TECHNOLOGY NEEDS ASSESSMENT

# TRINIDAD AND TOBAGO

## Identification and Prioritization of Technologies for Mitigation

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TNA Report

Trinidad and Tobago

Identification and Prioritization of Technologies for Mitigation

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## List of Acronyms

| | |
|---|---|
| BAU | Business as usual |
| BAT | Best Available Technology |
| CEC | Certificate of Environmental Clearance |
| CRS | Carbon Reduction Strategy |
| EMA | Environment Management Authority |
| GCM | General Circulation Models |
| GDP | Gross domestic product |
| GEF | Global Environment Facility |
| GHG | Greenhouse gas |
| GORTT | Government of the republic of Trinidad and Tobago |
| ICZM | Integrated coastal zone management |
| IDB | Inter-American Development Bank |
| ITCZ | Intertropical Convergence Zone |
| LECB | Low emission capacity building |
| MCA | Multi-Criteria Analysis |
| MEEI | Ministry of Energy and Energy Industries |
| MOWT | Ministry of Works and Transport |
| MTI | Ministry of Trade and Industry |
| MPD | Ministry of Planning and Development |
| NDC | Nationally determined contributions |
| NDCIP | Nationally determined contributions Implementation Plan |
| NGO | Non-Governmental Organisations |
| RCM | Regional Climate Models |
| SIDS | Small island developing states |
| SLR | Sea level rise |
| TAP | Technology Action Plan |
| TNA | Technology Needs Assessment |
| TNC | Third National Communication |
| T&TEC | Trinidad and Tobago Electricity Commission |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNESCAP | United Nations Economic and Social Commission for Asia and the Pacific |
| VCA | Vulnerability and Capacity Assessment |

## Executive Summary

The technology needs assessment (TNA) for mitigation is contained in this report. The approach to the TNA was focused on the country's Nationally Determined Contribution (NDC) and its Implementation Plan (NDC IP) under the Paris Agreement as an area of priority implementation. Accordingly, the TNA is focused on the three sectors addressed in the NDC and the NDC IP, that is, the power generation, industry, and transport sectors, as these sectors were identified as the most important where technological interventions are needed for the development opportunities in line with the establishment of carbon reduction and mitigation strategies, the imperative to achieve the NDC objectives as well as those in the National Climate Change Policy which includes the pursuance of a low carbon development trajectory. The TNA was therefore designed to fulfil both the NDC achievement as well as national development policy objectives.

The TNA therefore drew heavily on the substantive work already completed in developing the national Carbon Reduction Strategy (CRS), the NDC (which was derived from the CRS), and the NDC IP, which involved multicriteria analysis (MCA) and extensive stakeholder consultation to identify mitigation intervention options for the three sectors. The MCA included consideration of emissions reduction potential, and cost/benefit analysis of the identified mitigation measures and associated potential technologies. Stakeholders were consulted on a factsheet of the identified technologies and the MCA used.

The results of the MCA prioritised technologies in the listed order for the three sectors as follows:

Electricity generation:

- Energy Audit and Efficiency improvements of the Supply Side,
- Designing and Implementing utility scale Solar RE.

Industry:

- Renewable sources of fuel,
- Carbon capture storage and use.

Transportation:

- ICT for intelligent traffic management systems,
- Electric vehicles (EV)
- Hybrid electric vehicles (HEV).

The prioritised technologies were selected to be considered in the next step of the TNA, the barrier analysis and enabling framework.

# 1. Introduction

## 1.1 About the TNA

The Government of Trinidad and Tobago through the Ministry of Planning and Development joined a multi-country project entitled "Technology Needs Assessment (TNA) - Phase III" in collaboration with the United Nations Environment Programme (UNEP) and Danish Technical University (UNEP/DTU) Partnership with funding from the Global Environment Facility (GEF) and with technical support from the University of the West Indies (Mona) acting as the TNA Regional Centre for the Caribbean. The project intends to provide targeted financial and technical support to assist participating developing countries to carry out Technology Needs Assessments (TNAs) and develop national Technology Action Plans (TAPs) for prioritized technologies.

The Government of the Republic of Trinidad and Tobago has ratified the Paris Agreement, and the project aims to assist in implementing technologies to reduce greenhouse gas emissions in line with the country's Nationally Determined Contribution (NDC), support adaptation to climate change, and more importantly inform national development plans and contribute to sustainable development objectives. The TNA is therefore designed to address national development issues towards achievement of the National Climate Change Policy (NCCP) and pursuing a low carbon development pathway. The technology needs assessment focused on the industry, power generation and transport sectors as the NDC sectors, and will support the execution of the NDC Implementation Plan (NDC IP). Additionally, it will support Trinidad and Tobago in further defining the national technology barriers for the prioritised sectors and technologies and developing technology action plans (TAPs) to overcome these barriers for both adaptation and mitigation. These TAPs will then facilitate countries' efforts to access funding for implementation of these strategies (UNEP DTU 2014).

## 1.2 Existing national policies on climate change mitigation and development priorities

Table 1.2 provides an overview of the national policy and legislative context to support the TNA process and outcomes in keeping with the intention of the TNA priorities, particularly in respect of the NCCP.

Table 1.2 Existing national policies on climate change mitigation and development priorities

| ***Policy/Legislation Provision*** | **Relevance to technological innovation, adaptation to climate change and development priorities** |
|---|---|
| *National Climate Change Policy (2011)* | The Ministry of Planning and Development is the responsible ministry for developing and coordinating the implementation of the National Climate Change Policy. The Policy lists the broad objectives and strategies for climate change mitigation including renewable energy (RE), clean technologies, and research and development (R&D) In 2019, the Government initiated an updating of the Policy to incorporate provisions of the Paris Agreement, including NDC implementation. |
| *Nationally Determined Contributions and Implementation Plan (NDC IP)* | The NDC IP identified technologies and areas for three (3) sectors: power generation, industry and transportation. |
| *Carbon Reduction Strategy (CRS)* | The CRS was developed in 2015 with cost/benefit analyses of identified and recommended mitigation measures for the power generation, transport and industry sectors, based on a business-as-usual (BAU) baseline emissions projection to 2040. The NDC is based on and was derived from the CRS.<br><br>In 2020, the BAU baseline was updated to 2050 and forms part of the country's Long Term Strategy (LTS). |
| *Environmental Management Act* | The Environmental Management Act (2000) mandates the establishment of programmes to manage the environment including air pollution. It authorises the Minister responsible for the environment to make Rules (subsidiary legislation), including those related to air pollution, to give legislative support to the Authority's programmes. |
| *Certificate of Environmental Clearance (CEC) Rules* | The Certificate of Environmental Clearance (CEC) Rules (2001) under the Environmental Management Act (2000) provides for mitigating potential negative environmental impacts associated with any designated activity (e.g., the release of air pollutants such as carbon dioxide and other GHGs). |
| *National Environmental Policy* | The National Environment Policy (2018) includes provisions for climate change mitigation and adaptation. |
| *Air Pollution Rules (APR)* | The Air Pollution Rules (APR) (2014) provides for the regulation of air pollution in Trinidad and Tobago, and classifies GHGs as an air pollutant. |
| *Miscellaneous Taxes Act (Green Fund Levy)* | The Miscellaneous Taxes Act (2000) Chapter 77:01 Part XIV established a national environmental fund (Green Fund Levy), to finance environmental projects to eligible entities. The Green Fund is capitalised by a 0.3% tax on gross sales of receipts of companies doing business in Trinidad and Tobago and is payable quarterly. |
| *Finance Act* | The Finance Act No.13 (2010) includes fiscal incentives to promote renewable energy and energy efficiency. |

