disposal of refrigerants and related equipment

5.3 DEVELOP CAPACITY BUILDING AND PARTNERSHIP INITIATIVES

Building institutional capacity and training are essential to strengthen the coordination between the National Ozone Unit (NOU), policymakers and energy groups to provide the needed conditions as required to integrate EE in future HFC phasedown management plans. Capacity building will be geared towards the design and implementation of EE legislation, MEPs, labelling standards, data collection, monitoring and verification, and enforcement activities.

For the service sector, EE technologies based on the use of low-GWP refrigerants require capacity building and training actions to address the specific issues related to installation, operation, safety considerations and maintenance of low-GWP and flammable refrigerant-based equipment blends with a temperature glide. For importers and retailers, technical capacity-building and training are vital so that they will be able to identify the best technology to procure and supply to the local RAC market.

To this end, the GORTT in collaboration with relevant stakeholders shall:

- Strengthen the professional certification programme for RAC technicians
- Ensure that the syllabus for RAC programmes incorporate energy efficiency, green technologies and the latest technology and information
- Develop and conduct training programmes for officials and practitioners of public and private institutions in EE project development for RAC end-use.
- Facilitate information exchange and data sharing, analysis on design options and their costs, efficient component sourcing for maintaining or enhancing equipment energy performance, and for selection of low-GWP alternatives with significant energy efficiency benefits, and training for safety, mainly if importing flammable refrigerants.
- Develop and conduct training programmes for officials and practitioners of public and private institutions in the design, equipment procurement, and technology transfer, handling procedures, and monitoring performance operation for low-GWP, low-carbon RAC technologies for different end-use applications.
- Strengthen technical capacities in the formal training sector is also essential to promote market development of energy efficient, low carbon refrigeration and cooling systems
- Develop and conduct training programs for officials and practitioners of public and private institutions in the development of MEPs and labelling for RAC equipment.
- Develop awareness programmes for Importers, Sales Professionals, and Consumers in order for consumers to make better more informed choices on equipment and designing buildings/homes
- Develop and conduct training programs for bank officers and other financiers on life-cycle costs, financial risk analysis, the cost-benefit analysis for RAC replacement initiatives/projects.
- Develop an amendment to existing RAC occupational standards to include low-GWP, EE technologies, and refrigerant safety into the RAC training curriculum and certification schemes nationwide.
- Develop and conduct training for the servicing sector on installation, operation, safety considerations, and maintenance of energy efficient, low-GWP, and flammable refrigerant-based equipment.
- Develop and conduct training for the servicing sector on best practices of installation, commissioning and maintenance to achieve energy efficient operation of RAC equipment.

5.3.1 Outreach and Communications

Outreach and communications are also vital to the success of the NCSTT.

To this end, the GORTT in collaboration with relevant stakeholders shall:

- a) Develop a communication and outreach Strategy
- b) Prepare industry, retailers and the servicing sector for compliance (MEPS, labelling, EE targets, etc.) through outreach and communication channels
- c) Develop consumer awareness programmes promoting and reinforcing the need to hire only certified technicians
- d) Develop campaigns to educate the public on the labels and the benefits of using EE RAC technologies
- e) Implement a Demand Side Management Communication Programme with the aid of the Trinidad and Tobago Electricity Commission (T&TEC) and RIC is a strategy that can be implemented to bring awareness, understanding, and appreciation of the use of thermostat features to local consumers.
- f) Encourage and incentivize the purchase of Computerized Building Automation Systems in large commercial buildings which can offset the impacts of energy wastage and refrigerant emissions by facilities staff or private ESCOs coordinating the control over many A/C systems to cycle at alternating times or adjust thermostat temperatures daily for the most efficient energy use.
- g) Ensure that consumers are educated on the energy benefits of high-efficiency equipment, which may exhibit initial purchase cost but saves on operating costs (less electricity and maintenance costs) in the long term.
- h) Promote outreach activities to improve understanding of the use and implementation of the EER/SEER metric found on the specification sheets as MEPS to inform the decision of purchasing energy efficient A/C systems by local consumers.
- i) Ensure that the demand side communication Strategy is concurrent with the phase-out of ozone-depleting and high GWP refrigerants.

