TRINIDAD AND TOBAGO

POLICY OPTIONS *for* REDUCING GREENHOUSE GAS EMISSIONS IN THE OIL, GAS AND PETROCHEMICAL INDUSTRY

IDB

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Acronyms

BOD – Biological Oxygen Demand
CAC – Command and Control
CCS – Carbon Capture and Storage
CDP - Carbon Disclosure Project
CEC – Certificate of Environmental Clearance
CH_4 – Methane
CHP – Combined Heat and Power
CO_2 – Carbon Dioxide
COD – Chemical Oxygen Demand
COP – Conference of the Parties
DI&M - Directed Inspection & Maintenance
EC – European Commission
EIA - Environmental Impact Assessment
EMA – Environmental Management Authority
ETS – Emissions Trading System
FiT - Feed-in-tariffs
FVA – Framework for Various Approaches
GBP – Great British Pound
GDP – Gross Domestic Product
GHG – Greenhouse gas
GMI - Global Methane Initiative
GORTT – Government of the Republic of Trinidad and Tobago
GWP – Global Warming Potential
HAP - Hazardous Air Pollutants
ICAP – International Carbon Action Partnership
IDB – Inter-American Development Bank
LNG ´- Liquefied Natural Gas
M - Million
MAC – Marginal Abatement Cost
MBI – Market Based Instrument
MEEA – Ministry of Energy and Energy Affairs
MEWR – Ministry of Environment and Water Resources
MFE – Ministry of Finance and the Economy
MPL - maximum permissible limits
MRV – Measurement, Reporting and Verification
MWh – Megawatt hour
NAMA – Nationally Appropriate Mitigation Action
NCCP - National Climate Change Policy
NMM – New Market Mechanism
NPV – Net Present Value
O&G – Oil and Gas
O, G&P – Oils, Gas and Petrochemical
OECD - Organisation for Economic Co-operation and Development
PoA - Program of Activities
R&D – Research and Development
R,D&D – Research, Development and Demonstration
RE – Renewable Energy
SCS – Sectoral Crediting System
SECCI - Sustainable Energy and Climate Change Initiative
SIDS – Small Island Developing States
SWOT – Strengths, Weaknesses, Opportunities and Threats
tCO_2e – tonnes of carbon dioxide equivalent
ToR – Terms of Reference
TT – Trinidad and Tobago
UK – United Kingdom
UNDP – United Nations Development Programme
UNFCCC – United Nations Framework Convention on Climate Change
USD – United States Dollar
VOC – Volatile Organic Compounds
WEEE - Waste from Electrical and Electronic Equipment

1. Executive Summary

Assessment of legal framework and institutional capacity (Section 3.1)

- The key Government institutions overseeing Trinidad and Tobago's (TT) Oil, Gas and Petrochemical (O, G&P) sector include the Ministry of Energy and Energy Affairs and the Ministry of Finance and the Economy. In terms of environmental protection and climate change policy, the Ministry of Environment and Water Resources, the Environmental Management Authority, the Ministry of Energy and Energy Affairs, and the Ministry of Planning and Sustainable Development are relevant institutions to collaborate in the establishment of a policy instrument to limit the sector's GHG emissions.
- TT has signed major international climate change agreements, has developed its National Climate Change Policy and has clear institutional arrangements to limit GHG emissions. In order to establish an effective climate change mitigation instrument in the O, G&P sector, TT could leverage the leadership of the Ministerial Climate Change Committee to establish the new policy instrument, assign clear responsibilities among different institutions and improve the technical capacity of the Environmental Management Authority and the Ministry of Energy and Energy Affairs to continuously gather and annually update the GHG emissions database already compiled from 1990-2012 by the GORTT project titled "The Elaboration of a Strategy for the Reduction of Carbon Emissions in Trinidad & Tobago, 2040".
- A plan should be developed to improve communication with relevant stakeholders and secure national and international sources of finance to effectively implement the proposed policy instrument.

GHG emissions profile and options to reduce GHG emissions (Section 3.2)

- TT's O, G&P emits more than 50 $MtCO_2e$ annually. The main GHG contributors are: the ammonia sector (21 million) | the methanol sector (13 million) | the iron and steel sector (7 million) | electricity generation sector (6 million) | upstream oil and LNG (4 million)
- These sectors present different carbon intensity profiles, including 4.12 tCO_2 per ton of ammonia produced, 2.32 tCO_2e per ton of methanol produced, or 0.61 tCO_2 per MWh produced. The potential economic impacts will depend on the carbon price resulting from the GHG policy instrument, but an average price of 10 USD/tCO_2e would result in an overall carbon cost of 500 M USD for the O, G&P sector.
- The economic analysis has identified five (5) measures with high GHG emission reduction potential: (a) implementation of energy audits in LNG and methanol plants; (b) improvement in the use of heat; (c) revamping of ammonia plants; (d) reduction of venting and flaring emissions; and (e) improved power generation technology.
- A preliminary marginal abatement cost study has been undertaken to assess the sector's GHG emission reduction potential. If adopted early, these measures would have the cumulative potential to reduce GHG emissions by almost 53 $MtCO_2e$ by the year 2030. More than half of the GHG reductions would be achieved by the implementation of measures identified from energy audits in LNG and methanol plants (24 $MtCO_2e$), followed by reduced venting and flaring of CH_4 (13 $MtCO_2e$) and revamping of ammonia plants (almost 10 $MtCO_2e$).
- TT would be able to reduce the aforesaid GHG emissions at an average cost of USD 10.84 per tCO_2e. GHG emission reductions at ammonia plants may be achieved at negative costs (-9.84 USD/tCO_2e), while GHG emission reductions resulting from energy audits may be achieved at moderate costs (5.45 USD/tCO_2e).
- The investment needs required to meet those GHG emission reduction targets amounts to 1,540 M USD.

Policy Instruments to reduce GHG emissions in the Oil and Gas Sector (Section 4.1)

- TT can use different market and non-market based policy instruments to reduce GHG emissions in its O, G&P sector. Five (5) policy instruments have been identified and assessed: sectoral crediting mechanisms, a cap and trade system, a carbon tax, regulatory instruments and voluntary agreements.
- On one hand, non-market based instruments which are the traditional way to address pollution, for example, regulatory instruments for environmental protection have enabled the necessary framework to protect the environment and reduce emissions in many countries. When implemented correctly, they provide effective improvements and help companies understand the importance of reducing pollution. With voluntary agreements, improvements can be made at a lower cost but usually the effectiveness is not so easy to verify and it is a controversial topic in the literature. On the other hand, market based instruments provide theoretically a more cost-effective approach. All companies are encouraged to reduce until marginal abatement costs are equal to the charge or price of emissions. Both price-based and quantity-based instruments reduce pollution with low marginal costs. They also create incentives for technological innovation beyond meeting legal targets. The challenge is how to tackle traditional problems linked with these instruments such as over-allocation, free riding or carbon leakages, especially considering the limited international context. Also, according to the literature, these instruments give better results when operating in a perfect competitive market.

Selection and assessment of critical design elements of policy instruments to reduce GHG emissions in the Oil and Gas sector (Section 4.2)

- The five policy instruments were assessed against different criteria, such as environmental effectiveness, economic efficiency, transaction costs, economic impacts, technical requirements and capacity gaps, compatibility with international systems, and political practicality.
- The assessment of the five policy instruments revealed underlying compromises to be made between environmental effectiveness and other important assessment criteria, such as transaction costs and political practicality. Some instruments like cap and trade and performance-based standards would ensure environmental effectiveness, but at the expense of high transaction costs, higher technical requirements and limited political resistance. Voluntary agreements, on the other hand, would provide reduced environmental effectiveness, and have thus limited compatibility with international standards. From a climate change mitigation policy perspective, voluntary agreements and loose market-based instruments like sectoral crediting or carbon taxes would be more appropriate than cap and trade and performance-based standards to limit GHG emissions in the O, G&P sector.
- Another finding is that establishing a policy instrument to mitigate GHG emissions in TT's O, G&P sector will require a minimum set of technical requirements, including baseline setting and data gathering, development of monitoring, reporting and verification standards, and (in some cases) establishing a carbon registry and transaction log.

Multi-criteria evaluation of GHG emission reduction policy instruments (Section 4.3)

- The GHG emission reduction policy instruments were also assessed against broader assessment criteria, such as co-benefits of GHG emission reduction actions in the O, G&P sector, legal and institutional requirements, donor interest and political barriers to implementation.
- The multi-criteria analysis shows that (a) GHG emission reduction actions yield important co-benefits in terms of reduced local air pollution, and in terms of energy efficiency and security; (b) climate change mitigation policy instruments require adequate legal and institutional arrangements in terms of policy thrust, enforcement of penalties, in some cases regulating trading of carbon units and addressing negative economic impacts; (c) multilateral donors like Multilateral Development Banks and International Organizations prefer market-based instruments; (d) covered entities like multinational industries favor non-market instruments like mandatory GHG reporting, or (to a lesser extent) sectoral crediting and cap and trade schemes, provided that they address economic impacts.
- From a wider policy perspective, climate change mitigation policy options such as sectoral crediting mechanisms and non-market based instruments like voluntary agreements appear to be more appropriate to regulate GHG emissions in the O, G&P of TT.

Design of policy options to reduce GHG emissions in the oil and gas sector (Section 5.1)

- Based on the findings of this assessment, four (4) policy options were designed to reduce GHG emissions in TT's O, G&P sector:
- **A sectoral crediting mechanism based on sector-wide reporting of GHG emission and GHG emission reductions (Option 1).** Under this option, the Government of TT will undertake internationally binding GHG emissions intensity targets for the O, G&P sector and would implement policy measures to achieve such sectoral targets. Attainment of these targets would be documented by implementing internationally agreed measurement, reporting and verification (MRV) procedures. The TT would then decide how to allocate the credits received internationally, which are typically destined to support GHG reduction actions and to incentivize covered entities to undertake them.
- **A sectoral crediting mechanism with installation-level reporting and compliance requirements for individual entities above a GHG emitting threshold (Option 2).** Under this option, all individual installations having GHG emissions above a predefined threshold would be required to submit annual GHG inventories, along with production or output data to enable determination of their carbon emissions intensity. Installations having carbon intensity levels above an agreed upon benchmark would be expected to either pay a carbon tax for the excess emissions, or to offset their excess emissions through the purchase of carbon credits. Alternatively installations with carbon intensity levels below the agreed upon benchmark will receive tradable carbon credits.
- **A carbon tax for installations/GHG emission sources above a GHG emitting threshold (Option 3).** Under a carbon tax option, all individual installations having GHG emissions above a given threshold would be required to submit annual GHG inventories mandated to pay a carbon tax for each ton of carbon dioxide equivalent (tCO_2e) released to the atmosphere.
- **A mandatory reporting regime for individual installations/GHG emission sources above a GHG emitting threshold (Option 4).** Under a mandatory reporting system all individual installations in selected sectors that are emitting above a predefined GHG emission threshold, would be required to submit annual GHG inventories. This option does not require mitigation or offset of emissions but it is essential to the implementation of Options 2 and 3 listed above, and would provide very useful information to build reliable MRV systems under Option 1.

Common design elements (Section 5.2)

- All four designed policy options share a set of common elements, including (a) the preference for carbon-intensity benchmarks and objectives allowing compatibility between economic and development objectives, or (b) the important contribution of GHG emission reduction to reduced local air pollutants and health/welfare improvements, as well as increased energy efficiency and security.

Co-benefit analysis (Section 5.3)

A co-benefit analysis was conducted to measure the contribution of the different policy options to a set of 10 indicators reflecting the economic, social and environmental dimensions of sustainable development (4, 3 and 3 indicators respectively). **For every set of indicators, the co-benefits of individual crediting (Option 2) and the introduction of a carbon tax (Option 3) clearly exceed those to be obtained from a government crediting (Option 1) or mandatory GHG reporting (Option 4).** Interestingly, from the perspective of co-benefits, individual crediting (Option 2) performs slightly better than a carbon tax (Option 3), due to its ability to better influence outcomes at the installation level.

SWOT analysis (Section 5.4)

An analysis of the strengths, weaknesses, opportunities and threats (SWOT) inherent to each instrument has been conducted. **Instruments which are environmentally effective and able to reduce GHG emissions by introducing a carbon price (i.e. an individual crediting system and a carbon tax, Option 1 and Option 2) would face important threats**, such as the opposition from the industry or the need to allocate sufficient authority and resources to the public body responsible to implement the regulation. Importantly, the ability of "paths of least resistance" policy options to transform into more ambitious regimes differs between Government crediting (Option 1) and mandatory GHG reporting (Option 4), with mandatory GHG reporting retaining full flexibility and the ability to transform into subsequent instruments.

Roadmap to mandatory GHG reporting program (Section 6)

Developing a mandatory GHG reporting program provides the necessary basis to proceed to a more ambitious policy scenario compatible with the design and development of the New Market Mechanism (NMM), while still maintaining full flexibility in the design of such a future market-based mechanism. The establishment of such a program would rely on three main building blocks, including:

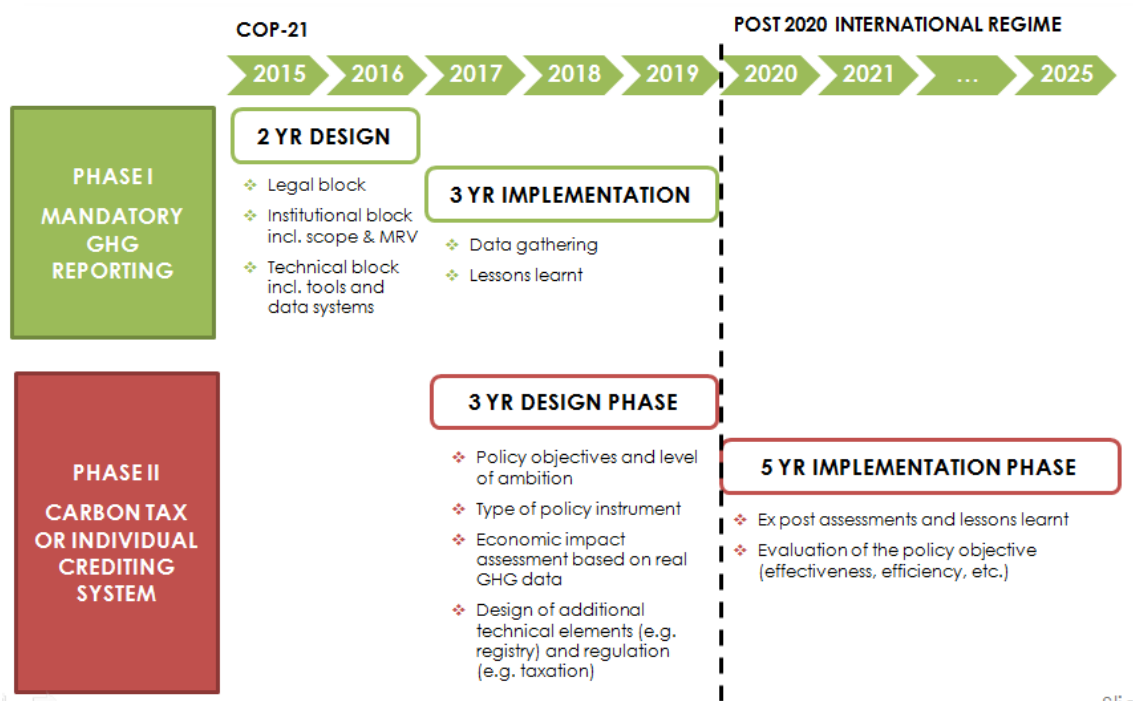
- **Legal and institutional framework,** including assignment of legal compliance responsibilities as well as managing the GHG reporting program;
- **Policy and regulatory implementation,** including descriptions of policy goals, government oversight, installations responsibilities and timeline for data collection;
- **Technical infrastructure,** for both the implementing agency and the reporting installation. This would include knowledge of the industrial sectors covered and their key emitting sources; applicable monitoring and measurement methods; reporting tools; training and outreach for industry to facilitate compliance and modalities for reporting and verification of GHG data.