| ***Policy/Legislation Provision*** | **Relevance to technological innovation, adaptation to climate change and development priorities** |
|---|---|
| *Draft National Spatial Development Strategy* | The Ministry of Planning and Development is the ministry responsible for the Draft National Spatial Development Strategy which was developed in 2014. The draft strategy outlines the national development and spatial planning up to 2033 for Trinidad and Tobago. |
| *Trinidad and Tobago Electricity Commission (T&TEC) Act* | The Trinidad and Tobago Electricity Commission (T&TEC) Act (1945) identifies that T&TEC is legally authorised to generate electricity under the T&TEC Act, Chap. 54:70. All independent power producers (IPPs) must be licensed by T&TEC. |
| *Regulated Industries Commission (RIC) Act* | The Regulated Industries Commission (RIC) falls under the purview of the Ministry of Public Utilities. The RIC Act was established in 1998 and regulates the power generation sector. The RIC is mandated to perform certain regulatory functions for service providers of public utilities and for the licensing of service providers. |
| *Renewable Energy Policy Framework* | The Renewable Energy Policy Framework identifies barriers, policy objectives and strategies for renewable energy (RE) implementation and directly impacts both the industry and power generation sectors in Trinidad and Tobago. |
| *Renewable Energy Target* | A renewable energy target of 10% in the national energy mix by 2021. |
| *Feed-in Tariff (FIT) Policy* | A Feed-In Tariff (FIT) Policy is being developed by the Ministry of Energy and Energy Industries. The draft policy develops a framework for policy and legislation to govern Feed-In tariffs for renewable energy feed into the national grid. |
| *ESCO Certification Committee* | The Ministry of Energy and Energy Industries has established an ESCO Certification Committee in 2016. It has produced draft recommendations which outline certification criteria for energy services companies (ESCOs) in Trinidad and Tobago in order to operationalise the fiscal incentives of the Finance Act No. 13 of 2010. |
| *Petroleum Act* | The Petroleum Act (1969) provides for any licensee "to take care that gas is not liberated in such manner as to cause pollution of the surrounding air and to prevent all waste". This section can be used to control the flaring of natural gas. |
| *National Transport Plan (NTP)* | Established in 1967, the National Transport Plan outlines strategy for development of road networks and was scheduled for complete revision by 1986. |
| *Motor Vehicle and Road Traffic Act* | The Motor Vehicle and Road Traffic Act (2010) identifies the rules and regulations for licensing and owning a vehicle. There is also an amendment to the Act which includes a fine for visible emissions from vehicle. GHG emissions are however not explicitly included in the Act, although there is potential for its inclusion. |

## 1.3 Sector selection

Trinidad and Tobago's NDC commits to a 15% reduction in cumulative greenhouse gas (GHG) emissions in the industry, power generation, and transportation sectors relative to a business-as-usual baseline by 2030. The sectors targeted in the NDC were prioritised for the TNA given the need to achieve its objectives as well as through previous stakeholder consultations which developed the Carbon Reduction Strategy from which the NDC was derived. A substantive amount of work had already been done therefore, and the TNA would now advance the process of NDC implementation as well as laying the technology pathway for a low carbon development trajectory consistent with the objectives of the NCCP. The NDC IP outlines the actions necessary for achieving the NDC target. A recent review of the mitigation measures in the NDC IP (2020, unpublished) provided updated figures for the sectors and which were used in the TNA.

Recent estimates (2018) indicate that total emissions projections for Trinidad and Tobago can increase between 6 and 30% to 2050 based on various socio-economic business-as-usual scenarios (GoRTT, 2019). In these estimates, the industry, power generation and transportation sectors accounted for approximately 60.5 %, 12.2 %, and 5.6% of the total GHG emissions respectively.

## 1.4 An overview of sectors, projected climate change, and GHG emissions status and trends of the different sectors

### *1.4.1 Electrical power generation*

In Trinidad and Tobago, natural gas is used for electrical power generation, and was introduced in 1953 as a cleaner and more economical fuel, and therefore is already at the cleaner end of fossil fuel type. However, a mix of combined and simple cycle turbines for power generation creates some space for increased efficiency, but more importantly, the next step for reducing emissions from this sector lies in the deployment of renewable energy sources, coupled with consumption efficiency. It is estimated for an optimistic economic growth scenario under a business-as-usual (BAU) trajectory projection, that GHG emissions for the power generation sector could grow to as much as 28% from 2018 levels up to 2050(NDC, IP 2020).

The power generation sector is a monopoly in Trinidad and Tobago and involves a single transmission and distribution network operator. The sector has limited renewable energy experience regarding utility scale generation of electricity. There are also separate government ministries tasked with the responsibility for power generation, transmission and distribution. There are limited renewable energy resource options (limited to solar and wind but potential for ocean-based energy), limited land available for renewable energy and limited data available for applicable renewable energy studies. Additionally, there are weak fiscal support mechanisms for energy conservation or alternative cleaner energy sources.

The enabling environment for renewable energy needs significant work as the existing policy and legislative framework, although being amended, is inadequate. Current subsidies on both fuel and electricity further hinder the uptake of renewables. Trinidad and Tobago currently has the second lowest electricity rates after Suriname in the English-speaking Caribbean.

Current legislation does not permit generating electricity outside of the existing monopolistic arrangements. However, efforts are underway, and significant progress is being made, towards developing demand-side management initiatives, a feed-in tariff policy framework for renewable energy, and amendment of the legislation to encourage and enable power generation through renewable sources.

### *1.4.2 Industry*

Industry refers to heavy industry which includes petroleum exploration and production, pipeline operation, natural gas processing, refining, iron and steel processing, LNG production, cement manufacture and petrochemical production.