Regional Collaboration

Harmonizing MEPS among countries with similar usage and energy cost conditions across the same product categories can help with verification and compliance. Harmonized measurement standards facilitate the work of market surveillance authorities because only one test is required and used across different markets, hence avoiding test duplication. Harmonization also relieves nations from the burden of developing new standards and allows them to leverage existing resources from other countries. It increases the comparability of products among regions and the transparency of the market.

To this end, the GORTT in collaboration with relevant stakeholders shall:

- Harness opportunities for regional collaboration
- Develop strategies for regional collaboration and recognition of MEPS and labelling systems.
- Promote the adoption of an agreement between CARICOM nations requiring individual nations to phase down domestic usage of high-GWP refrigerants and low-efficiency equipment, to curb regional demand and thus modify the supply chain for RAC technologies.
- Develop a mechanism for collaboration with neighbouring countries on data sharing, mutual recognition of product testing results, market monitoring, and training

5.4 MARKET MONITORING, VERIFICATION, AND ENFORCEMENT

The development of data collection and analysis mechanisms for market monitoring, verification, and enforcement are essential to the success of the NCSTT. These mechanisms should include the information needed to evaluate performance over time, energy savings, compliance with the relevant regulations and levels of equipment sales as this is essential to the monitoring and evaluation of the effectiveness of activities conducted. Data collected can also be used to incorporate EE into HCFC phase-out and HFC phase-down planning. These activities will also help to assess opportunities, identify mechanisms, inform prioritization of sectors and interventions, and develop strategies and roadmaps.

To this end, the GORTT in collaboration with relevant stakeholders shall,

- Identify required data sets and sources of data for monitoring, verification, and enforcement activities (import data, inventory of RAC equipment, etc.).
- Establish a medium for national data collection (collection channels and repository to make data accessible to policy/decision makers).
- Facilitate data collection and analysis: Definition of national testing and certification procedures, training inspectors, monitoring proper labelling, and coordination on enforcement.
- Ensure harmonization of the NCSTT with the Nationally Determined Contributions under the United Nations Framework Convention on Climate Change (UNFCCC) and the Sustainable Development Goals (SDGs)
- Develop and implement a Refrigeration and Air-conditioning Information System (RACIS) as the repository for information on all the NCSTT initiatives and information on the sector.
- Develop an overarching mechanism for the monitoring and reporting on each sub-project under the NCSTT

6 IMPLEMENTATION OF NCSTT

For effective roll-out of the NCSTT, stakeholders would need to effectively engage and mobilize to aide in the execution of the various initiatives.

6.1 STAKEHOLDER GROUPS

Considering the many key stakeholders that may have a direct or indirect effect on its success, the NCSTT takes an inclusive and collaborate approach; thereby ensuring that the concerns of all actors in the RAC and energy landscape are represented. The NCSTT establishes a framework that allows for regular consultation with stakeholders from government agencies, education, non-governmental organisations, service companies, and industry associations ensuring that their respective contributions are incorporated into the NCSTT’s implementation. These actions will promote consultation and collaboration between the stakeholders and enhance the communication and consensus building through the organization of formal groups, workshops, and forums, coordinated through the Environmental Policy and Planning Division (EPPD) of the Ministry of Planning and Development (MPD), in collaboration with the United Nations Development Programme and other entities. The group of stakeholders identified in Table 8 were engaged from the beginning and formed an integral part of the development of the NCSTT and will continue to be critical stakeholders as the Strategy is executed.

To this end, the GORTT in collaboration with relevant stakeholders shall:

- Create stakeholder awareness groups
- Enhance awareness, capacity building, environmental, and policy development activities of the NCSTT stakeholders.

Table 8: List of Identified main stakeholders

TYPE	STAKEHOLDER	DESCRIPTION
National Government	Environmental Policy and Planning Division (EPPD) of the Ministry of Planning and Development (MPD)	The EPPD of the MPD, as the focal point of the UNFCCC and the Montreal Protocol, is the lead public partner responsible for the development of the NCSTT. It is also responsible for liaison work with the other ministries and public agencies concerning participation and policy development.
	Ministry of Energy and Energy Industries (MEEI)	The MEEI oversees enforcing the country’s energy policy and planning. In this regard, its role in promoting market reform and the introduction of alternative RAC technologies is central to the main objective of the NCSTT through its Renewable Energy Division
	Ministry of Trade and Industry (MTI)	The MTI is a critical stakeholder in the implementation of the Montreal Protocol through the licensing system of refrigerants and refrigeration equipment. It grants import and export permits and as such strictly regulates what can come in and out of the country. MTI will also be integral to the implementation of the identified MEPS.