From the perspective of the individual entities covered by the scheme, a mandatory reporting program will address the reputational risk related to non-disclosure of GHG data. The annual costs of complying with the program will be approximately 20,000 USD per year per installation (2008 prices) and the main benefits will be related not only to reputation, but also to the likely identification of GHG abatement opportunities.

Sequencing and next steps (Section 6.4)

The mandatory GHG reporting program proposed for TT's O, G&P sector will anticipate a full market mechanism to reduce GHG emissions. As such, the design and implementation of the mandatory GHG reporting programme will provide valuable information and experience for the design and implementation of more ambitious policy instruments like a carbon tax or an individual crediting system (see Figure 1).

Figure 1. Roadmap for sequencing & transition into a fully-fledged market mechanism
Source: Own elaboration



The next steps to build the mandatory GHG reporting program should avoid duplication with the initiatives that are currently developing TT's capacity and technical infrastructure in terms of Measurement, Reporting and Verification of GHG emissions. These initiatives include a Low Emission Capacity Building Program promoted by the UNDP, and the ongoing work of the Energy Chamber, who is pre-designing an Emissions Trading Scheme with the support of the European Union.

2. Introduction

The present document is the Final Report of the project "Policy options for reducing GHG emissions in the oil, gas and petrochemical industry in Trinidad and Tobago".

Trinidad and Tobago faces a challenge with regards to climate change. The country contributes less than 1.0 % of global greenhouse gas (GHG) emissions but its annual emissions per capita rank very high (38.2 tCO_2 / inhabitant year) according to the World Bank (2010), only surpassed by Qatar (40.3) and followed by Kuwait (28.7), and Brunei Darussalam (23.1). The country's economy is highly dependent on the export of fossil fuels but, at the same time, as other Caribbean countries, it is vulnerable to the impacts of climate change and therefore a strong international action to mitigate climate change will be beneficial for the country.

Most of this challenge is related to the oil and gas sector. The country has used its hydrocarbon reserves to create a dynamic economy that goes beyond the extraction and processing of oil and gas. Having natural energy sources available is crucial to explain how energy intensive industries throve, as well as to understand the evolution of other emitting sectors such as transport.

Within this context, the IDB has engaged consultancy services for the identification and evaluation of policy instruments to reduce GHG emissions from the oil, gas and petrochemical (O, G&P) industry. The objectives of the project have been:

- To review existing literature and present an overview of the nature, main characteristics and requirements of relevant market and non-market policy instruments to reduce GHG emissions.
- To assess different policy options to reduce GHG emissions TT's O, G&P industry.
- To engage relevant stakeholders on the relevancy of the mitigation options proposed, and validate results of the analysis.
- To select the policy instrument most suited to reduce GHG emissions in O, G&P industry.
- To prepare the Terms of Reference for a feasibility study of the policy option selected.

In order to reach the objectives of this project the following actions were undertaken.

First, an outline of TT's O, G&P sector in terms of its international context and relevance was elaborated. This included an assessment of its institutional and policy framework, as well as a diagnosis and recommendations to strengthen it. A GHG emissions profile of the sector was also conducted, followed by an evaluation of the GHG emissions mitigation options available in the sector (Section 3).

Second, two families of policy instruments were assessed to tackle emissions reductions; on one hand, non-market based instruments such are regulatory instruments or voluntary agreements, which are the traditional way to address pollution; on the other hand, market based instruments such as sectoral crediting instruments, emission trading schemes or pollution fees, which provide theoretically a more cost-effective approach. These policy instruments were then assessed against a series of selected critical design elements and a multi-criteria evaluation methodology to define the best suited for the sector (Section 4).

Based on the findings of this assessment, four (4) policy options were designed to reduce GHG emissions in TT's O, G&P sector: (1) a Government Crediting System, (2) an Installation-level crediting system, (3) a Carbon Tax, and a (4) Mandatory GHG Reporting Scheme. The design of these policy instruments benefited from the inputs of TT's stakeholders, who were gathered to that end in a workshop held in November 2014 (see Annex 5). The four policy options were then assessed with two different methodologies: a Co-benefit Analysis, which provides a series of indicators to measure the climate-change mitigation co-benefits of the different options; and a

SWOT analysis which dissects each policy option showing its particular strengths, weaknesses, opportunities and threats (Section 5).

The analysis showed that developing a mandatory GHG reporting scheme was determined the most convenient policy option. Therefore, a roadmap for the implementation of such a policy option was prepared; including an analysis of the key options to consider, the building blocks necessary in terms of institutional, policy and technical aspects; also an assessment of the potential risks and benefits related to this policy option (Section 6).

Taking into account GORTT's long-term vision for the development of a full market mechanism in TT as well as other ongoing initiatives in this area, the report concludes with some terms of reference to develop the legal and policy building blocks of a mandatory GHG program in the O, G&P industry in TT(Annex 6).

3. Introduction to Trinidad and Tobago´s Oil and Gas Sector

TT consists of two islands and has 1.33 million inhabitants and 5,128 km^2 of territory. The largest island is Trinidad and has a population of 1.27 million and a territory of 4,827 km^2 whereas Tobago has only 300 km^2 of territory and less than 61,000 inhabitants.

TT is no longer part of the OECD developing country list; however, the country is included in the Small Islands Developing States (SIDS) group where developing countries facing special social, economic and environmental vulnerabilities are included. The geographical regions where SIDS are located include: the Caribbean, Mediterranean, Indian, South China Sea, and the Atlantic and Pacific Ocean. In general they share the same constraints such as a narrow resource base that constitutes a barrier for economies of scale; small domestic markets and strong dependence on remote markets; high services costs (energy, transportation, communication, infrastructure); being far away from export markets and the need to import resources; occasional international traffic volumes; high vulnerability to natural disasters and fragile ecosystems; growing populations and volatile economic growth; large dependence on the public sector and limited opportunities for the private sector.

One of the advantages of TT over the SIDS countries is its rich energy resources (oil and gas) that positions TT as a net exporter and with a well developed industrial sector. Its energy resources support industry development such as methanol, fertilizer production and steel, which play a major role in the economy of the country. According to the Review of the Economy (2012) the Petroleum Sector accounted for approximately 40.2% of the country´s GDP and 38.7% of Government revenues in 2012.

3.1. Legal and Institutional Framework

3.1.1. Policy Framework for Climate Change

The GORTT, understanding the importance of long term planning, has taken steps in the consolidation of a national strategic framework in terms of climate change.

In 1994 TT started taking climate change measures as a result of the "Global Conference on the Sustainable Development of Small Island Developing States". In 1995 it enacted the "Environmental Management Act", where the Environmental Management Authority of TT was created to coordinate environmental policy, legislation and enforcement. The current version of the legislation is the Environmental Management Act 2000.

TT's *National Climate Change Policy* (NCCP) contributes to the development of a low-carbon economy through; inter alia, the promotion of carbon markets and policies to reduce GHG emissions.

Table 1 below these lines lists the most relevant policies, legislation and related instruments which may have an influence on the nation's climate change mitigation agenda:

Table 1. Essential inventory of O, G&P industry relevant policies, legislation and other actions potentially affecting CC mitigation in TT

Source: Own elaboration

Policy/legislation/ Roadmap	Developing organization	Year	Description
Petroleum Act	Ministry of Energy and Energy Affairs	1969	Section 43(s) of the Petroleum Regulations provides for the 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.
Environmental Management Act	Environmental Management Authority (EMA)	2000	The EMA is mandated to establish programmes to manage the environment including air pollution. It authorizes the Minister responsible for the environment to make Rules (subsidiary legislation) to give legislative support to the programmes of the Authority.
National Environmental Policy	EMA	2006	The policy made under the EMA Act includes provisions for CC mitigation.
Certificate of Environmental Clearance Rules(CEC)	EMA	2010	The Certificate of Environmental Clearance process can be used to mitigate the potential negative environmental impacts associated with any designated activity (e.g., the release of air pollutants such as carbon dioxide and other GHGs)
Draft Air Pollution Rules	EMA	2010	The purpose of the EMA draft Air Pollution Rules 2010 is to regulate air pollution in Trinidad and Tobago. GHGs are not included but since the Rules are draft, there is still an opportunity to include GHGs.
National Climate Change Policy	Ministry of the Environment and Water Resources	2011	Lists broad objectives and strategies including use of Renewable Energy (RE), cleaner technologies and research and development (R&D)
Renewable Energy Policy Framework	Ministry of Energy and Energy Affairs	2011	Identifies Barriers, Policy Objectives and Strategies for RE Implementation
Mainstreaming Climate Change into National Development in TT	Ministry of the Environment and Water Resources	2011	Outlines and a high-level Action Plan for NCCP
Feasibility of CCS Projects in TT	Ministry of the Environment and Water Resources	2012	Identify implementation gaps and cost-benefit analysis of a national CCS program
Draft Green Paper on Energy Policy for TT	Ministry of Energy and Energy Affairs	2012	Prescribes Energy Policy Objectives and Strategies
Greenhouse Gas Inventory at Petrotrin	IDB for Petrotrin	2013	Identify and undertake technical and financial opportunities for CC mitigation
Petrotrin's Clean Development Mechanism (Oil Fields Associated Gas Recovery and Utilization)	Petrotrin	2013	Recover methane rich natural gas released during crude oil production and transport the gas to the national gas pipeline for industrial use. This project has the potential to remove 1.3 MM tCO_2e over the 20 year project span. (ECTT)
Petrotrin Corporate Social Responsibility Report	Petrotrin	2012-2013	25 CECs have been issued for projects such as development drilling, upgrade of pipeline networks and decommissioning of wells which may represent GHG reduction opportunities. Additionally, the Methane Gas Recovery Project whose aim is to reduce methane emitted to the atmosphere has 4 CECs approved, and also represents an opportunity for GHG reduction.
Second National Communication	Ministry of the Environment and Water Resources for UNFCCC	2013	Inventory, Overview of Policies, and Vulnerability and Adaptation Issues
The Economics of Climate Change Adaptation in TT	IDB for Ministry of Planning and Sustainable Development	2014	Includes case study of Climate Change vulnerability and adaptation Benefit/Cost analysis for Petrotrin oil refinery
Draft Strategy for the Reduction of GHG emissions in TT	UNDP for Ministry of the Environment and Water Resources	2014	Includes historical CO_2 emissions estimates and Benefit/Cost estimates for mitigation options in TT

3.1.2. Existing Institutional Framework and Capacity in the Oil and Gas Sector

From a policy perspective, the institutional structure of TT consists of different Ministries and public institutions, whose main functions and relevant legislation are detailed below and summarized in Table 2.

Ministry of Energy and Energy Affairs

One of the key institutions for the O, G&P sectors is the Ministry of Energy and Energy Affairs (MEEA). This entity is in charge of developing the policies, regulations and general management of the oil, gas and minerals sectors at a national level; the leasing and licensing of exploration and production activities in the mentioned sectors; the formulation and implementation of legal instruments and initiatives throughout the O, G&P sectors; representing the national interests in these sectors in the international arena; also, it shares the responsibility with the Ministry of Finance and the Economy for the state's petroleum revenue collection(GRTT, 2014).

The most relevant legislation enforced by this Ministry that is relevant to the oil and gas sectors is described as follows:

- The **Petroleum Act (1969)** is the main document providing policy definition for the sector. It depicts the legal and regulatory requirements applicable to the sector in terms of permits for exploration and extraction of the energy resources nationally. It also specifies that the licensees must prevent any damage to the water resources and take care that gas release is not performed in a manner that causes pollution of the surrounding air. This statement may set a precedent for natural gas flaring regulation. The act states that all licensees are subject to regulations promulgated by the MEEA (MLA, 1969).

- The **Petroleum Taxes Act (1974)** determines the taxes payable by all operators engaged in production and refining businesses. It sets several main taxes:
    - Oil Royalties ranging from 10% to 12%. Gas royalties are currently minimal in TT.
    - Petroleum Profit Tax (PPT) charges oil and gas producers as well as refinery operators with 50% of chargeable profit (reduced to 35% from income year 2011 for deep water operations only).
    - Supplemental Petroleum Tax (SPT) or windfall tax on Oil production is a sliding scale dependent on oil price, which is imposed on Oil income generated from production of crude oil net of royalty and over-riding royalty.
- The **Unemployment Levy Act (1970)** sets a tax to the Oil & Gas sector at a rate of 5% on chargeable profits, assessed annually and payable quarterly(MLA, 1970).

The **Petroleum Production Levy and Subsidy Act (1974)** subsidizes petroleum products in the domestic market by setting levy payments to the oil producing companies. It also establishes a ceiling for the levy payments at 4% of the company's gross income from the sales of crude oil.

As for specific environmental protection related aspects, the MEEA developed the **National Oil Spill Contingency Plan (2013)** to mitigate the effects of events of this nature, and preserve and protect human health and the natural environment from the ever-present risk of oil and chemical spills (GORTT, 2013)

Ministry of Finance and the Economy

This entity is in charge of the management of the economy of TT, as well as the development and implementation of innovative policies that benefit the population. It shares with the MEEA the responsibility for the collection of the government's petroleum revenue, the taxes defined in the Petroleum Taxes Act depicted in the previous section, and is also empowered to create legislation and determine contributions from the sector. As for its environmental protection related duties, it is charged with the collection of environmental taxes in the transport and tourism sectors; and the management of the **Green Fund**, which is funded upon by a 0.1% tax on the gross income of companies and unincorporated associations.

Environmental Management Authority

The Environmental Management Authority (EMA) reports to the Ministry of Environment and Water Resources. Since it is the enforcement authority for the provisions contained in the Environmental Management Act, it is the most relevant institution in the matter. Its main objective is to protect, conserve and enhance the environment of TT and its responsibilities include the implementation of programs and policies for the effective management and use of the nation's natural resources; drafting and enforcement of laws and regulations regarding the environment; as well as the design and implementation of environmental programs and projects (EMA, 2013).