It is estimated for an optimistic economic growth scenario under a business-as-usual (BAU) projection trajectory that GHG emissions for the industry sector could grow to as much as 21% from 2018 levels up to 2050 (NDC, IP 2020). The majority of the GHG emissions of the industrial sector are caused by fossil fuel combustion sources, although process-based emissions such as nitrous oxide from nitric acid production and carbon dioxide from ammonia production also contribute. Not only is the industry sector the largest contribution to the GHG emissions, but this situation is also not expected to change significantly through 2050, according to the results of the projections model.

The energy sector is one of the most important sectors in T&T. It amounts to 45.3% of national GDP (2011), provides almost 60% of government revenue, and is the most important export commodity with 83% of merchandise exports, mainly refined oil products, liquefied natural gas (LNG), and natural gas liquids (IDB, 2013). T&T is the main exporter of oil in the Caribbean, as well as the main producer of LNG in Latin America and the Caribbean (IDB 2018).

### *1.4.3 Transport*

Domestic transport in Trinidad and Tobago includes sea, land and air travel. The current transport system evolved as a consequence of the fuel-subsidy policies of the country and has resulted in a large number of privately-owned cars due to the unattractiveness, inadequacy and inefficiency of existing public transport systems to meet the needs of the population. The fuel subsidy is carded to be eliminated in Jan 2021.

The transport sector is the main consumer of the 20% of local consumption of the daily oil production (IDB, 2013). The transport sector contributed 5.6% of total GHG emissions in 2018 (GORTT). It is estimated for an optimistic economic growth scenario under a business-as-usual (BAU) trajectory that GHG emissions for transport could grow to as much as 144% from 2018 figures up to 2050 (NDC, IP 2020).

# 2. Institutional arrangement for the TNA and the stakeholder involvement

## 2.1 The National TNA team

The National TNA team consisted of the contracted consultants along with staff from the Ministry of Planning and Development (National Coordinator). This team was responsible for the coordination of the National TNA Advisory Committee, which had representation from a wide cross section of agencies and ministries which hold responsibility for the sectors identified in the TNA process. The TNA Advisory Committee comprised of representatives of the following organisations:

1. Council of Presidents for the Environment (Cope) (Non-governmental Organisation)
2. The University of the West Indies (UWI)
3. The University of Trinidad and Tobago (UTT)
4. The Environmental Management Authority (EMA)
5. The Institute of Marine Affairs
6. The Energy Chamber of Trinidad and Tobago
7. Water Resources Agency
8. The Water and Sewerage Authority of Trinidad and Tobago (WASA)
9. The Office of Disaster Preparedness and Management (ODPM)
10. Trinidad and Tobago Meteorological Services (TTMS)
11. The Office of the Prime Minister
12. Ministry of Agriculture Land and Fisheries
13. Ministry of Energy and Energy Industries
14. Ministry of Finance
15. Ministry of Planning and Development
16. Ministry of Public Utilities
17. Ministry of Rural Development
18. Ministry of Tourism
19. Ministry of Works and Transport

## 2.2 Stakeholder Engagement Process followed in the TNA – Overall assessment

Given the fairly advanced state of development of analysing mitigation measures for the sectors addressed in the NDC, including cost/benefit analyses, emissions projections, and potential technological approaches already identified in the NDC IP, a decision was taken to focus on these sectors for conducting the TNA. Accordingly, and building on the work already done, the TNA approach initially involved identifying potential technologies through a literature review of the relevant country implementation plans for the reduction of GHG emissions including the CRS, the NDC and NDC IP, and upon which a technology factsheet was developed (Annex I). Based upon this, a MCA was developed along the lines adopted in the CRS and NDC (including cost/benefit, mitigation potential, socio-economic issues) and applied to the identified technologies. A draft report was generated, and consultations on this report were conducted with key stakeholders.

The stakeholders consulted during the development of the background documents (CRS, NDC, NDC IP) were identified as important having been already involved in the process and familiar with the mitigation issues, such as the MCA, identified mitigation measures, and applicable technologies. Some of these stakeholders are also included on the TNA Advisory Committee. Stakeholders were invited to comment and give feedback on the first draft of the TNA Report for Mitigation as well as identify potential barriers and the enabling framework for the next step of the TNA. This approach was taken as stakeholders for the climate mitigation process in Trinidad and Tobago are consistently engaged and are key collaborators for the implementation of all mitigation work. There is therefore a fairly well-developed awareness and engagement of stakeholders for mitigation issues.

### 2.3 Consideration of Gender Aspects in the TNA process

The key actions identified from the TNA gender guidebook include identifying policy areas that potentially affect men and women in different ways for the implementation of each technology. Consultations with men's and women's organisations can highlight key policy issues for further analysis, collect gender-disaggregated data and gender information related to these key areas identified, conduct gender analysis to determine differentiated outcomes or impacts for men and women of proposed policy areas, design policy which incorporates actions to address these differentiated outcomes and impacts so that inequality is not perpetuated, and ensure that institutional mechanisms for the implementation and monitoring of policy actions include women and women's NGOs in decision-making bodies.

An Action Plan for Mainstreaming Gender in the Climate Change Sector and NDC Implementation in Trinidad and Tobago has been developed and was therefore translated into the TNA process. In the TNA process, the inclusion of women in decision making as well as identification and scoring of the related technologies was made a priority with eight of the seventeen agencies being represented by women on the stakeholder committee.

# 3. Technology prioritisation for Electrical Power Generation

## 3.1 GHG emissions and existing technologies of Electrical Power Generation

The power generation sector contributed 60.5% of total GHG emissions in 2018 (GORTT). It is estimated for an optimistic economic growth scenario under a business-as-usual (BAU) trajectory, that GHG emissions for the power generation sector could grow to as much as 28% from 2018 figures up to 2050.

Current electricity power generation is done using natural gas as feedstock and a combination of simple and combined cycle gas turbines. Substituting these simple turbines with combined-cycle plants could improve efficiency up to 45% (IDB 2015). Coupled with the implementation of energy efficiency measure for buildings and industrial processes, this would mean a reduced demand for electricity and reduction in the related gas consumption, reducing the direct and indirect GHG emissions.

Electricity in Trinidad and Tobago is generated by Power Generation Company of Trinidad and Tobago (Powergen), Trinidad Generation Unlimited (TGU) and Trinity Power Limited. Powergen currently operates two plants at Point Lisas (763 MW single cycle with co-generation being currently considered) and Penal (234 MW combined cycle). TGU is a combined cycle plant (720 MW) and Trinity Power utilises single cycle generation turbines (22MW) (TGU 2020).

The current low tariffs on electricity subsidies make the price of electricity one of the lowest in the LAC region and is a major barrier to the uptake of energy efficient measures for both domestic and commercial consumers and furthermore make the use of PV and other RE technology uncompetitive (ICAO 2019)

## 3.2 Decision context for electrical power generation

### *3.2.1 An overview of selected mitigation technology options in Electrical Power Generation and their mitigation potential and other co-benefits*

The prioritisation of technologies was carried out through the use of a MCA for the TNA process. The information for the technologies listing and the relevant criteria were taken directly from both the NDC IP, and the CRS. Given that Trinidad and Tobago already uses natural gas, the cleanest fossil fuel for power generation, mitigation technology options are narrow and potential mainly lies in efficient generation and consumption, and renewable energy.