	Ministry of Communications	The Ministry of Communications is seen as key stakeholder to assist in the awareness, consumer education, communication and outreach of the NCSTT.
	Ministry of Finance	The MOF oversees fiscal appropriations of Government funds for various projects and programmes such as climate change, energy efficiency, and any other related programmes inclusive of those related to the environment. The MOF currently in its legislation is responsible for any tax incentive to be identified and implemented, including tax exemptions and other fiscal measures.
	Ministry of Public Utilities	The MPU is a critical stakeholder as it oversees the agencies involved in electricity generation and distribution in the country
	Ministry of Education	This Ministry is seen as a key stakeholder in ensuring that the training, education and awareness aspects of the Strategy are adequately implemented.
	Ministry of Labour and Small Enterprise Development	The Ministry of Labour and Small Enterprise Development is seen as a key stakeholder as opportunities exist for collaboration with the National Entrepreneurial Development Company Ltd. (NEDCO) and the Occupational Safety and Health Agency (OSHA) which are agencies under this Ministry to execute some of the activities cited with respect to financial support for upgrade of businesses, technical assistance and monitoring.
	Town and Country Planning Division	The TCPD is a critical stakeholders in areas that concern building codes and the approval of building structures and hence would be instrumental in the inclusion of energy efficiency in these areas.
	Trinidad and Tobago Bureau of Standards (TTBS)	The TTBS is a crucial partner to monitor the import of ODS-dependent equipment and national labeling standards for refrigerants. The primary role of TTBS is to develop, promote and enforce energy efficiency standards and to label to improve the quality and performance of RAC technologies used in the country, based on minimum energy performance standards (MEPs) and testing procedures.
	Tobago House of Assembly (THA)	The THA is seen as a key partner to ensure that all initiatives are implemented on the island of Tobago.
Public agencies	Environmental Management Authority (EMA)	EMA is a statutory body established by the Government of Trinidad and Tobago in June 1995 under the Environmental Management Act 1995, which was later repealed and re-enacted as the Environmental Management Act Chapter 35:05. The role of EMA is to provide guidance and surveillance for compliance with national environmental regulation and the development of national environmental standards and criteria.

	Solid Waste Management Authority (SWMCOL)	The Trinidad and Tobago Solid Waste Management Company Limited (SWMCOL) is a wholly-owned state enterprise and is responsible for the design and implementation of solid and hazardous waste management systems and structures, and landfill management of three landfills in the country. SWMCOL is seen as a key stakeholder to assist in waste disposal of RAC equipment.
	Trinidad and Tobago Electricity Commission (T&TEC)	The T&TEC is the single power utility servicing the entire country and the largest utility in the whole of the English-speaking Caribbean. T&TEC is seen as a key stakeholder for the sustainable management of the demand side supporting the change in the existing paradigm for appropriate RAC technologies and business models for electricity end-users.
	Regulated Industries Commission (RIC)	RIC monitors public sector services (water, wastewater, and electricity) and represents the interests of consumers. RIC will participate by setting up appropriate tariffs for upcoming cutting-edge technologies and services.
Industry Associations / Non-profit Organisation	Air Conditioning and Refrigeration Association (ARIA)	ARIA is a membership Association primarily made up of companies, professionals, and students from the RAC sector of Trinidad and Tobago and its associates. As an Industry Association (Civil Society Organization), ARIA supports all initiatives under the Montreal Protocol for in-country capacity building activities. ARIA plays a vital role within the sector directly through the association and through its long-established training center ARIA Technical Institute (ATI), which serves both public and private interests.
	Refrigerant Recovery Recycle Association (RRRA)	RRRA is a non-profit organization formed to encourage and support all stakeholders involved in the protection of the Ozone Layer and reduce Global Warming. The RRRA will be able to assist in the development of mechanisms aimed at recovery, recycling, and final disposal of refrigerants in a sustainable manner.
Academic / Training Institutions	School of Refrigeration and Air-conditioning (SORAC)	The School of Refrigeration and Air-conditioning (SORAC) is a private institution formed in 1993 with its focus being the training of Refrigeration & Air Conditioning (RAC) Technicians at the craft level. The institute provides theoretical & practical training and is responsible for training over one thousand artisans in this field. Since this institute has twenty-five years' experience in the educational field, they would be a welcomed partner for the development of the capacity building activities of the NCSTT.
	University of Trinidad and Tobago (UTT)	The UTT is a state-owned university established in 2004. There are several campuses located throughout the country with a diverse range of disciplines taught. The UTT through its <i>Couva Point Lisas</i> Campus (also known as the energy campus), engages in research and development in renewable energy and energy

		efficiency and would be a key player in identifying suitable EE technologies to be utilized in Trinidad and Tobago
--	--	--