Concerning the relevant legislation and regulations enforced by this entity, the **Environmental Management Act, Chapter 35:05** is the main legislative instrument related to the nationwide environmental protection. It provides subsidiary legislation in several sectors such as waste management, water pollution, air pollution and noise pollution, among others. This Act also creates and empowers the EMA as the main institution regarding protection and conservation of the environment at a national level.

The **Draft Air Pollution Rules (2013)** are currently under review and are designed to protect the people and the environment from the harmful effects of air pollution. This Act, if approved, will set maximum permissible limits (MPL) as well as pollution prevention and control mechanisms. It does not include considerations of GHG emissions but since it is in draft stage (in 2013 it was submitted to the legislative committee, without finalization to date) it may be still possible, if needed, to include them.

Environmental Policy and Planning Division

Subordinated to the Ministry of Environment and Water Resources, the main responsibility of this entity is the guidance and formulation of national environmental policy as well as monitoring implementation of the policies. This includes those policies and regulations that apply to the O, G&P sectors of the country. It is also in charge of pollution control, hazardous waste and substance management; and monitoring and evaluation of the implementation of environmental policy in line with the **Government's Framework for Sustainable Development**. The Multilateral Environmental Agreements Unit of the EPPD has also chaired Inter-Ministerial Committees on the elaboration of a strategy for the reduction of CO_2 emissions and mainstreaming climate change into national development, and also on the feasibility of carbon capture and storage (CCS) in geological formations.

Ministerial Coordinating Committee

The mission of this entity is the facilitation of the proper integration of climate change policies into the national sustainable development plan. This Committee's mandate is cross-sectoral coordination; it has the potential and capacity to act as a link between the different Ministries promoting communication, coordination, and guidance. It is in charge of the overall oversight at the ministerial level with a view to addressing barriers to implementation of the NCCP.

Table 2. Summary of Governmental Institutions' functions and relevant legislation
Source: Own elaboration

	Ministry of Energy and Energy Affairs	Ministry of Finance and the Economy	Environmental Management Authority (EMA)	Environmental Policy and Planning Division (MEWR)
Relevant legislation	Petroleum Act Petroleum Production Levy and Subsidy Act Unemployment Levy Act	Petroleum Taxes Act Miscellaneous Taxes Act (Environmental Fund Part XIV: Green Fund Levy)	Environmental Management Act	Government's Framework for Sustainable Development National Environmental Policy National Climate Change Policy
Main functions	Regulate and manage the Oil, Gas and Minerals sectors of TT Collection of state's Oil and Gas derived revenue	Management of the economy of the nation Collection of state's Oil and Gas applied taxes	Enforcement of the Environmental Management Act. Design and execute regulations on environmental matters	Guidance, formulation and observing implementation of environmental related policies.
Main functions related to environmental Protection	No statutory environmental protection functions, however it developed the National Oil Spill Contingency Plan to mitigate the effects of this events	Administration of the Green Fund	Issuing CEC permits, and evaluating EIAs of industries in the O&G sector, and enforcing their compliance	Has chaired Inter-Ministerial Committees on the elaboration of a CO_2 strategy reduction and Carbon Capture and Storage (CCS) feasibility

3.1.3. Diagnosis of Institutional Capacity in the Oil and Gas Sector

The main institutions that need to be involved in the policy instrument to mitigate GHG emissions in the O, G&P sector are:

- MEEA is relevant to the policy related to the O, G&P sectors;
- The Ministry of Environment and Water Resources and the EMA, which is the enforcement unit for most environmental policies and legislation;
- The Ministry of Finance and the Economy, which is in charge of the tax administration and partially of the revenues of O, G&P sectors; and
- The Ministerial Climate Change Committee, which is entitled to act as an umbrella coordinating agent.

The reduced number of institutions involved in the policy making and implementation for the sectors relevant to this project is an advantage since it simplifies any process that requires inter-ministerial participation and coordination (institutional arrangements).

EMA needs to be empowered with greater resources so that it has adequate capacity to enforce the technical specifications that are spelled out in the CEC. This would allow it to undertake monitoring and enforcement of the permits that it has issued over the years. The enforcement process as laid out in the Environmental Management Act remains complicated and

needs to be revised to allow summary offenses to be created under the Act for certain types of environmental breaches.

Also, there are no mandatory obligations for the stakeholders in the O, G&P sectors to collect or report information on their GHG emissions, no institution is responsible for the collection of GHG emissions data, and there is not an on-going process to develop a national GHG inventory.

Regarding the policy framework, **a positive aspect is the fact that precedents exist in the matter. For example, the NCCP, even though it does not present specific measures to address the subject or allocate specific responsibilities, it shows a political and institutional will to address this matter**. Also, in the oil and gas sectors there is an air and water pollution regulatory scheme run by the Petroleum Inspectorate division of the Ministry of Energy and Energy Affairs, whose inspectors visit industrial facilities on an ongoing basis to investigate pollution incidents. However, there appears to be a lack of consistency between some documents and sparse coordination of the measures and strategies being implemented.

In order to facilitate the understanding of the regulatory scheme, it should be noted that the main regulatory framework for water and air pollution is administered by the EMA under the Environmental Management Act 2001 Chapter 35:05 of the Laws of Trinidad and Tobago (the "EMA Act"). The relevant Subsidiary legislation under the EMA Act currently includes:

- The Certificate of Environmental Clearance Rules; and
- The Water Pollution Rules.

The Certificate of Environmental Clearance Rules only applies to new developmental projects which may have impacts on the environment. It, defines the 44 activities which require a CEC. At the preliminary phase of the assessment of the proposed project, if potential significant environmental and human health impacts have been identified, the applicant may be asked to conduct an Environmental Impact Assessment (EIA).

During the development of the EIA, an opportunity for all stakeholders, including the public, to participate in the identification of issues of concern, practical alternatives, and opportunities to avoid or mitigate adverse impacts regarding the project is provided. At the end of the process, the findings are compiled into an EIA Report and submitted to the EMA.

The CEC granted by the EMA will usually contain information regarding, among other things, water and air pollution standards that must be met during the operation of the new activity. Those will be derived from the Water Pollution rules and draft Air Pollution Rules of the EMA.

If the applicable environmental standards are not met, for each violation a $10,000 dollar fine will be paid. In case of a continuing violation, $5,000 dollars will be paid for each day the violation is not remedied. Furthermore, the intentional or reckless release of any pollutant or hazardous substance by any person is designated a criminal offence which carries a penalty of $100,000 and imprisonment for two years. Additionally, the EMA has the power to halt activities and projects or prevent potential violations which may lead to a violation of any environmental requirement.

The Water Pollution Rules (2001), amended by The Water Pollution (Amendment) Rules (2006), were designed to regulate water pollution from all significant point sources into the environment. They prohibit any person or organization from releasing water pollutants into a receiving water body exceeding the designated maximum permissible levels and which may cause harm to human health and the environment. In fact, any person or organization that takes part in activities that releases a water pollutant into the environment must register with the EMA as a Source and apply for a Permit to discharge into the environment. However, there are some exceptions to this rule:

- Releases from normal operation of motor vehicles used for transportation;

- Releases from domestic households such as laundry, kitchen, shower, etc.;
- Discharges of sewage into sewerage facilities.

After all the necessary information is provided and the source is deemed to be significant, the EMA may issue a permit stipulating, among other things, the maximum permissible levels of designated pollutants, monitoring requirements, compliance responsibilities and special conditions.

The country's participation in international programs, such as the ratification of the UNFCCC and the Kyoto Protocol and the submission of the second National Communication under the UNFCCC is a positive aspect from the political point of view and the disposition of the Government.

An analysis presenting the strengths, weaknesses, opportunities and threats (SWOT) for the O, G&P sector regarding the implementation of GHG emissions mitigation measures is presented in Table 3 below.

Table 3. SWOT Analysis
Source: Own elaboration

Strengths	Weaknesses
• TT has elaborated a National Climate Change Policy that states its position in the matter. • Clear definitions' of Ministries' competences. • The institutional elements required to the implementation of MBIs are in place and functional. • An inter-ministerial coordination entity already exists. • Legislation already exists that can be leveraged to support GHG reduction policies e.g. Petroleum Act. • MFE is a solid collection entity, already implementing environmental taxes. • EMA is a solid institution already experienced in the design and implementation of environmental regulations. • Participation in International forums and conferences on climate change (provides visibility and promotes knowledge exchange). • International commitments to reach emissions reduction goals. • There are environmental legal instruments already in place.	• The National Climate Change Policy does not specify actions in the O, G&P sectors. • The financial resources expected to be allocated for the implementation of new measures are limited. • No institution is clearly responsible for the collection of data on GHG emissions, although the EMA has occasionally put the collection of GHG emissions data as a CEC condition • Even though some companies have developed individual GHG inventories (e.g. Petrotrin), currently a sector-wide GHG inventory is non-existent. • There is no obligation for industries to collect data or report on their GHG emissions.
Opportunities	**Threats**
• The recent reforms to the ministerial structure present an opportunity for the implementation of changes in responsibilities and functions on the new entities "from scratch". • There are several international funds and organizations that may provide financial support for the design and implementation of measures to address climate change. • There is a need to strengthen the capabilities of MEWR and EMA to implement and empower mitigation instruments.	• Changes in the ministerial structure might have left operational blanks if not performed carefully enough. • The capacity of the Ministries to incorporate new elements and endure changes must be strengthened prior to the implementation of new instruments. • Support and coordinated efforts at all government levels will be needed in the implementation of new mitigation measures. • Personnel throughout the involved institutions will require sufficient capacity building. • It should be recognized that it is fundamental to develop leadership and effective communication with stakeholders in order to accomplish a successful implementation of any measure.

Recommendations

The recommendations presented in Table 4 were prepared based on an analysis of the existing policies and institutional structure. It is worth mentioning that these recommendations are preliminary and are subject to further discussion. In addition, these guidelines are rather general and will need to be tailored depending on the GHG policy option which is finally chosen.

Table 4. Roadmap proposal
Source: Own elaboration

REQUIRED CAPACITY	RECOMMENDATIONS
Coordination capacity and leadership	• The institution in charge of leading the implementation of the CC mitigation policy instrument must have the necessary authority. • It is very important to empower the designated Ministerial Climate Change Committee so that it can effectively align the efforts of the different Ministries involved, being able to guide the process. • The assignment of human, economic, and technical resources is fundamental for the design of policy actions. • Political will is required to empower the coordination entity for a given policy instrument in order to ensure that is capable of implementing, supervising, and evaluating the measures to be undertaken.
Capacity building in CC mitigation	• Capacity-building covering, among other, at least the following topics: (1) Development of GHG emissions inventories; (2) Future projection of GHG emissions; (3) Methodologies for the analysis and prioritization of GHG emissions mitigation measures; (4) MRV systems for the policy actions and specific projects; and (5) Knowledge on international instruments to support the GHG emissions reduction: Nationally Appropriate Mitigation Actions (NAMA), Program of Activities (PoA), Clean Development Mechanism (CDM)
Communication and leadership with stakeholders	• It is necessary to design a Stakeholder Uptake Strategy to effectively communicate with the key actors in the O, G&P sectors and lead them through the acceptance and implementation of the mitigation measures. • Creation of channels of communication between the Government and stakeholders so information relevant to the measures can effectively flow between them. • Stakeholders should be included in the process of design of the measures, since their input will give information on the real conditions in the sector, and also it is important that they feel relevant to the process since it will promote their participation and ultimately determine the success of the measures.
Financing	• A close and effective management of the budget allocated to the measures must be executed, always prioritizing the most cost-effective measures available. • If additional financing sources are required, TT can approach international funds and organizations such as IDB, World Bank, UNDP, GEF, GCF, among others. Also, the option of implementing environmental taxes is available in order to fund the measures to be implemented.

3.2. GHG Emissions profile and options to reduce GHG emissions in the Oil and Gas Sector

3.2.1. GHG Emission Profile

The information about GHG emissions in TT is fragmented and there are different sources of information to consider. According to TT's Second National Communication under the UNFCCC, TT's total GHG in 2006 amounted to 63.4 $MtCO_2e$ (GORTT, 2013).

TT's O, G&P is a major contributor to the country's national GHG emissions. According to the GHG estimations carried out in the context of this project for the year 2011[1]:

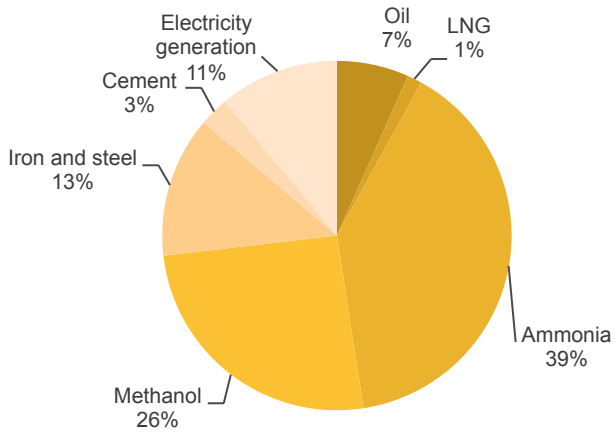
[1]An overview and a definition of the sector are provided in Annex 1. As discussed in a previous deliverable, a broad definition is provided so as to include the GHG emissions and the GHG emissions reduction potential of energy-intensive industries which are heavily reliant on natural gas. In turn, the GHG emissions data of this section have been produced "ad-hoc" for this report. This is so because the only publicly available comprehensive study, which refers to the country's energy CO_2 emissions in 2007, seems to underestimate the GHG emissions of some important processes, such as ammonia and methanol production.

- If the upstream, midstream and downstream activities of the oil and natural gas sector are considered, the emissions derived from the oil production would account for more than 3.5 $MtCO_2$ and the production of LNG for 0.72 $MtCO_2$.
- In addition, the production of ammonia contributed to more than 21 $MtCO_2$, and the production of methanol to more than 13.5 $MtCO_2$ in 2011.
- Moreover, the iron and steel production generated almost 7 $MtCO_2$ in that same year, followed by the electricity generation with almost 6 $MtCO_2$ and the cement production, which surpassed the figure of 1 $MtCO_2$ emitted according to the estimations carried out.