There are several mitigation measures and technologies for Trinidad and Tobago for reducing GHG emissions in the Electrical Power Generation sector. The conversion of existing single-cycle to combined-cycle gas turbines (CCGT) power plants - a combined use of sets of components: combustor of gas, gas turbine, heat recovery boiler, steam turbine - was once envisioned to be a technology of choice for the energy efficiency improvements in power generation is already underway.

The identified technologies, taking into account that there is already conversion to combined cycle gas turbine technology in power generation, were guided by the mitigation analysis conducted under the CRS (2016) and NDC IP (2020), and the short list of technologies chosen to perform a multi-criteria analysis are listed below in Table 3.2 (in no order of rank):

Table 3.2 List of technologies chosen for MCA for electrical power generation

| Technology | $CO_2$ Mitigation potential |
|---|---|
| Energy Audit and Efficiency improvements of the Supply Side | Energy audit and updating of the generating plants and generation dispatch algorithms. |
| Cooperative renewable energy (RE) (Solar) | This would encourage RE participation by a wider economic cross section and Solar RE generation on a small scale. |
| Utility Scale Renewable (Solar) Energy | Gradual replacement of fossil-based power generation by solar plants as the old fossil plants are retired, and the natural gas reserves are depleted. |
| Solar powered water treatment plants | If solar panels are installed, there would be cost reductions even considering the payback period. Additionally, use of these solar panels would improve the country's resilience in case of a natural disaster. |

## 3.3 Criteria and process of technology prioritisation for Electrical Power Generation

The Electricity Power Generation Sector is a single operator transmission and distribution network, and it is therefore important to evaluate on the basis of reduction in emissions for mitigation. It was also identified that the benefit/cost ratio, perceived importance and urgency, job creation, and generation of economic activity were also important in evaluating measures to reduce $CO_2$ emissions in any sector that generates economic activity for the country (CRS 2015). The calculated level of $CO_2$ emissions identified in the NDC IP was used as a baseline for the technology prioritisation using the MCA approach.

The carbon emissions reduction was calculated by comparing the emissions associated with the generation of electricity through renewable sources, compared with the purchase of the same amount of electricity from the network using natural gas as the feedstock. The results of the prioritisation MCA is shown in Table 3.4. The top two technologies were moved forward to the Barrier and Analysis and Enabling Framework (BAEF) stage.

### 3.4 Results of technology prioritisation for Electrical Power Generation

Table 3.4 List of prioritised technologies after MCA

| Technology Name | Criterion | | | | | | | Rank |
|---|---|---|---|---|---|---|---|---|
| | Environment/ $CO_2$ reduction | | Cost Effectiveness | | Overall Evaluation of Importance | | | |
| | 40% | | 30% | | 30% | | 100% | |
| | Mitigation potential - Total $CO_2$ Avoided (figures NDCIP 2020 review) in $tCO_2e$ | Normalised Score | Cost Efficiency (figures from NDCIP 2020 review) | Normalised Score | Importance (figures from NDCIP 2020 review) | Normalised Score | Final Weighting | |
| Energy Audit and Efficiency improvements of the Supply Side | 751,915.80 | 75.69 | -23 | 100.00 | 3.6 | 100 | 90.28 | 1st |
| Designing and Implementing utility scale Solar RE | 986,876.10 | 100.00 | 57.2 | 0.00 | 3.5 | 90 | 67.00 | 2nd |
| Cooperative Solar RE | 27,723.00 | 0.77 | 33.7 | 29.30 | 2.7 | 10 | 12.10 | 3rd |
| Solar power water treatment plants | 20,247.90 | 0.00 | 35.7 | 26.81 | 2.6 | 0 | 8.04 | 4th |

Normalised Score=100 *(score-Xmin)/(Xmax-Xmin) were 100=most desirable score and 0=least desirable score

# 4. Technology prioritisation for Industry Sector

Trinidad and Tobago has a significant industrial sector. Crude oil and natural gas are consumed in large quantities in several industry sub-sectors as fuel and feedstock for export products. Most recent statistics show that the Petroleum Sector accounted for an estimated 40.2% of the national GDP and 38.7% of Government revenues in 2012. For the purpose of this study, industry refers to heavy industry which includes petroleum exploration and production, pipeline operations, natural gas processing, refining, iron and steel processing, LNG production, cement manufacture, and petrochemical production. Electricity generation and distribution is treated under the Power Generation Sector. Light manufacturing, which refers to economic activities related to food and beverages and printing and packaging, is not included.

## 4.1 GHG emissions and existing technologies of Industry Sector

In 2011 the commercial and industrial sector accounted for approximately two thirds of the country's energy consumption (CRS 2015). The industry sector in Trinidad and Tobago accounted for the highest GHG emissions from 1990 to 2018, with a contribution of 60.5% total $CO_2$ eq. emissions in 2018. It is estimated for an optimistic economic growth scenario under a business-as-usual (BAU) trajectory that GHG emissions for the industry sector could grow to as much as 21% from 2018 figures up to 2050. The majority of the GHG emissions of the industrial sector are caused by fossil fuel combustion sources. Not only is the industry sector the largest contribution to the GHG emissions, but furthermore, this situation is not expected to change through 2050 according to the results of the projection models.

The vast industrial landscape of Trinidad and Tobago provides numerous opportunities for reduced GHG emissions through the use of renewable technology, improvements in energy efficiency of plants and equipment and even adjustments in processes. Specific assessments therefore are required to determine what are the best available technologies and actions needed to improve the efficiency and reduce the GHG emissions.

The manufacturing plants in the industrial sector consume the largest quantity of energy in Trinidad and Tobago and the most effective reductions can be achieved through reducing the energy consumption of these facilities. Process-based greenhouse gas emissions, particularly nitrous oxide emissions from nitric acid production was also identified for mitigation action given its large global warming potential.

Concerning fugitive and vented emissions, these are directly related to the production of natural gas and oil. In order to reduce their impact, measures must be oriented towards monitoring these leaks so that they can be rectified and at seeking alternatives for recapture and reusing them.

## 4.2 Decision context for Industry Sector

### *4.2.1 An overview of selected mitigation technology options in the Industry Sector and their mitigation potential and other co-benefits*

The prioritisation of technologies was carried out using a multi criteria analysis for the TNA process. The information for the technologies listing and the relevant criteria were taken directly from both the NDC IP (as well as the unpublished review), and the CRS. The technologies chosen for MCA are listed in Table 4.2.