6.2 NCSTT IMPLEMENTATION AND OVERSIGHT

The implementation of the projects under the NCSTT shall be managed by a Cabinet appointed Committee over its ten (10) year implementation period. These initiatives can follow the timeline as identified in the project timeline diagram below.

NCPTT Timeline



Figure 6: NCSTT Implementation timeline

The dynamic nature of the RAC sector requires the NCSTT to be continuously reviewed to adjust to changes in technology and the industry catalysed by shifts in both the local and international environments. The NCSTT takes into consideration the components needed for Trinidad and Tobago to chart a sustainable cooling path based on information that's currently available. This may change as new challenges arise, and new information/data becomes available. The NCSTT would, therefore, be reviewed on a biennial basis to ensure that it remains relevant and to make necessary amendments.

The cooling Strategy integrates current activity into a synergistic pathway for sustainable cooling. The Government of the Republic of Trinidad and Tobago hopes to realize the resulting energy cost savings and pollution reduction benefits by encouraging the use of high-efficiency, low-GWP equipment through market-transformation programs that include standards, labelling, procurement, performance assurance requirements for imports, and incentive programs. This integrated strategy replaces current refrigerants with climate-friendly alternatives while simultaneously improving the equipment's energy efficiency and could double the climate benefits from the HFC phasedown alone, while also supporting development through enhanced energy security, reduced energy costs to the government and consumers.

Once Trinidad and Tobago stay the course concerning the execution of the identified initiatives outlined in this cooling Strategy coupled with monitoring and continuous improvement to cater for changes in the internal and external environments the country can reap all the benefits identified and further contribute to a globally sustainable cooling future.

7 REFERENCES

- CEIC Data (SG) Pte Ltd. (2018, October 10). Retrieved from Trinidad and Tobago Motor Vehicle Registered 2015 - 2019: <https://www.ceicdata.com/en/indicator/trinidad-and-tobago/motor-vehicle-registered>
- Commission, R. I. (2017). *Review of the Status of the Trinidad and Tobago Electricity Commission 2010-2015*. Port of Spain: Regulated Industries Commission.
- CSO. (2018, May). *Home: Central Statistical Office - Latest Indicators*. Retrieved from Central Statistical Office: <http://cso.gov.tt/>
- EC. (2019, January 7). *Fluorinated greenhouse gases*. Retrieved from European Commission: https://ec.europa.eu/clima/policies/f-gas_en
- EPA. (2016, September 27). *Basic Information of Air Emissions Factors and Quantification*. Retrieved from EPA: <https://www.epa.gov/air-emissions-factors-and-quantification/basic-information-air-emissions-factors-and-quantification>
- Form, G.-6. P. (2017). <https://www.thegef.org>. (UNDP) Retrieved 2019, from Gef-6 Project Identification Form (pif). Retrieved from https://www.thegef.org/sites/default/files/project_documents/PIF_for_resubmissio.
- GORTT. (2011). *National Climate Change Policy*. Port of Spain.
- GORTT. (2015). *Strategy for Reduction of Carbon Emissions in Trinidad and Tobago*. Retrieved from Ministry of Strategyning and Development: https://www.Strategyning.gov.tt/sites/default/files/CRS%20_Strategy_Final.pdf
- GORTT. (2016). *Ministry of Strategyning and Development*. Retrieved from Vision 2030: The National Development Strategy of Trinidad and Tobago: <https://www.Strategyning.gov.tt/sites/default/files/Vision%202030-%20The%20National%20Development%20Strategy%20of%20Trinidad%20and%20Tobago%202016-2030.pdf>
- GORTT. (2017). *Review of the Economy: Changing the Paradigm, Putting the Economy on a Sustainable Path*. Port of Spain: Government of the Republic of Trinidad and Tobago.
- GORTT. (2017). *Ozone Depleting Substances Alternative Survey Report*. Port of Spain: Government of the Republic of Trinidad and Tobago.
- GORTT, M. o. (2018, February). *Government Ratifies Paris Agreement*. Retrieved from Ministry of Strategyning and Development Website: <https://www.Strategyning.gov.tt/content/government-ratifies-paris-agreement>
- Government of the Republic of Trinidad and Tobago. (2011). *National Climate Change Policy*. Port of Spain.
- Humpert, M., & Ramon, E. (2016). *Energy Dossier: Trinidad and Tobago*. Interamerican Development Bank.
- IPCC. (2013). *The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. The United Kingdom and New York, NY, USA: Cambridge University Press, Cambridge