Table 5. GHG emissions of selected industrial processes
Source: Own elaboration

Sector	Process	GHG emissions (tCO_2, 2011)
Oil and natural gas	Oil	3,565,711
	LNG	721,157
Petrochemical	Ammonia	21,139,075
	Methanol	13,686,182
Industrial	Iron and steel	6,976,388
	Cement	1,463,617
Electrical Power	Electricity generation	5,912,156

Figure 2. GHG emissions in the O, G&P sector
Source: Own elaboration



3.2.2. Carbon intensity of selected industrial processes

These GHG emissions are closely related to the production rates of every sector and process. According to the Central Bank of Trinidad and Tobago, in 2011 the country produced 33,550,000 oil barrels and 141 cubic meters of LNG. Furthermore, it produced more than 5 million tons of ammonia and almost 6 million tons of methanol, out of which more than 90% were exported. The iron and steel production and the cement production accounted for almost 2.5 million tons and more than 1.5 million tons respectively, with export rates of approximately 30% and 10%. Finally, since TT does not have any connections with other countries for importing and exporting electricity, all the electricity produced is consumed in the country. The electricity production of the country in 2011 was almost 10 million MWh. The table below summarizes both the production rates of the different products and the carbon intensity of the processes:

Table 6. Production (t, MWh), GHG emissions and carbon intensity of oil and natural gas, petrochemical, industrial and electricity generation sectors
Source: Own elaboration

Sector	Process	Production (2011)	Unit	GHG emissions (tCO_2, 2011)	Carbon intensity (2011)	Unit
Oil and natural gas	Oil	3,565,711	t	3,565,711	-	-
	LNG	721,157	t	721,157	-	-
Petrochemical	Ammonia	21,139,075	t	21,139,075	4.12	tCO_2e/t
	Methanol	13,686,182	t	13,686,182	2.32	tCO_2e/t
Industrial	Iron and steel	6,976,388	t	6,976,388	2.85	tCO_2e/t
	Cement	1,463,617	t	1,463,617	0.92	tCO_2e/t
Electrical Power	Electricity generation	5,912,156	MWh	5,912,156	0.61	tCO_2e/t

The high carbon intensity of the electricity production of TT should be noted. Even though the fuel used to produce electricity in the country is almost solely natural gas, the high carbon intensity (when compared to other natural gas fuelled power plants) is caused by the low efficiency of the electricity production plants.

3.2.3. Options to reduce GHG emissions in the Oil and Gas Sector

A Marginal Abatement Cost (MAC) study has been undertaken to assess the GHG abatement potential of the O, G&P industry[2].

This study has identified five measures with high GHG emissions reduction potential: (a) implementation of energy audits in LNG and methanol plants; (b) improvement in the use of heat; (c) revamping of ammonia plants; (d) Reduction of venting and flaring emissions; and (e) improved electrical energy generation technology.

Table 7. Summary of mitigation measures and description
Source: Own elaboration

Code	Measure	Brief description
M1	Implementation of energy audits to detect and engage in improvement areas in LNG and methanol plants	Revisions in the operation process of methanol and LNG plants to detect improvement areas for energy conservation and apply reduction measures.
M2	Improvement in the use of heat	Implementation of a Combined Heat and Power (CHP) operation. Installation and maintenance costs as well as benefits from electricity and gas produced are considered.
M3	Revamping of ammonia plants	Reformation of ammonia plants facilities to substitute old equipment with modern equipment reducing the energetic consumption of the plants.
M4	Reduction of venting and flaring emissions	Implementation of a program to recover and utilize associated gas emanating from oil-wells, reducing the emissions associated to venting and flaring.
M5	Improvement in electrical Energy generation technology	Conversion of 2 single-cycled turbines to combined-cycle turbines reducing the emissions associated to their operation (on a per MWh basis).

The study assumes an optimistic scenario that all the measures identified will be implemented progressively. If not, the projections will be displaced forward depending on the time lag. This will lead to significant GHG emission reductions that will increase significantly after 2020, once the

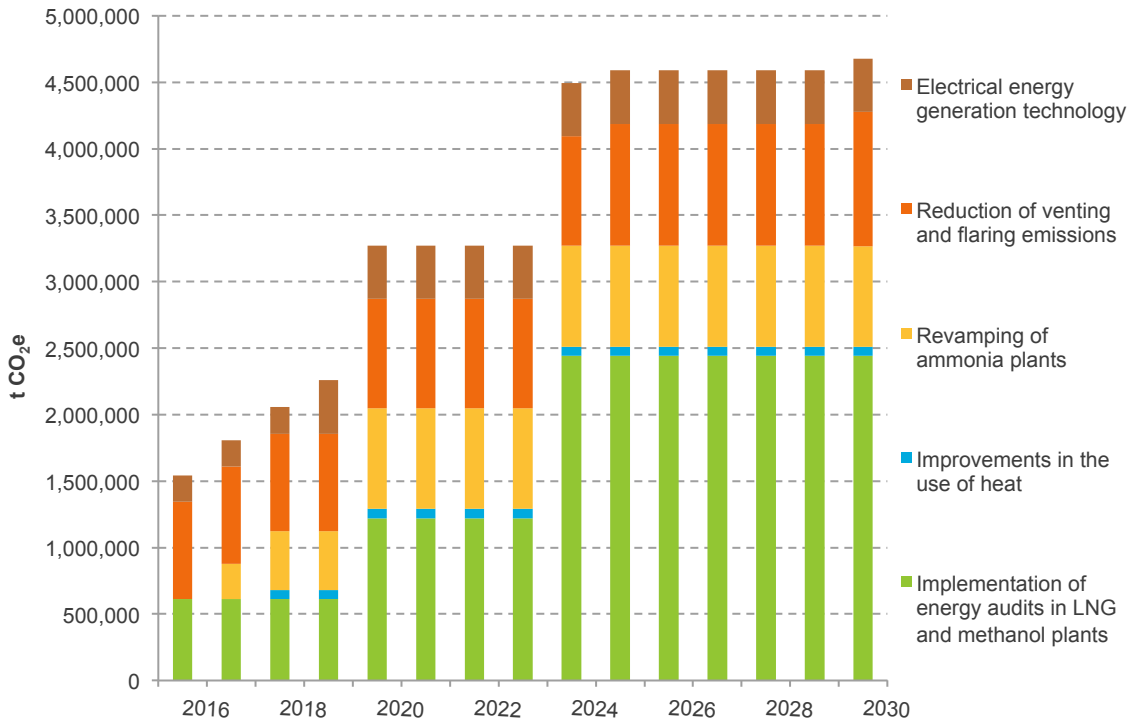
[2]See Annex 2 for details on the methodology used, assumptions made and results obtained.

energy audits carried out in LNG and methanol plants will identify and implement energy efficiency improvements that will lead to operational improvements and additional investments to reduce GHG emissions.

Nevertheless, it should be noted that before the implementation of any GHG emission reduction measure, they need to be analyzed in detail and discussed with all the relevant stakeholders. In this report, a first approach to the GHG emissions reductions that could be achieved is made, but the implementation of the actions would require an in-depth analysis of the measures.

The following figure shows the abatement potential abatement potential of the measures considered, up to the year 2030.

Figure 3. Annual GHG emission reduction potential up to 2030
Source: Own elaboration



Under these assumptions, the O, G&P sector of TT would be able to reduce almost 53 $MtCO_2e$ by 2030 (i.e. more than 3.5 $MtCO_2e$ per year).

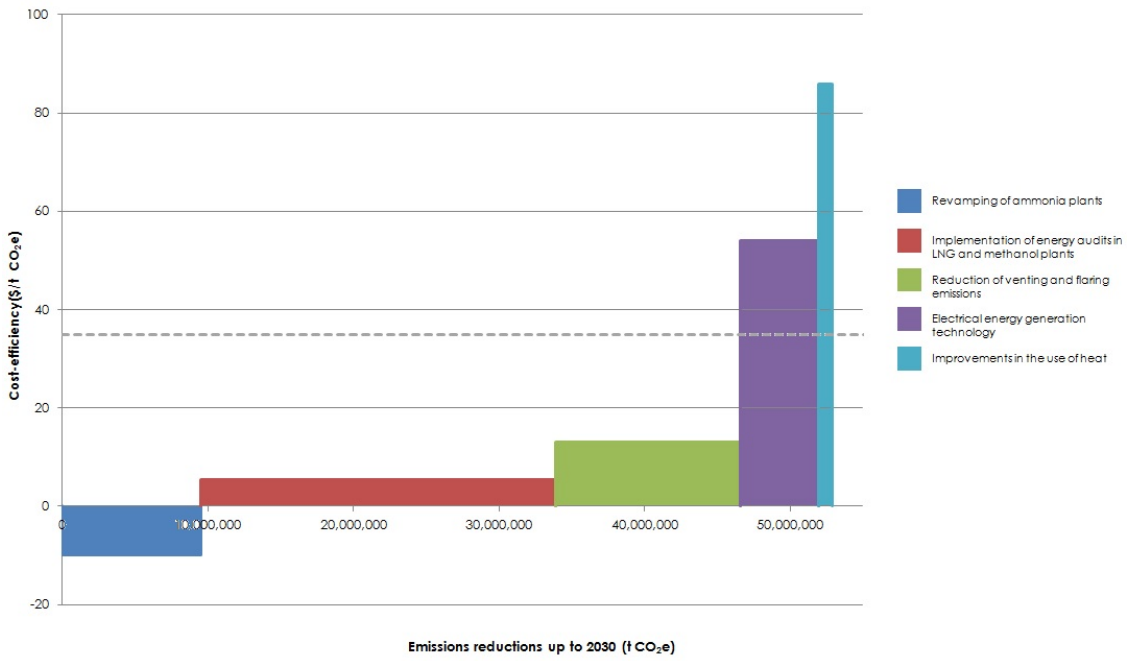
GHG abatement cost

The abatement cost of a measure is, in simple terms, the price of each tCO_2e prevented from being emitted to the atmosphere.

According to the results of the preliminary study, TT would be able to reduce the aforesaid GHG emissions at an average cost of US$ 10.84 per tCO_2 (see Annex 2 for details). GHG emission reductions at ammonia plants may be achieved at negative costs (-9.84 US$/$tCO_2e$), while GHG emission reductions due to energy audits can be achieved at moderate costs (5.45 US$/$tCO_2e$). Furthermore, the GHG reductions achieved through the application of venting and flaring reduction would have a limited cost (12.99 US$/$tCO_2e$), also below the social cost of carbon (SCC), which has been recently estimated at 35 US$ (World Bank, 2014). In fact, only the costs of the improvement of

the use of heat and of the electrical energy generation technology would be higher than the SCC (85.88 and 53.96 US$/t$CO_2$e, respectively).

Figure 4. Mitigation Abatement Cost analysis
Source: Own elaboration



Investment needs

The measures analyzed vary widely in terms of financing needs due to their nature and vocation as technical solutions in some cases and practice improvements in other. It is important to point out that all the amounts hereby presented are translated to its NPV.

The investment required to achieve the emissions mitigation determined in the reduction potential of the detailed measures totals $1.54 billion USD (measure 1 is not included in this figure, due to lack of data) this figure considers the expenses for infrastructure development. It should be noted that these cost figures do not account for the benefits that could be obtained from the implementation of the GHG emission reduction actions, which are derived mainly from the reduced use of energy and, in the case of the CHP measure, the incremental generation of electricity[3].

[3] TT has experience with attractive tax incentives to attract finance in the Oil and Gas industry, such as an automatic tax deduction for investments (based on a depreciation schedule), faster depreciation or recovery schedules and tax uplifts for Enhanced Oil Recovery Projects.

4. Policy Instruments to reduce GHG emissions in the Oil and Gas sector

4.1. Identification of policy instruments to reduce GHG emissions in the Oil and Gas sector

4.1.1. Introduction

According to the OECD glossary of statistical terms, "market-based instruments" seek to address the market failure of environmental externalities either by incorporating the external cost of production or consumption activities through taxes or charges on processes or products, or by creating property rights and facilitating the establishment of a proxy market for the use of environmental services".

MBIs can be classified in two groups: price-based instruments and quantity-based instruments. Price-based instruments set a fix price on pollution directly which needs to be addressed. Environmental taxes (such as the carbon tax) are the most common price-based instruments, although pollution charges[4] and feed-in tariffs are also considered price-based instruments. Environmental taxes are sometimes called Pigouvian taxes, named after Arthur Pigou who developed the notion of a negative externality.

Unlike price-based instruments, quantity-based instruments set a limit on the total quantity of pollution, and then allow the trade of tradable permits among the entities covered by the system. Emission Trading Schemes are the most common quantity-based instruments, although other forms of quantity-based instruments are emerging, such as project-based crediting schemes, sector-based crediting instruments, government crediting systems, or tradable intensity standards (ECORYS, 2014). Quantity-based instruments are inspired in Ronald Coase's theorem, which described economic efficiency through bargaining of property rights when addressing negative externalities.

Environmental economic theory suggests that achieving environmental control through market-based instruments has clear advantages relative to more traditional command and control regulations, such as technology or performance standards. By placing a general price on avoiding pollution, market-based instruments give a general incentive for environmental protection. Several studies, notably in climate change mitigation, have demonstrated that this approach can lead to significant gains in effectiveness related to technology mandates. Instead of favoring emission reduction activities with different policy instruments (financial incentives to direct investment, feed-in tariffs to certain types of electricity generation, subsidies, among others), market-based instruments ensure that GHG abatement is rewarded equally and impartially, regardless of the technology, sector or geographical location where the GHG emission reduction takes place (IEA, 2010).

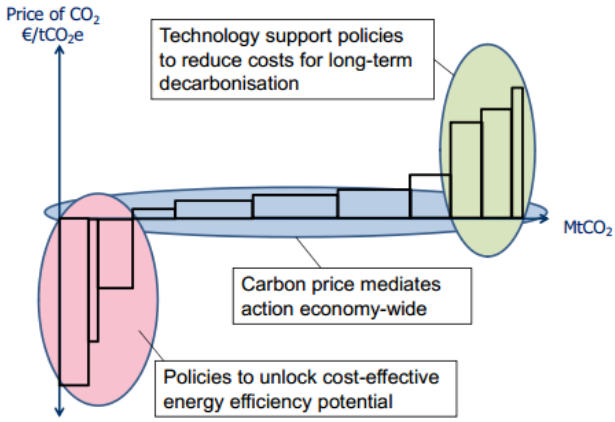
In turn, non market-based instruments (non MBIs) are policy mechanisms such as voluntary agreements (actors voluntarily agree to take action given environmental goals), performance-based-standards, regulatory instruments (command-and-control regulations where public

[4]Contrary to taxes, which seek to generate revenue for the State, pollution charges seek to cover the expenses derived of the emission of pollutants or the consumption of natural resources without generating revenue.

authorities mandate the performance and technologies to be used), voluntary pledges, and information programs (i.e. awareness campaigns).

Non MBIs may also be used to supplement market-based instruments. Current literature suggests that carbon pricing instruments need to be supplemented with other policies which can effectively tackle market barriers and imperfections. Energy efficiency policies can, for instance, unlock cost-effective energy efficiency potential in the short term. In turn, technology support policies can reduce decarbonization costs in the long term (IEA, 2011).

Figure 5. Policy mixes for decarbonization
Source: IEA (2011)



In the process of sel[illegible] rket and Non-market based instruments w[illegible] nts depicted in Table 8.