Table 4.2 List of technologies for Industry chosen for MCA (in no order of rank).

| Technology | $CO_2$ Mitigation potential |
|---|---|
| Biofuels | The reduction of emissions in this measure is based on the substitution of natural gas by biofuels. It is estimated that 10% of natural gas consumption can be replaced by alternative fuels by 2050. |
| Captured Carbon | The available potential could reduce emissions generated by the industrial sector by 10% under a trend scenario. |
| Blue and green hydrogen | It is estimated that 10% of natural gas consumption can be replaced by alternative fuels by 2050. |
| $NO_x$ Abatement technologies | Plant retrofit for lower process emissions and reduction in emissions from venting. |

## 4.3 Criteria and process of technology prioritisation for Industry

The criteria used to evaluate the technologies for the industry sector included GHG emissions reduction potential (taken from the projected emissions reductions calculated for the NDC IP), benefit/cost ratio, perceived importance and urgency, job creation, and generation of economic activity. The results of the MCA are shown in Table 4.4. The top two technologies were moved forward to the Barrier and Analysis and Enabling Framework (BAEF) stage.

### 4.4 Results of technology prioritisation for Industry

Table 4.4 List of prioritised technologies after MCA.

| Technology Name | Criteria | | | | | | | Rank |
|---|---|---|---|---|---|---|---|---|
| | Environment/ $CO_2$ reduction | | Cost Effectiveness | | Overall Importance | | | |
| | 30% | | 40% | | 30% | | 100% | |
| | Mitigation potential - Total CO2 Avoided (figures from NDC IP) $tCO_2e$ | Normalised Score | Cost Efficiency (figures from NDC IP) | Normalised Score | Importance (figures from NDC IP) | Normalised Score | Final Weighting | |
| Captured Carbon | 44573060.00 | 100.00 | 59.5 | 51.52 | 3.3 | 88 | 76.86 | 1st |
| Biofuels | 1107884.20 | 0.0000 | -4.4 | 100.00 | 3.4 | 100 | 70.00 | 2nd |
| Blue and green hydrogen | 1108960.40 | 0.0025 | 127.4 | 0.00 | 2.9 | 38 | 11.25 | 4th |
| $NO_x$ Abatement technologies | 1745407.00 | 1.4667 | 1.36 | 95.63 | 2.6 | 0 | 38.69 | 3rd |

Normalised Score=100 *(score-Xmin)/(Xmax-Xmin) were 100=most desirable score and 0=least desirable score

# 5. Technology Prioritisation for Transport Sector

## 5.1 GHG emissions and existing technologies of Transport Sector

Trinidad and Tobago's transport sector comprises three components: sea, land and air, and is a major contributor to greenhouse gas emissions. The transport sector is the main consumer of the 20% of local consumption of the daily oil production (IDB, 2013). The transport sector contributed 5.6% of total GHG emissions in 2018 (GORTT). It is estimated for an optimistic economic growth scenario under a business-as-usual (BAU) trajectory that GHG emissions for transport could grow to as much as 144% from 2018 figures up to 2050.

The availability of historical data on GHG emissions of the transport sector in Trinidad and Tobago is limited, and there are several data gaps that make it difficult to obtain a comprehensive and coherent picture of the historical evolution of the transport sector's emissions. The total number of vehicles registered grew by 4.8 % for the period January to July 2019, when compared to the same period in 2018 (CBTT 2019). The number of private motor vehicles registered for January to July was 10,876 and represented a 5.3% increase from the previous year (CBTT 2019).

The exiting fuel subsidy is scheduled to be eliminated in Jan 2021. The uptake of CNG which was offered as a transition technology towards hybrid and electric vehicles, has been slowly increasing. EV and hybrid vehicles are subsidised and available as both new and imported used. There also needs to be development of infrastructure to power as well as service these types of vehicles. It is also important to note however, the use of electricity from fossil fuels to power an electric or hybrid vehicle still accounts for indirect GHG emissions, although there are policy indications that ideally the country intends to move to emissions-free transport through electric vehicles charged by renewable energy.

## 5.2 Decision context for the Transport Sector

The transport sector accounted for 5.6 % of the GHG emissions for 2018 and technologies were chosen that accounted for the reduced GHG emissions from the primary road-based factors like miles travelled, type of fuel and operational efficiency of vehicle. While there is already an aggressive drive for fuel-switching to compressed natural gas, and which is being progressively deployed, the global trend towards phasing out internal combustion engines has been taken into account. The list of technologies chosen for MCA is shown in Table 5.2 (in no order of rank).

### *5.2.1 An overview of possible mitigation technology options in Transport Sector and their mitigation potential and other co-benefits*

Table 5.2 List of technologies chosen for the Transport sector to perform multi-criteria analysis

| Technology Name | $CO_2$ Mitigation potential |
|---|---|
| Electric Vehicles (EVs) and Hybrid Electric and Gasoline vehicles (HEV) | Introduction of EV and HEV for public transport vehicles including buses and maxi taxis; Reduction in consumption of fossil fuels and CO2 emissions. |
| Biogas for marine navigation | Use of alternative fuel for marine navigation and other systems on ships in order to reduce the overall CO emissions associated with the use of fossil fuels. |
| Information Communication Technology (ICT) | Promote of ICT technologies to avoid the need to travel, red light coordination and traffic management systems to reduce traffic and increase traffic coordination. |
| Vehicle emissions monitoring systems | Establish vehicle registration fees and taxes to control vehicle emissions and promote efficient vehicles with lower fossil fuel consumption. |

### 5.3 Criteria and process of technology prioritisation for Transport Sector

The criteria for the technology prioritisation of the Transport Sector were taken from figures found in the CRS as a preliminary weighting. The process involved weighting each of the 6 identified technologies based on quantity of $CO_2$ reduced, perceived importance and urgency, job creation, and generation of economic activity.

The environmental impact in the form of amount of $CO_2$ reduction was weighted as 40%, the benefit cost analysis was weighted at 30% and the overall importance as 30% which included the generation of jobs, economic activity and perceived importance of the technology. The results of the MCA are shown in Table 5.4. The top three technologies were moved forward to the Barrier and Analysis and Enabling Framework (BAEF) stage. These were Information Communication Technology (ICT), electric vehicles (EV) and hybrid electric vehicles (HEV). HEV and EV were scored and rated together but will be treated separately in the BAEF stage.