- James, S., & James, C. (2010). The food cold-chain and climate change. *Food Research International*, 43(7), 1944-1956. Retrieved 1 22, 2019, from <https://sciencedirect.com/science/article/pii/S0963996910000566>
- Kashav, S. &. (2018). Food Cold Chain Management: From A Structured Literature Review to A Conceptual Framework and Research Agenda. *The International Journal of Logistics Management*, 792 - 821.
- Loy, D., Klein, J., Casado Cañeque, F., & Marzolf, N. C. (2015). *A Unique Approach for Sustainable Energy in Trinidad and Tobago*. Interamerican Development Bank.
- MEEI. (2011, January 1). *Renewable Energy and Energy Efficiency Fiscal Incentives*. Retrieved from Ministry of Energy and Energy Industries: <http://www.energy.gov.tt/our-business/alternative-energy/renewable-energy-and-energy-efficiency-fiscal-incentives/>
- Melville, S., (2017). SUSTAINABLE POLICY AND ADMINISTRATION IN TRINIDAD. St. Augustine, Trinidad, and Tobago.
- McMahon, J., and Buskirk, R. (2019). *Standards and Labels: Transforming the Market for Energy Efficient Appliances*
- NOU. (2014, September 16th). *National Ozone Unit World Ozone Day 2014 Message*. Retrieved from National Ozone Unit Blog: <http://nou-tt.blogspot.com/search?q=Article+V>
- NOU. (2017). *Ozone Depleting Substances Alternative Survey Report*. Port of Spain.
- NOU. (2018, September 14). *Global Environment Facility Project to encourage low carbon technologies in the Refrigeration and Air Conditioning (RAC) Sector*. Retrieved from Trinidad and Tobago National Ozone Unit Blog: <http://nou-tt.blogspot.com/2018/09/global-environment-favity.html>
- OAS. (2011). *National Climate Change Policy”, Government of the Republic of Trinidad and Tobago*. Retrieved from Organisation of American States - OAS: [http://www.oas.org/en/sedi/dsd/Biodiversity/Sustainable_Cities/Sustainable_Communities/Events/SC%20Course%20Trinidad%202014/ModuleIII/Climate%20Change%20Policy%20FINAL%20doc%20\(1\).pdf](http://www.oas.org/en/sedi/dsd/Biodiversity/Sustainable_Cities/Sustainable_Communities/Events/SC%20Course%20Trinidad%202014/ModuleIII/Climate%20Change%20Policy%20FINAL%20doc%20(1).pdf)
- OBG. (2019). *Oxford Business Group*. Retrieved from Trinidad and Tobago targeting reduced food imports: <https://oxfordbusinessgroup.com/analysis/aiming-revival-targeting-reduction-costly-food-imports-and-bolstering-development-agricultural>
- OECD. (2017). *Complexity, Observatory for Economic*. Retrieved from What does Trinidad and Tobago import? (2017): https://atlas.media.mit.edu/en/visualize/tree_map/hs92/import/tto/all/show/2017/
- Peters, P. T., (2018, April 19). *A Cool World: the energy conundrum we are not discussing*. Retrieved from The University of Birmingham: <https://www.birmingham.ac.uk/news/thebirminghambrief/items/2018/04/a-cool-world-the-energy-conundrum-we-are-not-discussing.aspx>
- Suxin Qian, D. N. (2016). Not-in-kind cooling technologies: A quantitative. *International journal of refrigeration* 62, 177-192.
- Tim Herzog, J. P. (2005). Navigating the Numbers: Greenhouse Gas Data and International Climate Policy. *World Resource Institute Publication*, 22.
- UNDP. (2011). *Project Proposal: Trinidad And Tobago HCFC Phase-out Management Strategy*. Montreal: United Nations Environmental Programme.