Table 8. Market and Non-market based instruments analyzed
Source: Own elaboration

Market Based Instruments	Sectoral Crediting System
	Environmental Tax
	Pollution Fees
	Installation-based emissions trading schemes
Non-market Based Instruments	Regulatory Instruments
	Voluntary Agreements

The common factors considered in the assessment include: the individual reporting characteristics of the instrument, its incentives scheme, GHG abatement potential, International compatibility, baseline-setting complexity, need for compensation mechanisms as well as for a trading registry.

4.1.2. Market-Based Instruments

Sectoral Crediting Systems (SCS)

Description

According to Ward (Ward, M., et al, 2008), under this type of scheme, credits are granted to governments instead of private entities. The government is therefore responsible for passing the incentives to reduce emissions on to the private actors, but has to decide how this is done.

In a SCS, the reduction of GHG emissions below a sector baseline awards credits for the entire sector. The credits awarded are the difference between the baseline and the actual emissions of the sector. The use of credits depends if the country has obligations at the international or national level and its value will depend on the existing carbon market. SCS is voluntary therefore, if emissions are not reduced below the baseline there are no sanctions (Schneider, L., Cames, M., 2009).

Authors such as Bosi and Ellis (2005) have presented three options for sectoral crediting including:

- **Policy-based.** Sectoral crediting would occur based on GHG reductions as a result of a well-identified policy. A thorough ex-post evaluation of the policy's actual contribution to abatement is required.

- **Rate-based (or intensity-based).** The baseline is defined as GHG emissions divided by a metric reflecting the sector's activity level (e.g. GWh of electricity). Credits represent the difference between the baseline and the observed rates multiplied by the level of output over the period.

- **Fixed target (or cap-and-trade).** A sector would become eligible to credit GHG reductions if emissions were to be below a fixed, pre-agreed quantity.

Requirements

According to Baron (Baron, R., Ellis, J., 2006), a SCS requires strong governance arrangements within the host country and at the international level. The following arrangements have been identified:

- *A National Coordination Entity.* It seems advisable that one entity takes the responsibility of coordinating all activities: collection of relevant data, development of a proposal for a SCS, monitoring of emission reductions and the coordination of measures with the government, the private sector and other stakeholders and also be the focal point at the international level.

- *Incentives for the Private Sector.* The success of a SCS depends strongly on whether the private sector has strong incentives to reduce emissions or not. Incentives for the private sector could in principle include:

    - **Policies and measures.** Adopted by the government to provide incentives for the private sector to reduce emissions. The government gets the credits from the achieved emission reductions and may use them to support the sector in reducing its emissions.

- **Direct distribution of credits to entities in the sector.** The government forwards credits from the mechanism directly to private entities in the sector which can sell the credits on the carbon market.

- *Monitoring.* The coordinating agency needs to monitor the achieved emission reductions. Monitoring reports may be submitted to the regulatory body which, after a technical review may issue the credits. (Schneider, L., Cames, M., 2009).

Advantages and disadvantages of this scheme are presented in Table 9.

Table 9. Advantages and Disadvantages of Sectoral Crediting Systems
Source: Own elaboration

Advantages	Disadvantages
Not binding. The voluntary nature and the financial incentives of the mechanism could make this instrument interesting for a large group of developing countries.	Little homogeneity in a sector may add difficulty to the development of sector-wide baselines thus, multiple baselines may be needed.
Up scaled mitigation efforts beyond levels that are achievable with a project-by-project approach, such as the CDM.	Sectoral baselines will require institutions with technical skills capable of evaluating, monitoring and verifying sectoral crediting proposals.
Depending on its design, sectoral crediting systems may not require addressing whether individual projects are additional.	Collection of reliable data may be difficult, depending on the availability of information in the implementation country.
Sector-wide transformations focusing on sectors that are development priorities for the host country.	Responsibility and rewards between companies and the government may be unclear plus the challenge of integrating into the carbon market.

The following box displays a relevant experience for SCS in the power sector:

Box1. Relevant Experiences: Application of SCS to the power sector
Source: Bloomberg New Energy Finance

The power sector is usually characterized by a high degree of variability in resource base and fuel mixes across regions however, the homogeneity of electricity production means that performance targets may be readily calculated.
Some of the benefits include:
Emissions coverage. The power sector accounts for a large proportion of energy-related CO2 emissions in major emerging economies – for example, 50% in China and 56% in India in 2007.
Benchmarks. The fact that only one product is produced in the power sector generally facilitates the definition of targets.
Benefits to developing countries. A globally based SCS in the power sector could complement domestic renewable energy policies and thus, help achieving the related co-benefits such as the independence of increasingly expensive imported fuels as well as better air and water quality.

Some of the challenges include:
Differences in resource and cost base. In the case of thermal power plants running off combinations of coal, gas and oil, variations in CO_2 emissions are largely due to differences in thermal efficiencies, which may be improved over time but not necessarily be captured under a single benchmark.
Long time horizons. The long lead time of power sector investments creates difficulties in a SCS because there is a large stretch of time between the initial investment and the payoff. If payment for the credits is 'on delivery', the project developer carries the risk in having to make a large upfront outlay well ahead of receiving the revenue. If payment is upfront, the credit buyer takes the risk (Bloomberg, 2010).

Environmental Taxes

Description

A negative externality is a cost that one economic agent imposes on another but does not take into account when making production or consumption decisions. Environmentally related taxation is one policy instrument that can be used to try to ensure that the costs to the environment are internalized or "priced" into the decision-making process (OECD, 2001). For example, in designing a policy to reduce carbon emissions a policymaker may tax the emissions directly, thereby setting the price but, not the quantity of pollution abatement.

The complexity of designing environmental taxes often includes how to set the level of the tax in such a way that the price gives the correct signal to achieve the desired amount (in this case of emission reductions), and it has to take into account whether the tax will be revenue neutral or not, what welfare impacts it may have on the population, industry competitiveness, among others. In theory, environmental taxing is an option for governments to introduce a measure that may reduce environmental harm in the least costly manner, by encouraging changes in behavior by those firms and households that may reduce their pollution at the lowest cost (Levinson, A., 2007).

Requirements

According to the OECD (2011), when implementing environmentally related taxes, it is essential to clearly state environmental policy objectives from the very beginning. While designing environmental taxes, the following concepts should be taken into account:

- Scope; the environmental tax should be as broad as the scope of the environmental damage.

- Tax rate; ideally should be commensurate with the environmental damage.

- Competitiveness: specific energy-intensive sectors could experience harmful economic consequences (increase in prices) therefore, a careful analysis should be carried out to assess whether partial or total exemptions could help tackle this issue.

- Neutrality: The government should consider the potential regressive effects of the taxes implemented in the lower-income groups, and design and implement compensation mechanisms that do not wane the tax' environmental impact.

- Acceptance: it is a key condition for effective green-tax reforms. Efforts including stating clearly the environmental tax objectives, disseminating information, and allowing sufficient time for public hearing or other forms of consultation should be made.

Additional requirements are related to the features of the sector and to the availability of information. When it comes to the first issue, carbon taxes usually are more effective when operating in competitive markets. Monopolists or oligopolists may simply pass the cost through to consumers without changing their behavior (Field and Field, 2013). When it comes to the information, it is clear that governments should have information about the marginal abatement cost curves of the participants if they really want to have an influence on the level of pollution. And companies usually have no interest in providing accurate information in this regard.

Carbon Taxing

A carbon tax is a type of environmental tax based on GHG emissions generated from burning fossil fuels. It puts a price on each ton of GHG emitted, sending a price signal that seeks to have a market response across the entire economy, resulting in reduced emissions (in the short run). According to the Ministry of Finance of British Columbia (2014), by reducing fuel consumption, increasing fuel efficiency, using cleaner fuels and adopting new technology, businesses and individuals may reduce the amount they pay in carbon taxes, or even offset it altogether.

A carbon tax can be levied at any point in the energy supply chain given that measuring the carbon content of fuels is a straightforward task. However, for administrative simplicity one should levy the tax at a point where there are relatively few entities subject to the tax (e.g. upstream) so it´s easier to control, given that if the tax is levied downstream and falls on millions of users (consumers) this will entail higher administrative costs and may become a burden as it may be hard to monitor.

In order to deal with this type of challenges some taxes use a mixed collecting system, addressing big consumers when they pollute whereas small consumers pay the tax when purchasing goods (e.g. 1991 SO_2 Tax in Sweden).

Dividend Scheme

This scheme may work very well together with a carbon tax since it consists in the implementation of a carbon fee and the establishment of a dividend to be returned to the citizenship.

The dividend is defined as the quantity of revenue to rebate to the households within the implementation territory. Ideally, 100 percent of the total carbon tax collected may be divided up and given back to all households equally. This dividend helps citizens pay the increased costs associated with the carbon tax while the nation transitions to a clean energy economy.

This scheme is effective in the reduction of emissions since it encourages users to maintain their consumption below the average, since by doing so they get profit from the program. For example, a household which has several automobiles, and high fossil fuel consumption will pay a carbon tax that is greater than the dividend they get from the program. In the other hand, a household that consumes fossil fuels below the average will receive benefits from the dividend bigger than the tax they pay on their consumption.

Some of the basic elements needed for a carbon tax and dividend scheme to work out include solid institutional capacities to manage the collection and distribution of resources in a clear, honest way. The implementation of the carbon tax may use already existing infrastructure for taxes such as the legislative tools for setting up the level of the tax. However, some modifications may be needed to include the dividend scheme itself within the country. Effective regulations to collect the tax will be critical, as well as monitoring of the scheme effects to identify any potential regressive effects. Advantages and disadvantages of using carbon taxes are presented in Table 10.

Table 10. Advantages and disadvantages of environmental taxes
Source: Own elaboration

Advantages	Disadvantages
Business certainty (short term): for a given period, a tax rate is known; liable parties face no uncertainty about what the price of carbon will be. However, over time the tax rate may be subject to change, particularly if emissions outcomes were not what were expected.	**Long-term price risk for business:** a carbon tax might require periodic adjustments to ensure carbon pollution is on track for meeting the targets set. Uncertainty prevails as a carbon tax does not guarantee that any particular emissions outcome will be reached.
Revenue: a carbon tax creates a source of Government revenue, which could be used to provide transitional assistance to households and businesses. This is relevant for budget neutrality, fairness, addressing impacts and opportunities on the competitiveness of industries and potentially for recognition of impacts and opportunities for energy security and environmental effectiveness.	**Carbon leakage.** The displacement of economic activities and/or changes in investment patterns, that directly or indirectly cause GHG emissions to be displaced from a jurisdiction with GHG constraints, to another without constraints (Marcu, Egenhofer, Roth, & Wijnand, 2013) may arise as a consequence. Measures such as lowering labor or other taxes to compensate for carbon costs could be included (Grubb & Thomas, 2010).
Speed of implementation: no auctions platforms or unit registries are required, which implies relatively short lead times for its implementation plus administrative simplicity. (Australian Department of Environment, 2014)	**Regressive**. There's a risk of regression if there is a failure to correctly analyze the income distribution of the population to set the tax at a level that does not affect the lower income portion.
Stimulate investment in RE: by promoting that fossil-fuels lose competitive price advantage over clean energy.	**International competitiveness:** When imposing an economic burden to carbon intensive industries, there is the risk of diminishing their international competitiveness. Measures such as premiums added on imported carbon intensive goods or exemptions granted to the exports of these goods, among others, should be considered.
Dividends may support the citizens' transition to clean energy and also stimulate the economy. According to the double dividend theory, revenues can also be used to reduce taxes on desirable behaviours (e.g. labour market).	A **specific institution** to handle the accounting and distribution of the dividends needs to be created.
Efficient, transparent and enforceable mechanism to drive an effective and fair transition to a clean-energy economy.	Although to a lesser extent than other mechanisms such as emission trading schemes, environmental taxes require **strong institutional capacities** from the government to keep the whole process clear and prevent unpredicted money displacements.
Businesses incentives to increase their energy-efficiency and reduce their carbon footprints in order to remain competitive. Companies have incentives to reduce even when they have met a certain target, as long as they keep on paying.	**Bias of public opinion** if the government fails to provide sufficient information on the scheme and its benefits to the citizenship.

Table 11 below includes examples of countries with operating carbon taxes:

Table 11. Countries with carbon taxes
Source: Center for Climate Change and Energy Solutions (2013) and own elaboration

COUNTRY / JURISDICTION	START DATE	TAX RATE	ANNUAL REVENUE	REVENUE DISTRIBUTION
Finland	1990	\$30/metric ton CO_2	\$750 million	Government budget; accompanied by independent cuts in income taxes
Netherlands	1990	~\$20/metric ton CO_2 in 1996	\$4.819 billion*	Reductions in other taxes; Climate mitigation programs
Norway	1991	\$15.93 to \$61.76/metric ton CO_2	\$900 million (1994 estimate)	Government budget
Sweden	1991	Standard rate: \$104.83/metric ton CO_2 Industry rate: ~23.04/metric ton CO_2	\$3.665 billion	Initially government budget; Starting in 2000, revenue used to offset labor taxes
Denmark	1992	\$16.41/metric ton CO_2	\$905 million	Environmental subsidies and returned to industry
Costa Rica	1997	3.5% tax on hydrocarbonfossil fuels	n/a	A portion goes to program that incentivizes sustainable development and forest conservation.
United Kingdom	2001	\$0.0078/kWh for electricity; \$0.0027/kWh for natural gas provided by gas utility; \$0.0175/kg for liquefied petroleum gas or other gaseous hydrocarbons supplied in a liquid state; and \$0.0213/kg for solid fuel	\$1.191 billion	Reductions in other taxes
Switzerland	2008	\$11.41/metric ton CO_2 in 2008, increased to \$34.20/metric ton CO_2 in 2010.	\$209 million	One-third of revenues funds climate-friendly building renovations; remainder redistributed back through benefits system
Ireland	2010	\$19.60/metric ton CO_2 in 2010 to \$26.17 per metric ton CO_2 in 2012	\$523 million (in 2012)	Government budget
Australia	2012	\$23.78/metric ton CO_2, increasing 2.5% annually. The fixed price will transition to a cap-and-trade system in July 2015.	\$24 billion (for the first three years)	Over 50% of the revenue will be used to assist households, reduction in other taxes, energy intensive trade exposed industries will receive assistance.
Boulder, Colorado	2007	\$12-13/metric ton CO_2	\$846,885	Climate mitigation programs
Quebec, Canada	2007	\$3.20/metric ton CO_2	\$191 million	Climate mitigation programs
British Columbia, Canada	2008	\$9.55/metric ton CO_2 in 2008 increasing \$4.77/metric ton CO_2 annually to \$28.64 in 2012.	\$292 million	Reductions in other taxes
Bay Area Air Quality Management District, California	2008	\$0.045/metric ton CO_2e.	\$1.1 million (expected)	Climate mitigation programs
Mexico	2014	Varies between US\$1–5/tCO2 depending on the type of fuel.	Unknown	Used for climate mitigation measures. Companies may offset the tax using CDM projects developed in Mexico
Chile	Established in 2014 (will enter into force in 2017)	\$5 / ton CO_2	\$160 million (expected)	Government budget and use most funds on education reform and investment in renewable energy

The table above shows that carbon taxes have had a widespread use since the 1990´s and onwards. European countries started setting the example in the early 90´s and later on only Costa Rica followed. There was a bit of an impasse at the beginning of the decade (2000) and it was until 2007 when countries started implementing carbon taxes again, mainly in America, although other countries in Europe and Australia followed suit.