## 5.4 Results of technology prioritisation for the Transport Sector after Multi-Criteria Analysis

Table 5.4 technology prioritisation for the Transport Sector after Multi-Criteria Analysis

| Technology Name | Criteria | | | | | | | Rank |
|---|---|---|---|---|---|---|---|---|
| | Environment/ $CO_2$ Reduction | | Cost Effectiveness | | Overall Evaluation | | 100% | |
| | 40% | | 30% | | 30% | | | |
| | Mitigation potential - Total $CO_2$ Avoided (figures from CRS) $tCO_2e$ | Normalised Score | Cost Efficiency (figures from CRS) | Normalised Score | Importance (figures from CRS) | Normalised Score | Final Weighting | |
| Information Communication Technology (ICT) | 2281050.00 | 100.00 | -151.90 | 28.39 | 51 | 100 | 78.52 | 1st |
| EV and HEV | 668969.00 | 5.19 | -791.41 | 100.00 | 42 | 67 | 52.08 | 2nd & 3rd |
| Vehicle emissions monitoring systems | 580743.00 | 0.00 | 101.63 | 0.00 | 48 | 89 | 26.67 | 4th |
| Biogas for marine navigation | 780777.00 | 11.76 | 60.01 | 4.66 | 24 | 0 | 6.10 | 5th |

Normalised Score=100 *(score-Xmin)/(Xmax-Xmin) were 100=most desirable score and 0=least desirable score

# 6. Summary and Conclusions

## 6.1 Final list of technologies chosen to move to BAEF

The list of prioritised technologies for the three sectors, electrical power generation, industry and transport will enable Trinidad and Tobago to implement mitigation measures in the sectors where the $CO_2$-eq emissions are the largest. The top two technologies for each sector will be used for the next step of the TNA Process, the Barrier Analysis and Enabling Framework. These technologies are as follows:

| Technology Name | Rank |
|---|---|
| **Electrical Power Generation** | |
| Energy Audit and Efficiency improvements of the Supply Side | 1st |
| Designing and Implementing utility scale Solar RE | 2nd |
| **Industry** | |
| Captured Carbon | 1st |
| Biofuels | 2nd |
| **Transport** | |
| Information Communication Technology (ICT) for intelligent traffic management systems | 1st |
| Introduction of Electric and Hybrid Electric Vehicles, EV and HEV for both public transport and private vehicles | 2nd & 3rd |

## 7. List of References


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# 8. Annex I Technology Factsheets for selected technologies

## 8.1 Electrical Power Generation

| **Energy Audit and Efficiency improvements of the Supply Side** | |
|---|---|
| Supply side management refers to optimizing the efficiency of Electric Power Generation, Transmission and Distribution. Proper Supply side management involves energy audit and updating generating plant and generation dispatch algorithms, plant and equipment. | |
| Timeframe | Short 2-5 years |
| Required implementation | 1. Establishment of multi-stakeholder audit and research team<br>2. Identifying power management issues and solutions<br>3. Implement and updating plant, equipment and management of utility |
| Mitigation Potential | This measure is aimed at designing models/programs that help to optimize the energy consumption of the industry and therefore to improve its energy efficiency by reducing consumption and related emissions. Since energy industries are large consumers of energy, the study estimates that an annual reduction of 1% of total demand could be obtained (10-15MW).<br><br>Accumulated: 751,916 $tCO_2e$<br>Annual average: 50,128 $tCO_2e$. |
| Relevant agencies | TTEC, MEEI |
| Barriers | Lack of installed technology to measure generator performance required for optimization studies |
| Advantages/opportunities/Co-benefits | -Low cost if done in conjunction with local universities<br>- Opportunities for innovation.<br>- Better prepared professionals.<br>- Jobs formation.<br>- Increase of energy efficiency.<br>- Air quality improvement that implies health benefits and less public health costs |

| **Cooperative Renewable Energy** | |
|---|---|
| Solar Cooperative Renewable Energy for small to medium scale renewable energy installations with private investment from localized communities. This would allow Renewable Energy participation by a wider economic cross-section. Facilities would be metered and used to compensate shareholders. | |
| Timeframe | Greater than 10 years |
| Required implementation | 1. Feasibility studies (including business structure and potential sites)<br>2. Establishment of coordinating body or government company to oversee deployment<br>3. Development of Pilot sites<br>4. Nationwide expansion of program |
| Mitigation Potential | Directly reduces GHGs by reducing fossil fuel generation.<br>The reduction of emissions is due to the use of renewable energy with an emission factor of 0 compared to a trend consumption of the same coming from the electrical system. Therefore, to calculate the reduction through this measure, the emissions associated with the generation of electricity through renewable energies are compared with the purchase of the same amount of electricity from the network, assuming the EF of the country's electricity mix (if this system were not available, what associated emissions this purchase of electricity would have). The study considers the installation of 200kW per year over the period analysed.<br><br>Accumulated: 27,723 $tCO_2e$<br>Annual average: 1,848 $tCO_2e$. |
| Relevant agencies | MPU, MEEI, MPD, TTEC, RIC, AGLA |
| Barriers | Lack of policies governing RE and feed in tariffs |
| Advantages/opportunities/Co-benefits | - Allows a wider section of society to participate.<br>- Opportunities for innovation.<br>- Increase of energy efficiency.<br>- Air quality improvement that implies health benefits and less public health costs. |
| Synergies and/or trade-off with adaptation | Builds climate and disaster resilience in communities. |
| Synergies and/or trade-off with other development aspects | Aids in creating new jobs for RE technicians |

| **Utility Scale Renewable Energy** | |
|---|---|
| Designing and Implementing utility scale RE Installations with appropriate storage capabilities. This would allow Utility Scale RE Power generation to replace fossil-based power generation gradually, as the old fossil plants are retired, and the natural gas reserves are depleted. | |
| | |
| Timeframe | Greater than 10 years |
| Required implementation | 1. Feasibility studies (technical and economic)<br>2. RFPs<br>3. PPAs with IPPs<br>4. Installation of RE facilities |
| Mitigation Potential | The reduction of emissions is due to the use of renewable energy with with an emission factor of 0 compared to a trend consumption of the same coming from the electrical system. Therefore, to calculate the reduction through this measure, the emissions associated with the generation of electricity through renewable energies are compared with the purchase of the same amount of electricity from the network,assuming the EF of the country's electricity mix (if this system were not available, what associated emissions this purchase of electricity would have). The study considers additional installed capacity of 100MW of renewables by 2050.<br><br>Accumulated: 986,876 $tCO_2e$<br>Annual average: 65,792 $tCO_2e$. |
| Relevant agencies | MPU, TTEC, RIC, MEEI |
| Barriers | -Cost of implementation<br>-Low rates of Electricity using conventional generation<br>-Lack of legislative and policy frameworks.<br>-Compromised grid security and stability with increasing penetration of RE |
| Advantages/opportunities/Co-benefits | - Directly reduces GHG emissions by replacing fossil fuel generation.<br>- Increase of general knowledge.<br>- Opportunities for innovation.<br>- Increased energy security<br>- Air quality improvement that implies health benefits and less public health costs.<br>- Increased Energy Security |
| Synergies and/or trade-off | Increased climate resilience |