Pollution Fees

Description

According to Bernstein (Bernstein, J.D., 1997), a pollution charge or fee may be defined as a "price" to be paid for the use of or damage inflicted to the environment. The four main types of charges used for controlling pollution are: (i) effluent charges, i.e. charges which are based on the quantity/ quality of the discharged pollutants, (ii) user charges, i.e. fees paid for the use of collective treatment facilities, (iii) product charges, i.e. charges levied on products that are harmful to the environment when used as inputs for the production process, consumed, or disposed of, and (iv) administrative charges, i.e. fees paid to the authorities for chemical registration or financing licensing and pollution control activities.

The difference between fees and taxes consist in the allocation of the revenues they produce. While taxes are meant to generate revenue to the state, fees are implemented with the goal of covering the expenses derived of dealing with the emission of pollutants or the consumption of natural resources without generating revenue to the state. Pollution charges are usually based on Pigouvian principles, meaning the tariff is based on the actual amount of the pollutant/substance discharged (OECD 2011).The challenge, however, lies in identifying the appropriate level of the charges and the design of the whole tariff system.

Requirements

- **Analysis of the economic sectors** and wealth distribution must be carried out in order to establish the fees at the appropriate level, preventing polluters from choosing to pollute and pay the charge instead of mitigating their emissions.
- **A capable and well designed institution** is required to implement and enforce the fees created, as well as collecting and administrating them. (Bernstein, J.D., 1997)
- **Appropriate pricing.** Pricing should be based on competitive market prices, and the principle of full cost recovery for each service should be applied unless there is a clear rationale for fees different than full cost recovery (e.g. for vital resources such as potable water). Consideration needs to be given to charges for substitute services as they can have a significant impact on the demand for substitute services if they are not subjected to a similar price.
- **Equity considerations.** Reduced charges for users where full cost recovery would mean an ‘excessive financial burden’ on individual users should be considered, especially for low-income individuals, smaller entities and users located in remote areas. Differentiated fees or charges might be considered based on specific criteria, e.g. setting fees to be paid above a consumption threshold.
- **Finance transition period.** Provisions should be made to allow users to adequately change their behavior as a response to the fee or user-charge introduced. Finance might be provided for small and medium sized enterprises allowing them to invest in resource efficiency measures as a response to a newly introduced charge.

- **Revenue treatment.** The revenues raised may be considered as offsetting receipts to illustrate that users are paying a charge in return for a specific service but the revenue management responsibility rests within the organization. (GTZ, 2006)

The advantages and disadvantages that this scheme offers are presented in Table 12 below these lines.

Table 12. Advantages and disadvantages of pollution fees.
Source: Own elaboration

Advantages	Disadvantages
Flexibility. Allow commercial organizations and individuals to respond in line with market prices to meet environmental management objectives at the least cost. (Bernstein, J.D., 1997)	Level of pollution. Some polluters choose to pollute and pay for it, if the charge is not set at the appropriate level.
Growth. Consider growth expectations of existing and new industries more than may be possible under a regulatory approach. (Bernstein, J.D., 1997)	Government agencies and individual polluters may probably tend to resist the introduction of economic instruments.
Incentives. Emission charges may provide strong price incentives towards resource efficiency, e.g. by discouraging emissions.	Institutions. Usually required for proper implementation and enforcement, particularly in the case of charges and tradable permits. (Bernstein, J.D., 1997)
Full cost recovery. Government service providers are often under-funded, but full cost recovery may allow these institutions to be financially self-sustaining, thus freeing money for other expenses.	Water user-charges: they may have regressive effects borne at disproportionate levels by the poor, depending on the concrete pricing mechanism. A solution is to apply fees only above a certain level of usage volume.
Point sources. Charges may be applied to point sources, which are relatively easy to monitor or to non-point sources such as farms and urban areas where administrative and service fees are comparatively easy to collect.	Trade-off. Social issues vs. environmental effectiveness. Political considerations regarding social consequences of charges may lead to underestimated charge rates that do not cover the costs of the service provided and may be insufficient to have an impact on resource efficiency improvements.
Rewards. Careful and efficient users of governmental services or environmental goods may be rewarded to avoid the problem of indirectly subsidizing wasteful users. (GTZ, 2006)	Public Service providers conflict. If charges reduce demand for services, public service providers will lose clients, budgets and influence and may lead to accountability pressure. (GTZ, 2006)

Installation based Emissions Trading Schemes

Description

In an emissions trading scheme (ETS), regulated entities (responsible for emissions e.g. electricity generators) must hold allowances to match their emissions over a given timeframe. A cap on the total number of allowances available sets a limit on the total quantity of emissions. Regulated entities have the possibility to sell or purchase allowances, for minimizing their cost of compliance. Trading of allowances establishes a market price for emissions and promotes least-cost actions to meet the cap.

According to Hood, (Hood, 2010), in most schemes implemented or proposed, one allowance represents the emission of one ton of carbon dioxide equivalent (tCO_2e), that is, the equivalent quantity of another GHG that gives the same amount of warming based on emission factors adopted by UNFCCC. The unit of trade of an allowance is important, especially considering the potential for linkage in the long run.

Regulated entities responsible for emissions and required to report emissions and submit allowances can be “upstream” (e.g. petroleum suppliers) or “downstream” (e.g. motorists). The latter obligations provide a more immediate price signal to stimulate behavioral change and can be practical where a size threshold is used to limit the number of participants (as in the EU ETS) whereas, the upstream obligations are generally simpler and cheaper to implement as they involve fewer participants and there is usually better data available, but the price signal is less direct. It may be possible to mix upstream and downstream liabilities within a single ETS and to allow for the voluntary transfer of obligations downstream however, it depends on the design features of the ETS.

Requirements

A thorough assessment in terms of the conditions of the market, industry, and environment of the country has to be carried out where the ETS is planned to be implemented.

An analysis of institutional capacity is also desirable, as cap and trade systems usually require complex allocation and monitoring regulations. From a technological perspective, sophisticated systems need to be installed in order to prevent bad practices and even crimes when managing the allowances.

One of the most critical decisions in designing an ETS is setting the level of the cap that is the level of emissions that will be delivered by the scheme. Caps can be in absolute or relative terms. In absolute terms it refers to the quantity of emissions for the given time period, whereas relative terms refers for example to the behavior of economic parameters such as production levels or GDP. An absolute cap guarantees the level of emissions that will be delivered and is much more stringent, while a relative cap can allow for increases in emissions if production levels or GDP increase, or the other way around depending on the performance of the economic indicators. A variant of the scheme includes a "baseline and a credit", in which participants are assigned a target emissions pathway. They are liable for emissions above that level, but receive credits if emissions are below the baseline.

For an ETS to function properly, the cap must be set tightly enough to constrain emissions, so that there is demand for allowances and a price is established. Within the overall cap, there must also be procedures for distributing allowances to scheme participants. Allowances can be auctioned, grandfathered (allocated for free), or hybrid (combination of these). Grandfathering usually involves decisions based on historical emissions, current production levels, or some other formula. Other decisions include how to deal with firms that enter or exit the scheme and whether to provide credit for early action (before the scheme's beginning). If there is auctioning of units, the government has a revenue stream that may be used for revenue neutrality, for example, to offset the impacts of the scheme on consumers, businesses and the wider economy. (Hood, 2010)

The advantages and disadvantages that this scheme offers are presented in Table 13.

Table 13. Advantages and disadvantages of Installation-based ETS
Source: Own elaboration

Advantages	Disadvantages
Certainty. Emissions trading directly limits carbon pollution by prescribing a scheme cap that is designed to ensure compliance with the relevant international or domestic commitment. There is certainty about the level of carbon pollution for the period of time over which scheme caps are set.	**Market Susceptibility**.- when designing ETS systems there is certainty about quantities, but the carbon price is unknown, so competitive consequences can be relevant. A market without enough competition may be manipulated by a large individual firm. In a perfectly competitive market, in which many large traders are active, no single trader has control over the market price.
Revenue. If emissions permits are auctioned, this creates a source of Government revenue, which could be used to provide transitional assistance to households and businesses, or for any other purpose (e.g. supporting the development of low emissions technologies, or reducing other taxes).	**World Trade**.- An international market for emissions trading is likely to encounter the same problems as other international markets such as irresponsible stock and currency trade. Unregulated, the market for emissions permits could increase the socio-economic gap between countries.
Minimizing fiscal risk. Since emissions trading give a high level of confidence that emissions will match the country's international commitments, there is minimal risk left to taxpayers that they will need to purchase international units.	**Multiple Jurisdictions and Emission Leaks**.- If an ETS is implemented in a particular jurisdiction, there is a risk that any reduction in the level of emissions will simply be balanced out with an increase in another jurisdiction. (Bachmann, 2009)
Cost-effectiveness. Theoretically, companies will reduce emissions until marginal abatement costs are equal to the price of carbon. Therefore, excessive costs for some companies will be prevented with the market, reducing social abatement costs.	**Environmental Effectiveness.**- As noted by the literature for other MBIs like environmental taxes, monopolists or oligopolists may simply pass the cost through to consumers instead abating their GHG emissions, thus undermining the environmental effectiveness of the policy instrument.

The following box explains a practical experience using emissions trading schemes.

Box 2. Relevant experiences: Switzerland's Carbon Market
Source: International Emissions Trading Association

In 1999, Switzerland adopted the Act on the Reduction of CO_2 Emissions (CO_2 Act) as a supplementary environmental policy that centers on carbon dioxide (CO_2) mitigation. The voluntary ETS was designed to help achieve the 1999 CO_2 Act's goal of reducing CO_2 by 10% relative to 1990 levels by 2010. The CO_2 Act was implemented as a means of achieving most of Switzerland's Kyoto Protocol pledge to reduce total GHG emissions 8% relative to 1990 levels for 2008-2012. For 2013-2020, Switzerland aims to reduce GHG emissions by 20% relative to 1990 by 2020.

Scope:

- **2008-2012**, it covered firms that set absolute caps themselves in order to receive exemption from the CO_2 Act's carbon levy, where the emissions threshold for a company to qualify as a direct participant was at least 0.25 $MtCO_{2e}$/year.
- **2013-2020**, the Federal Council will specify economic sectors from which installations that operate with high or moderate GHG emissions may apply to participate in the ETS.

Each year over 2008-2010, ETS emissions were between 12% and 16% lower than targeted levels. According to FOEN (2011), "this outperformance demonstrates that the companies take their responsibilities towards the federal authorities seriously and in some cases have invested early in carbon reduction measures."

According to IETA (International Emissions Trading Association, 2013), the main challenges include:

1. Modifying certain program characteristics in order to link with the EU ETS.
2. The small size of this market results in less cost-effective reduction potential, liquidity, price stability, and flexibility in achieving targets.

4.1.3. Non Market Based Instruments

Non-MBIs are policy mechanisms that include regulatory instruments such as command and control regulations (public authorities mandate the performance and technologies to be used) as well as voluntary agreements (actors voluntarily agree to take action on GHG emission reductions). According to a study developed by OECD (OECD, 2010) non-MBIs may be more suitable where it may be difficult to monitor activities of private individuals, and where the impacts of their activities are confined to a particular location.

Regulatory Instruments

Description

Prior to 1990 virtually every environmental regulation took the form of command-and-control (CAC) regulations, and they are still commonly used. These regulations are so named because they "command" that emissions be "controlled" to meet a given minimum quality or maximum emissions standard. As such, they tend to be either technology-based or performance-based. (West, S., Wolverton, A., 2003)

- **Technology or design standards.** It mandates the specific control technologies or production processes that an individual pollution source must use to meet the emissions standard (e.g. end of pipe technology), regardless of whether such an action is the most cost-effective. They may be particularly useful in cases where the costs of emissions monitoring are high. However, since these types of standards specify the abatement technology required to reduce emissions, sources do not have an incentive to invest in more cost-effective methods of abatement or to explore new and innovative abatement strategies or production processes that are not permitted by regulation. This may have *competitiveness* implications.

- **Performance-based Standards.** Requires that polluters meet a source-level emissions standard, but allows a polluter to choose among available methods to comply with the standard. The available methods may be constrained by additional criteria specified in the regulation.

Performance-based standards allow for more flexibility given that the source may meet the standard depending on whether the standard specifies an emission level or an emission rate. The former allows a source to choose an appropriate technology, change its input mix, or reduce output to meet the standard. Whereas the latter may be more restrictive depending on how it is defined. (National Center for Environmental Economics, 2011)

Requirements

According to a study developed by UNEP (UNEP, 2004), the following requirements are critical for the proper design of regulatory instruments:

- Governmental Capabilities. Appropriate physical, human and organizational resources to collect and assess information of the environmental issues at hand, as well as technical and human capacity for decision making on appropriate mitigation measures.

- Legal Authority and efficacy. A functioning, responsive legal system is required for establishing and implementing norms and standards.

- Effective control system. A well-functioning control system with sufficient capacities (e.g. physical equipment, adequate number of competent employees) needs to be in place or to be set up.

- Effective and transparent consultation. Norms and standards should be enacted only after effective and transparent consultation. This process should enable governments to assess stakeholders' positions and gain access to their knowledge and experience, without allowing affected groups an inappropriate influence on the policy.

- Good political structure and clear priorities. Political commitment and appropriate political structures are needed to balance special interests with norms and standards enacted to protect or enhance public goods.

- Policy coherency. Coherency between different policies enacted is necessary for norms and standards to achieve the desired effect at reasonable cost.

Advantages and disadvantages that this scheme offers are presented in the table below.

Table 14. Advantages and disadvantages of regulatory instruments
Source: Own elaboration based on references mentioned

Advantages (Seik, 1996; Hricko 2004; Bartle and Vass, 2007)	Disadvantages
Directness and relative certainty of outcomes due to compliance measures.	Poor conditions for cost-minimization compared with emissions taxes and ETS.
Effectiveness and quickness when social damages are very high because of critical environmental problems or when human health is at stake.	There are limitations in the ability of these instruments to optimally engage the various channels for emissions reductions.
Significant effect on the control of air pollution in many countries (Ringquist, 1993).	Uncertainty in the potential amount of aggregate emissions reductions, although it may indicate limits on emissions at the facility or firm level.
Preferable in cases where the pollutant is so highly toxic that concern over their impact outweighs any economic efficiency concerns.	Uncertainties in terms of the effective price of emissions e.g. the shadow price of emissions or the marginal cost of abatement implied by the regulations. (Goulder L.H., Parry, I., 2007)
Preferred when the Marginal Abatement Cost Curves (MAC) are uniform across all of the firms in the regulated industry and the government can easily know the MAC curve.	Limited firm's ability to find the most cost-effective way to continue production while reducing pollution. This may occur given differing cost structures of individual firms, so a one-size-fits-all standard may not address their particular externality problems. This leads to economic inefficiency. (Gruber, J., 2005)
Marginal Benefits. Preferred when the initial reduction in the amount of pollutant significantly benefits society, while continued reduction doesn't offer as much benefit (Marginal Benefit of reduction is highly inelastic). (Gruber, J., 2005)	Low innovation incentive. It doesn´t necessarily stimulate the development of new technologies in the long run, as no incentives for companies exist to improve beyond the set standard.
Independent from market conditions, therefore supportive infrastructures such as functioning markets, tax and fiscal payment systems are not needed. (UNEP, 2004)	Vulnerability to free riding and corruption. If implementation means are weak, enforcement of norms and standards may be difficult. (GTZ, 2006)

The following box explains a practical experience in the use of regulatory instruments:

Box 3. Relevant experiences: European Directive on Waste from Electrical and Electronic Equipment
Source: GTZ, 2006

The Waste from Electrical and Electronic Equipment (WEEE) Directive is part of an overarching strategy to increase the responsibility of producers not only to finance recycling and disposal but also to provide incentives for minimizing life-cycle impacts of electrical and electronic equipment. The objective is to reduce waste by encouraging and setting criteria for the collection, treatment, recycling and recovery.

For each of the 10 product categories WEEE covers, producers are obliged to collect and recycle prescribed quantities of electrical and electronic equipment. EU member states are responsible for enacting domestic legislation that meets the requirements of the Directive including the organization of collection and recycling systems, the control and the waste treatment-logistics.

Usually responsibilities are differentiated:

- **Producers**: financing collection, treatment, recovery and environmentally sound disposal of WEEE, register of quantities of electrical and electronic equipment placed on the market, operation of return-collection systems.
- **Retailers/distributors:** provision of free take-back of WEEE for private consumers who are purchasing electrical equipment on an old for new basis, delivery of collected WEEE to designated facilities.
- **Private householders:** entitled to return WEEE to designated collection facilities without charge.

Challenges

- Definition of collection targets and product exemptions, which may complicate financing schemes.
- Supply disruptions for hazard free parts and wide variations in penalty clauses, as well as unpreparedness of many companies and governments to comply with their report obligations.
- Inter-EU trade in second hand goods since fees would have been paid in the country of original sale while final disposition occurred in a different jurisdiction.
- Exports of used electrical goods to developing countries given that these countries lack capabilities to effectively manage WEEE when it eventually reaches end of life.
- Information gathering and control which is needed to demonstrate compliance with collection and recycling targets.

Weaknesses

- Collection targets are considerably lower than collection performance in many European countries.
- Differences in the financing and operation of the systems in the different member states may distort incentives for producers to integrate environmental considerations in product design.

Conclusions: The Directive has achieved global significance and can be said to have established a new global standard for the phase-out of toxic substances and recyclability of WEEE, given the significance of the European market for the electrical and electronics industry. The Directive is an example of international scale implementation of the Producer Responsibility Principle and integration of external costs for products.

Voluntary Agreements (VA)

Description

Voluntary approaches are schemes whereby firms make commitments to improve their environmental performance beyond legal requirements. This definition provides a wide scope, since it also applies to self regulatory arrangements (e.g. voluntary codes).

In fact, some authors define voluntary agreements in opposition to regulation (Borck and Coglianse, 2009). This idea is very common in the literature, considering the agreements as a second best world when regulation is not possible or too costly (Krarup, 2001).

The main types of voluntary approaches include the following:

- **Public voluntary programs:** involve commitments devised by the environmental agency in which individual firms are invited to participate. Participation is voluntary.
- **Negotiated agreements:** involve commitments for environmental protection developed through bargaining between a public authority and industry. They are usually signed at the national level between an industry sector and a public authority, although agreements with individual firms are also possible.
- **Unilateral commitments:** set by the industry acting independently without any involvement of a public authority. (Börkey, P. et al., 1998)
- **Voluntary programs for firms:** designed to provide green consumers and investors with new information that may alter their consumption and investment patterns in favor of cleaner firms. Firms may also use their environmental achievements to differentiate their products from competitors' products.

- **Product labeling:** applied to either intermediate inputs in a production process or to a final good. Labels on intermediate goods encourage firms to purchase environmentally responsible inputs. Labels on final goods allow consumers to identify goods produced using a relatively clean production process.

Requirements

There is a broad array of Voluntary Agreements available depending on the context. According to Börkey (Börkey, et al., 1998), some recommendations on the implementation of voluntary approaches include:

- *Clearly defined targets:* VAs should define quantitative targets and the setting of interim objectives is crucial since they allow all the parties to identify difficulties arising during implementation at an early stage.

- *Characterization of a business-as-usual scenario:* Before setting the targets, estimates of business-as-usual trends should be established in order to provide a baseline scenario.

- *Credible regulatory threats:* Made at the negotiation stage, a threat of regulation by public authorities provides companies with incentives to go beyond the business-as-usual trend.

- *Reliable monitoring:* Monitoring constitutes the key to avoiding failure to reach targets. It should be made both at the firm and sector level in the case of collective VAs.

- *Third party participation:* Involving them in the process of setting the objectives and the performance monitoring of VAs increases their credibility. Environmental performance should be made public and transparent.

- *Individual penalties for non compliance:* Provisions should be made for individual sanctions for non-complying firms, by either making binding commitments, or by establishing linkages between VA commitments and regulatory requirements.

The advantages and disadvantages that this scheme offers are presented in the table below.

Table 15. Advantages and disadvantages of voluntary agreements
Source: Own elaboration

Advantages	Disadvantages
Participation may entail benefits (avoidance of costs)for firms in the form of regulatory flexibility, preemption of existing regulation, and improved anticipation of future regulation.	Participation may be costly for both firms and regulators. Both the bargaining processes and the administration of the agreement require resources plus opportunistic behavior of partners can translate into transaction costs. Regulators risk poor compliance from firms as VA are legally non-binding.
Companies are allowed to act in advance to command-and-control regulation; this allows them to reach emission targets at their own pace and through their own means.	**Free-riding behavior**. Many benefits are of a collective nature thus, provides the incentive to free ride and to benefit from the shared results. If the number of free riders is too high the system may collapse plus it imposes higher costs on complying firms.
Participation in VA may help anticipate and shape future regulations, it may allow firms to influence and learn about potential future regulations, thus earning a competitive advantage.	**Uncertainties** in terms of the effective price of emissions; the shadow price of emissions or the marginal cost of abatement implied by the regulations. (Goulder L.H., Parry, I., 2007)
Opportunity to develop innovative environmental solutions that may improve their performance and provide competitive advantages. (Delmas, M., Terlaak, A., 2001)	**Potential low effectiveness** in achieving environmental benefits in case of no compliance by the involved parties.

4.2. Selection and assessment of critical design elements of policy instruments to reduce GHG emissions in the Oil and Gas sector

Based on the existing literature, the presented policy instruments were assessed against different criteria, such as environmental effectiveness, economic efficiency, transaction costs, economic impacts, technical requirements and capacity gaps, compatibility with international systems, or political practicality (Michelowa, 2012; ECORYS, 2014).

Table 16. Listing of critical design elements of GHG emission reduction policy instruments
Source: Own elaboration

1. Environmental Effectiveness
2. Economic Efficiency
3. Transaction Costs
4. Economic Impacts
5. Technical Requirements and Capacity Gaps
6. Compatibility with International Systems
7.Political Practicability

The assessment methodology followed in this section is straightforward. For each of the assessment criteria, policy instruments receive scores of 0 (non-existent), 1 (low), 2 (medium) or 3(high). For each policy instrument, the total "positive" scores (i.e. the scores received at criteria such as environmental effectiveness, economic efficiency, compatibility with New Market Mechanism (NMM), political practicability) are added up, and then the total "negative" scores (i.e. scores received at transaction costs, economic impacts, technical requirements) is subtracted from the initial figure.

4.2.1. Environmental effectiveness

The key design element of any climate change mitigation policy instrument is environmental integrity, which **in light of the new international framework refers to the ability of the policy instrument to contribute to reducing GHG emissions**. Unlike the Clean Development Mechanism, where emission reductions are used to offset GHG emissions by compliance entities, the NMM defined during the Durban Conference of the Parties (COP) in 2011 needs to achieve a net atmospheric benefit by itself, i.e. not just offset GHG emissions by a country with GHG emission limits but achieve a net decrease of GHG emissions (Michelowa, 2012; ECORYS, 2014).

As it has been widely discussed in the literature, **under perfect market conditions cap and trade schemes are able to provide environmental protection at a lower cost**, especially in those cases of scarce information available about technology costs and emission mitigations. For instance, if the cost of reducing GHG emissions is higher than considered initially (i.e. if the actual marginal abatement cost curve is higher than the expected marginal abatement cost curve), then carbon taxes –unlike cap and trade schemes– will not be able to meet desired GHG emission reduction goals (EPA, 2003). The environmental effectiveness of cap and trades will of course depend on advance knowledge of actual emission levels and the stringency of the cap. As the experience of EU ETS and other environmental markets suggest, over-allocation of allowances will

lead to low carbon prices, thereby undermining the instrument's environmental effectiveness (Michelowa, 2012).

Sectoral crediting (defined as "credits being issued ex-post based on sectoral no-lose targets to individual operators", see ECORYS, 2014) **may only be comparable to cap and trade schemes in terms of environmental integrity if absolute emission baselines are established**. No matter how ambitious, indexed baselines, which are based on benchmark carbon intensities by unit of output, may fail to achieve absolute GHG emissions reductions if economic growth outpaces the relative efficiencies achieved by the policy instrument in terms of lowering carbon intensity. As proposed by the European Commission, a more balanced compromise between economic growth and environmental protection may be struck **if the sectoral crediting sets binding carbon intensity levels and credits are issued only beyond that carbon intensity level or benchmark** (ECORYS, 2014).

Performance-based standards in terms of technologies and processes, by definition focus on carbon intensity rather than on absolute emission levels, and have the ability to reduce GHG emissions in a manner that is comparable to sectoral crediting. **Voluntary sectoral agreements rank lower in their environmental effectiveness score due to lack of certainty of emissions reduction and lack of environmental ambition**. However, if structured robustly they have other advantages both for regulators and the regulated community, in terms of capacity building and understanding sectoral emissions, which may make them attractive especially in a previously unregulated domain (EPA, 2012; Price, 2005).

Table 17. GHG Policy Instruments' environmental effectiveness
Source: Own elaboration

GHG Policy Instrument	Environmental effectiveness
Sectoral crediting	2
Cap and trade	3
Carbon tax	2
Performance-based standard	2
Voluntary agreements	1

4.2.2. Economic Efficiency

Economic efficiency is defined as the ability of the policy instrument to achieve low-cost GHG reduction opportunities (i.e. if lowest-cost options are first mobilized, and then, once exhausted, options with the second-lowest options are taken up) (OECD 2003; Michelowa, 2012).

As discussed extensively by the literature, **market-based instruments can be more cost-efficient than command and control measures including performance based standards to reduce GHG emissions**. Within MBIs, instruments providing general carbon price signals like carbon taxes and emission trading schemes are more efficient than sectoral crediting, which (depending on their design) may fail to capture low-cost GHG reduction opportunities. Voluntary agreements will be highly cost efficient, as covered entities will only undertake those GHG emission reduction activities which have a negative carbon abatement cost.

Table 18. GHG Policy Instruments' economic efficiency
Source: Own elaboration

GHG Policy Instrument	Economic efficiency
Sectoral crediting	2
Cap and trade	2
Carbon tax	2
Performance-based standard	1
Voluntary agreements	3

4.2.3. Transaction costs

A broad definition of transaction costs exceeds those incurred during market exchanges, and includes "all the costs of gathering information, making decisions/contracting and controlling/policing" (OECD 2001 in Jaraité 2010).

GHG emission reduction instruments give rise to transaction costs for public authorities running the program, and for private entities covered by the program. In broad terms, transaction costs in GHG emission reduction instruments will include: (a) one-off costs for public authorities related to the establishment of the system, including baseline studies, economic impact assessments and the establishment of reporting tools, registries and exchange venues; (b) recurrent monitoring, reporting and verification costs for public and private authorities; (c) recurrent costs related to the enforcement of the program for public authorities; and (d) in some policy instruments, recurrent costs related to trading of emission allowances or carbon credits, also for public and private authorities.

Sectoral crediting mechanisms will face high transaction costs related to baseline setting, as initial resources will be necessary to draw standardized carbon intensity baselines and policy objectives for each of the technology/process targeted by the GHG emission reduction policy instrument. The extent to which sectoral crediting will entail MRV and enforcement costs will depend on whether achieving the carbon intensity policy objective will be voluntary or mandatory for individual installations. Trading costs will be limited, as crediting and subsequent trading will only occur if the sectoral target is met.

Cap and trade schemes will face the highest transaction costs. Baseline setting will involve an effort similar to sectoral crediting. When it comes to MRV, however, measuring the total GHG emissions in stationary sources (and not just the net GHG reductions) will entail granting emission permits, approving monitoring plans, installing measurement equipment, keeping track of the fuel combusted, drafting GHG emission reports and undergoing third party verification. Enforcement provisions will include penalties for not submitting real or timely GHG emission information, or for failing to surrender the required number of emission allowances. Establishing and maintaining a trading system of carbon units, in turn, will entail setting up emission allowance registries, drafting or adapting accounting and fiscal rules, as well as establishing financial controls to ensure effective governance of the system (Michelowa, 2012).

According to the Impact Assessment for EU ETS's 2008-2012 trading period, administrative costs for operations range between EUR 2,000 (2,520 USD) and EUR 15,000 (18,900 USD) per site per year, and for authorities between EUR 3,000 (3,700 USD) and EUR 10,000 (12,600 USD) per site per year. This cost would vary significantly depending on the size of the facility and the industrial sector, with large facilities incurring over EUR 100,000 (126,000 USD) per year (but keeping

transaction costs at around EUR 0.05 [0.063 USD] per tCO2e), and small facilities incurring EUR 7,500 (9,450 USD) per year (and having transaction costs over EUR 1 per tCO2e)[5]. A specific study for UK companies provides some detail pertinent to the Oil and Gas Sector, pointing out to the high administrative costs incurred by refineries under the EU ETS, due to fuel sampling and analysis costs, MRV management systems, maintenance and calibration of meter system and verification activities. The overall annual cost would be of GBP 125,000 (200,000 USD) for refineries, compared to the GBP 60,900 (110,400 USD) of large electricity producers, GBP 15,000 (24,000 USD) of chemical plants (Aether, 2010).