| **Solar power for water treatment plants** | |
|---|---|
| Use of solar power for water treatment plants e.g. use of floating solar panels in dams/reservoirs | |
| Timeframe | 1-5 years |
| Required implementation | Prepare Feasibility Study<br>Project Proposal Approval, Tender process, Contract with Private entity to supply, install and operate<br>Purchase panels - Install panels - Provide feedback on effectiveness and efficiency of panels in use |
| Mitigation Potential | The reduction of emissions is due to the use of renewable energy with an emission factor of 0 compared to a trend consumption of the same coming from the electrical system. Therefore, to calculate the reduction through this measure, the emissions associated with the generation of electricity through panels are compared with the purchase of the same amount of electricity from the network, assuming the EF of the country's electricity mix (if this system were not available, what associated emissions this purchase of electricity would have). The study considers additional installed capacity of 1MW which covers an area of about 5 acres.<br>Accumulated: 20.248 $tCO_2e$<br>Annual average: 1.350 $tCO_2e$. |
| Relevant agencies | WASA T&TEC Ministry of Public Utilities, MEEI, Ministry of Trade and Industry - Customs and Excise Division, desalination plants, Ministry of Energy and Energy Industries. |
| Barriers | - Capital cost<br>- The cost of traditional energy (fossil fuel) is subsidized by the GORTT therefore making it substantially cheaper than renewable energy<br>- Available Surface Area<br>- Political will,<br>- Vision to transition and invest in alternative energy supply.<br>- Security of panels |
| Advantages/opportunities/Co-benefits | - This would allow the water company to reduce their costs over time and thus enable them to focus on other areas such as access for all to potable water. It would also aid in GHG reduction targets of the company. -Saving large areas of land. -Job creation. -Reduce evaporation from water reservoirs, as the solar panels provide shade and limit the evaporative effects of wind. -Improve water quality, through decreased algae growth. -Reduce or elimination of the shading of panels by their surroundings. -Eliminate the need for major site preparation, such as levelling or the laying of foundations, which must be done for land-based installations. -The same solar energy they produce can be used for the operation of ventilators and devices that allow water to circulate in order to oxygenate it and keep it in good condition, |

| | |
|---|---|
| | which leads to less use of chemicals and obviously less maintenance. |
| Synergies and/or trade-off | This would form part of the country's response to disasters such as hurricanes or floods. It is also linked to the country's commitment to GHG reductions. |

Reference NDC, IP 2020

## 8.2 Industry

| **Biogas as a Renewable Source of Fuel** | |
|---|---|
| | |
| Timeframe | 5 to 10 years |
| Required implementation | 1. Feasibility studies (Renewable Fuel Production potential vs importation)<br>2. If RE Technology is feasible, the power generation sector is open for RFPs for new power generation.<br>3. Tendering and contractor selection<br>4. Phased implementation continuing as required |
| Mitigation Potential | The reduction of emissions in this measure is based on the substitution of natural gas by biofuels. It is estimated that 10% of natural gas consumption can be replaced by alternative fuels by 2050. Therefore, in the case of biogas (considering that there will be a mix with more biofuels), 5% of consumption can be reached in 2050 (Replacement of 3,194 TJ of natural gas per year).<br><br>Accumulated 1,107,884 tCO2e<br>Annual average: 73,859 tCO2e. |
| Relevant agencies | AGLA, MEEI, MPU MPaD |
| Barriers | - Natural Gas Subsidy<br>- Political Inertia<br>- Availability of Renewable fuels in enough quantities |
| Advantages/opportunities/Co-benefits | - Since Renewable fuels are chemically identical to their fossil fuel counterparts no change in operation process is necessary.<br>- Opportunities for innovation.<br>- Air quality improvement that implies health benefits and less public health costs.<br>- Jobs formation. |
| Synergies and/or trade-off | New industry in the production of biofuels is possible which would create employment |

| **Captured Carbon** | |
|---|---|
| Development of downstream industries to make use of captured carbon so that it is feasible for industries to implement carbon capture technologies which would otherwise not be economically feasible. | |
| Timeframe | 5 to 10 years |
| Required implementation | 1.Establish task force to determine feasibility of downstream captured carbon industries and detail plans for industry development.<br>2. If feasible: RFPs, Tendering and contractor selection<br>3. Implementation on a phased basis in the long term |
| Mitigation Potential | Emission reductions are estimated based on carbon capture potential. The reduction of emissions is associated with carbon capture technologies. The study considers that the available potential could reduce emissions generated by the industrial sector by 10% under a trend scenario.<br><br>Accumulated 44,573,060 $tCO_2e$<br>Annual average: 2,971,537 $tCO_2e$. |
| Relevant agencies | MEEI, MPaD, Energy Chamber, Industry stakeholders |
| Barriers | - Cost and recovery costs<br>- Lack of financial incentives<br>- Possible long term liability risks<br>- Lack of current regulatory framework for CCS |
| Advantages/opportunities/Co-benefits | - Opportunity for creation of new industries and jobs.<br>- Air quality improvement that implies health benefits and less public health costs. |
| Synergies and/or trade-off | - Opportunity for creation of new industries and jobs |

| **Hydrogen for e-fuel** | |
|---|---|
| Production of blue and green hydrogen for e-fuel conversion for industrial, power generation and transportation. | |
| Timeframe | 5 to 10 years |
| Required implementation | - Establish task force for determining feasibility of blue and green hydrogen programs and detail plans for development<br>- If feasible: RFPs, Tendering and contractor selection<br>- Implementation on a phased basis in the long term |
| Mitigation Potential | The reduction of emissions in this measure is based on the substitution of natural gas by biofuels. It is estimated that 10% of natural gas consumption can be replaced by alternative fuels by 2050. Therefore, in the case of hydrogen (considering that there will be a mix with more biofuels), 5% of consumption can be reached in 2050 (Replacement of 3,194 TJ of natural gas per year). The study considered the replacement of natural gas with green hydrogen , to which no GHG emissions are associated.<br>Accumulated 1,107,884 $tCO_2e$<br>Annual average: 73,859 $tCO_2e$. |
| Relevant agencies | MEEI, MPD, Energy Chamber, Industry stakeholders |
| Barriers | - Cost of hydrogen production, storage and distribution<br>- Competing low cost of fossil fuels |
| Advantages/opportunities/Co-benefits | - Opportunity for creation of new industries and jobs.<br>- Air quality improvement that implies health benefits and less public health costs. |
| Synergies and/or trade-off | - Opportunity for creation of new industries and jobs |

| **$NO_x$ Abatement technologies in the Industrial Sector** | |
|---|---|
| Plant retrofit for lower process emissions and reduction in emissions from venting and flue gas particularly in high temperature manufacturing processes, plastic and cement manufacturing | |
| Timeframe | 1-5 years |
| Required implementation | - Feasibility study on relevant industrial manufacturers<br>- Phased implementation in manufacturing process |
| Mitigation Potential | Accumulated Average of 1,745,407 $tCO_2e$ |
| Relevant agencies | MEEI, MPD, Energy Chamber, Industry stakeholders |
| Barriers | - Capital Cost<br>- Lack of financial incentives or policy regulatory requirements<br>- Low cost of energy limiting incentives for improving manufacturing processes |
| Advantages/opportunities/Co-benefits | - Opportunity for creation of new industries and jobs.<br>- Air quality improvement that implies health benefits and less public health costs. |
| Synergies and/or trade-off | - Capacity building for increased process efficiency |

Reference NDC, IP 2020

## 8.3 Transport

| **Electric vehicles (EVs) and Hybrid electric vehicles (HEV)** | |
|---|---|
| Introduction of battery electric vehicles and hybrid electric vehicles for use in both public transport, buses, and cars. | |
| Timeframe | 1-5 years |
| Required implementation | - Feasibility study on relevant industrial manufacturers<br>- Phased implementation in manufacturing process |
| Mitigation Potential | Accumulated Average of 1,745,407 $tCO_2e$ |
| Relevant agencies | MEEI, MPD, PTSC |
| Barriers | - Capital Cost<br>- Lack of financial incentives or policy regulatory requirements<br>- Low cost of gasoline limiting uptake of technologies |
| Advantages/opportunities/Co-benefits | - Air quality improvement that implies health benefits and less public health costs.<br>- More reliable public transport system<br>- Job Creation |
| Synergies and/or trade-off | - Capacity building<br>- More efficient public transport |
| **Biogas for marine navigation** | |
| Use of alternative fuel for marine navigation and other systems on ships in order to reduce the overall CO emissions associated with the use of fossil fuels | |
| Timeframe | 10 to 20 years |
| Required implementation | Define a program of activities for the assessment of the viability of using alternative fuels in the navigation sector.<br>Develop plan for implementing the use of biofuels in navigation based on the results of the assessment of the viability.<br>Modification of legislation to include the roadmap for the use of alternative fuels in the navigation sector. |
| Mitigation Potential | - Reduction in the amount of fossil fuels require for the movement of ferries and marine public transport |
| Relevant agencies | - MOWT, MEEI, MPD |
| Barriers | - Resistance to uptake of technology in private settings<br>- Long term implementation is dependent on legislative change and implementation (Long term) |
| Advantages/opportunities/Co-benefits | - More efficient marine navigation systems |
| Synergies and/or trade-off | - Efficiency improvements onboard ships |
| **Information Communication Technology (ICT) for integration and networking of land transport system for intelligent traffic management systems** | |
| Promote of ICT technologies to avoid the need to travel, red light coordination and traffic management systems to reduce traffic and increase traffic coordination. Electric transponders or license plate system or similar technology. | |
| Timeframe | 5-10 years |

| | |
|---|---|
| Required implementation | - Installation of relevant hardware at street lights and stop signals for the monitoring and coordination of traffic<br>- Develop relevant policies and legislation<br>- Setting up traffic management branch software and capacity building |
| Mitigation Potential | - Reduction in carbon emissions associated with high traffic routes, in Trinidad and Tobago the capital city centre is the no. 1 transport location due to the high concentration of businesses and offices |
| Relevant agencies | - MOWT, MPD |
| Barriers | - Lack of legislative and policy framework<br>- High cost of infrastructure and training |
| Advantages/opportunities/Co-benefits | - Opportunities for decentralisation of government agencies from the capital city and innovative work arrangements to reduce traffic/emissions<br>- Correspondingly reducing the need/pressure for increased road capacity and reducing emission levels, energy use and other environmental impacts<br>- More reliable public transport system<br>- Job Creation |
| Synergies and/or trade-off | - Better coordination of services to respond to accidents and emergencies |

| **Vehicle emissions monitoring systems. Soft technologies required for implementation of vehicle emissions standards** | |
|---|---|
| Vehicle emissions monitoring systems. Establish vehicle registration fees and taxes to control vehicle emissions and promote efficient vehicles with lower fossil fuel consumption | |
| Timeframe | 5-10 years |
| Required implementation | - Legislative and policy framework<br>- Build capacity in vehicle registration and licensing authorities, including training and software installation |
| Mitigation Potential | - Reduction in carbon emissions associated with older less well-maintained vehicles |
| Relevant agencies | MOWT, MPD |
| Barriers | - Lack of legislative and policy framework<br>- High cost of infrastructure and training<br>- Enforcement, lack of incentives |
| Advantages/opportunities/Co-benefits | - Opportunities for the implementation of EV and HEV<br>- Systematic approach to vehicle registration and ongoing vehicle monitoring after registration<br>- More reliable public transport system<br>- Job Creation |
| Synergies and/or trade-off | - Minimum safety operating requirements for on road vehicles |

Reference NDC, IP 2020

# 9. Annex II List of stakeholders consulted for Mitigation TNA

1. Atlantic LNG
2. BP Trinidad and Tobago
3. Desalination Company of Trinidad and Tobago (DESALCOTT), Limited
4. Environmental Management Authority (EMA)
5. Factor Ideas Integral Services
6. General Electric
7. Heritage Petroleum
8. Institute of Marine Affairs (IMA)
9. Inter-American Institute for Cooperation on Agriculture (IICA)
10. Mayaro/Rio Claro Regional Corporation
11. Methanex Trinidad Limited
12. Ministry of Agriculture, Land and Fisheries
13. Ministry of Education
14. Ministry of Energy and Energy Industries
15. Ministry of Health
16. Ministry of Planning and Development
17. Ministry of Public Utilities
18. Ministry of Rural Development and Local Government
19. Ministry of Tourism
20. Ministry of Works and Transport
21. National Infrastructure Development Company (NIDCO)
22. Nucor Corporation/Nu-Iron Unlimited
23. Office of Disaster Preparedness and Management
24. Office of Prime Minister, Government of Trinidad and Tobago
25. Port of Spain City Corporation
26. Point Lisas Nitrogen Limited
27. Princess Town Regional Corporation
28. PROMAN//Methanol Holdings Trinidad Limited (MHTL)
29. Public Transport Service Company (PTSC)
30. Shell Trinidad and Tobago Limited
31. South West Regional Health Authority (SWRHA)
32. Trinidad and Tobago Civil Aviation Authority
33. Trinidad and Tobago Solid Waste Management Company (SWMCOL)
34. Trinidad Cement Limited, TCL Group
35. The Tobago House of Assembly (THA)
36. The University of the West Indies
37. Trinidad and Tobago Airport Authority
38. Trinidad Generation Unlimited (TGU)
39. University of Trinidad and Tobago (UTT)
40. Water and Sewerage Authority (WASA)
41. Yara Trinidad Limited