When compared to sectoral crediting and cap and trade schemes, carbon taxes will face reduced transactions costs. Transaction costs will be related to MRV and to revenue collection, thereby saving resources that are necessary to hand out or auction emission allowances, as well as to establish, process and oversee carbon trading systems. Some developing countries like South Africa have pointed out to the administrative complexities of cap-and-trade systems to substantiate a carbon tax policy option (Republic of South Africa, 2013).

Performance-based standards will also face high transaction costs related to baseline setting in the Oil and Gas industry[6]. Although regulating air pollution in general and not global warming in particular, US EPA's Oil and Natural Gas New Source Performance Standards (NSPS) and EU's Integrated Pollution Prevention and Control (which covers mineral oil and gas refineries, as well as large volume inorganic chemicals) provide good examples of the extent to which performance-based standards require extensive baseline-setting (EC 2003; EC 2007; EPA 2012). Once in place, there are substantial on-going MRV costs for the regulated community, as the regulator will track the information on an on-going basis and will issue revisions amendments or sanctions in case of non-compliance. Trading of carbon units is non-existent.

Voluntary agreements on the other hand provide flexibility to participating entities to assess their needs and focus their activities on areas of highest impact within reasonable cost-effectiveness boundaries. Well run public-private partnerships help companies create plans that include knowledge about the relevant sector share knowledge that has the highest likelihood of reducing emissions. However, there is a need to institute a mechanism of rewards and recognitions for voluntary actions in order to achieve the desired targets (EPA, 2012).

Table 19. GHG policy instruments' transaction costs
Source: Own elaboration

GHG Policy Instrument	Baseline	MRV	Enforcement	Trading	Mean
Sectoral crediting	-3	-1	-1	-1	-2
Cap and trade	-2	-2	-3	-3	-3
Carbon tax	-2	-2	-2	0	-2
Performance-based standard	-3	-2	-2	0	-2
Voluntary agreements	-2	-2	-1	0	-1

4.2.4. Economic impacts

The introduction of climate change mitigation policies has positive and negative impacts on the economy, both among companies and households. The existing literature discusses the first issue

[5]Exchange rate 1 EUR=1.26 USD, 1 GBP=1.60 USD, October 22nd 2014.

[6]Although performance based standards may have high base-line setting costs for existing industries, these standards may be implemented for new industries, for example, by using international best practices to set minimum standards for construction of new industrial facilities.

under the topic of carbon leakage, i.e. from an international perspective. The second issue, in turn, addresses how potential adverse impacts on low-income households can be addressed.

According to the IPCC, **carbon leakage can be defined as "the increase in CO_2 emissions outside the countries taking domestic mitigation action divided by the reduction in the emissions of these countries"** (IPCC, 2007). Carbon leakage is caused by asymmetrical carbon policies, i.e. due to the fact that under the existing international regime, which is based on the principle of common but differentiated responsibilities, the price of emitting GHG varies substantially from one jurisdiction to another. However, asymmetrical carbon policies are just a prerequisite for carbon leakage, which will only occur effectively if a given sector is unable to pass-through the new carbon cost down the economic value chain, either because it faces a significant increase in its production cost or because it is highly exposed to international competition (Marcu et al, 2013).

The introduction of a carbon price in TT may translate into significant cost implications to the industry. According to recent information made available by the European Commission for European installations, a carbon price of 30 € per tCO_2 would increase the costs of manufacture of refined petroleum products in 17.9% of the sector's gross value added, and the costs of manufacture of fertilizers and nitrogen compounds by 31.8% (EC, 2014).

Market-based instruments like cap and trade schemes and carbon taxes have different ways of addressing the risk of carbon leakage. Cap and trade schemes like the EU ETS or the California's cap-and-trade regulation provide the following compensation and support mechanism to avoid carbon leakage: (a) provision of free allocation of allowances (up to the sector's benchmark); (b) use of "in-country" or international offsets up to a given threshold; (c) flexibility in terms of banking and borrowing of allowances over time; (d) compensation of indirect CO_2 costs related to the increase of electricity; (e) revenue sharing and public benefit utilization of proceeds from emission allocation auctions (Marcu et al., 2013).

In the same way, carbon tax schemes like South Africa's proposal introduce the following measures to address the risk of carbon leakage: (a) a basic tax-free threshold of 60% of the total GHG emissions; (b) additional 10% tax-free threshold of trade exposed sectors; and (c) the possibility of using international offsets like CER units from the CDM up to additional 10% (Republic of South Africa, 2013). Sectoral crediting mechanisms and performance-based standards will need to devise comparable compensation and support mechanisms.

Climate change mitigation policy instruments also generate distributional impacts among low-income households, due to increases in the cost of electricity and transport fuels. South Africa's carbon tax proposal suggests that several revenue recycling options are available to address this issue, such as tax shifting, rebates, tax incentives and other mechanisms (Republic of South Africa, 2013). The same measures would be applicable to cap and trade schemes, provided that a portion of the emission allowances are auctioned and the government is able to generate revenue that can be shared with the public or used to fund public benefit programs such as education, public health, innovative technologies and more. Sectoral crediting mechanisms and performance-based standards would need to counter undesired distributional impacts with external sources of finance. Voluntary agreements would typically not have such economic impacts. By design, they provide flexibility of implementation, focusing first on measures that result in reduced losses of material and efficiency of production and thus lower potential impacts.

Table 20. GHG policy instruments' economic impact
Source: Own elaboration

GHG Policy Instrument	Competitiveness without support mechanisms	Competitiveness with support mechanisms	Low-income households (increase in energy outputs)
Sectoral crediting	-1	0	-2
Cap and trade	-2	0	-1
Carbon tax	-2	0	-1
Performance-based standard	-3	-2	-2
Voluntary agreements	0	0	0

4.2.5. Technical requirements and capacity gaps

Establishing a policy instrument to mitigate GHG emissions in TT´s O, G&P sector will require a minimum set of technical requirements. The existing literature for market readiness suggests the following technical building blocks: (a) "baseline setting", i.e. collecting data on GHG and output at installation level to establish a baseline as well as a carbon intensity target; (b) "monitoring, reporting and verification"; (c) "registry and transaction log", i.e. setting-up a registry and a transaction log to issue, hold and transfer carbon credits or emission allowances (IEA/OECD, 2010; World Bank, 2012).

Baseline setting for market-based instruments entails choosing a reference year or period as the basis of an emission cap or baseline. The existing methodologies for collecting GHG emissions include general (top-down, official) IPCC guidelines for developing national GHG inventories (IPCC, 2006), as well as overall (bottom-up, private and voluntary) guidelines for reporting carbon footprint and GHG emissions (WRI/WBCSD GHG Protocol, ISO standards to report carbon footprint, see WBCSD, 2004), including oil and gas industry standards (IPIECA, 2011).

In addition, baseline-setting will entail gathering installation-data output information so that carbon intensity standards or benchmarks can be developed. Defining the most appropriate unit of output or benchmark unit is not a straightforward task in sectors with several outputs, which is the case of the petrochemical sector. However, international practice suggests that existing technical complexities can be overcome with public-private cooperation. For instance, with support of Conservation of Clean Air and Water in Europe (CONCAWE), the EU has applied a specific benchmark called Solomon "CO_2 weighted ton" (CWT) approach to hand out free allowances in the EU ETS (ECOFYS, 2009).

Data gathering will begin by collecting existing, readily available data such as energy statistics, and then addressing data gaps through specific surveys. Confidentiality concerns are likely to appear in sectors where a few large firms dominate and shape its direction, an issue which will be more sensitive in cap and trade schemes rather than carbon taxes or sectoral crediting, and which will require masking the data once aggregated (IEA/OCDE, 2010).

Robust and transparent MRV mechanisms are key in proving environmental effectiveness, and hence a pre-requisite for linking with various approaches and NMM arising from international climate change agreements. **MRV mechanisms will have a different approach in systems which keep track of all GHG emissions (i.e. cap and trade systems and carbon taxes) and in systems which keep track of GHG emission reductions only (i.e. sectoral crediting).** The technical requirements of MRV for sectoral crediting will depend on their technical design (a

NAMA-like MRV system if crediting stays within the government, and a CDM-like system if crediting is passed-on to individual installations). In any case, third-party verification of GHG emissions and GHG emission reductions will be instrumental in increasing transparency. This will require developing an accreditation mechanism for verifiers, and building capacity (among the private sector) to carry out external verification checks. The CDM experience has built capacity in a series of international companies with global reach.

Finally, some policy instruments like a cap and trade system and the sectoral crediting will require establishing and maintaining a trading system of carbon units. From a technical perspective, the carbon registry will be instrumental in creating, holding and cancelling carbon units while the transaction log will drive the transfer of units across accounts (IEA/OCDE, 2010).

The table below further describes the technical requirements to mitigate GHG emissions in TT´s O, G&P Sector. It also defines the identified gap level, as well as to the existing elements to build capacity.

Table 21. Functions, institutional elements, gap level and existing elements to build capacity for a sectoral GHG emissions reduction measure
Source: Own elaboration

Building Block/Technical requirement	Description	Gap level	Existing elements to build capacity
Baseline setting	• Define overall baseline and overall GHG reduction objective	Medium/High	• EPPD has mandate, experience in planning for sustainable development, but lacks specific experience
MRV	• Define an annual compliance cycle • Develop and maintain GHG reporting procedures and formats • Establish and operate an accreditation system for verifiers	Medium/Low	• EMA familiar with draft air pollution rules, but lacks specific capacity in GHG reporting • Lack of specific capacity, but accreditation body available
Registry and transaction log	• Set up and operate a registration and issuance system for emission allowances or carbon credits	High	• Nonexistent capacity with carbon registries

Based on the above, the different GHG policy instrument's technical requirements and capacity gaps have been assessed as reflected in the table below.

Table 22. GHG policy instruments' technical requirements and capacity gaps
Source: Own elaboration

GHG Policy Instrument	Technical requirements
Sectoral crediting	3
Cap and trade	1
Carbon tax	1
Performance-based standard	0
Voluntary agreements	2

4.2.6. Compatibility with international systems

On-going negotiations (which will hopefully lead to a global and ambitious post-2020 GHG limitation agreement, to be reached in COP 21 in December 2015) are shaping up the landscape of international systems to mitigate GHG emissions.

The Durban Decisions (December 2011) have set dual, complementary approaches: on one hand, a framework for various approaches (FVA) to promote cost-effective GHG emission reduction actions; on the other, a NMM that is to meet standards that deliver real, permanent, additional and verified mitigation outcomes, avoid double counting of efforts, and achieve a net decrease and/or avoidance of greenhouse gas emissions (Decision 2/CP.17 as referred to by Michelowa, 2012). Interestingly, the views of different negotiating blocks are divided as to what extent FVA should include mechanisms other than Kyoto Protocol flexibility mechanisms and the NMM, i.e. whether unilaterally driven market mechanisms and non-market approaches could be considered under FVA. While the EU prefers a strict definition of FVA, OECD countries like Japan, USA, New Zealand, and Australia are in favor of accepting party-driven market mechanisms. In contrast, the Alliance of Small Island States, South Africa, and the Environmental Integrity Group (including Mexico and the Republic of Korea) favor a broad definition of FVA (IGES, 2014).

Sectoral crediting and cap and trade mechanisms (and, to a lesser extent, carbon taxes) are compatible with FVA and NMM, whereas performance-based standards would only be compatible under a broad definition of FVA. Similarly, voluntary agreements would also fit only under the definition of FVA.

In all cases compatibility with international systems will require the use of internationally agreed (a) "currency" units, i.e. reporting of different GHG aggregated in units of tons of carbon dioxide equivalent; as well as the use of (b) internationally agreed principles and standards, e.g. the principles and tiered methods to build national GHG inventories.

Table 23. GHG policy instruments' compatibility with international systems

Source: Own elaboration

GHG Policy Instrument	With FVA (broad definition)	With NMM
Sectoral crediting	1	3
Cap and trade	1	3
Carbon tax	1	3
Performance-based standard	1	1
Voluntary agreements	1	0

4.2.7. Political Practicality

In general terms, GHG policy instruments with high compliance costs will usually face strong opposition from the affected entities. For this reason sectoral crediting will be more attractive than carbon taxes to entities impacted by the regulation, whereas cap and trade and performance-based standards are likely to face some opposition. Voluntary agreements are possibly a path of least resistance (politically) but they would have barriers in terms of engaging the industry sector. Well-

articulated voluntary agreements could serve as an initial phase for gaining information and relevant data for more ambitious policy actions design down the road.

The political practicality of the GHG policy option will depend on the final design of the policy instrument. For instance, a voluntary sectoral crediting mechanism which credits carbon intensity benchmarks below a threshold will be more attractive than a binding crediting mechanism requiring a minimum performance per unit of output. The devil is in the details for theoretically stricter carbon tax and cap and trade schemes, as generous tax-free thresholds and free allocation procedures can minimize compliance cost for covered entities (while undermining environmental effectiveness). Interestingly, the literature suggests than cap and trade schemes are more palatable for covered entities than binding crediting mechanisms, because cap and trade schemes (contrary to sectoral crediting) transfer allowances ex-ante, thus providing an additional source of funds to finance GHG emission reduction projects (ECORYS, 2014).

In any case, regardless of the policy instrument chosen and the underlying abatement costs introduced by it, an early and well-designed stakeholder involvement will be very important in attaining acceptance by the sectors affected by the policy instruments. Technical assistance programs like the World Bank's Partnership for Market Readiness provide careful attention to organization, communication, consultation and engagement (World Bank, 2012).

Political practicability should not be a totally negative element here if politicians can present it as the creation of a new type of market with associated jobs through the MRV process and trading, as well as the environmental and public health improvements and international goodwill related; arguments perfectly consistent with the implementation of a sectoral crediting mechanism.

Table 24. GHG policy instruments' political practicality
Source: Own elaboration

GHG Policy Instrument	Political practicality
Sectoral crediting	3
Cap and trade	1
Carbon tax	1
Performance-based standard	0
Voluntary agreements	2

4.2.8. Overview and discussion

The table below provides an overview of the relative advantages and disadvantages of each climate change mitigation policy instrument against the different design elements. The comparison triggers a trade-off (and a compromise to be found) between environmental effectiveness on one hand, and transaction costs, technical requirements and political practicability on the other (ECORYS, 2014).

Based on a very preliminary, qualitative and non-weighed approach, which takes into account the strengths of weaknesses of different policy instrument, **voluntary agreements and loose market-based instruments like sectoral crediting or carbon taxes would be more appropriate than cap and trade and performance-based standards**.

Table 25. Comparative analysis of GHG policy instruments
Source: Own elaboration

	SCM	Cap & Trade	Carbon tax	Standards	Voluntary agreements
Environmental effectiveness [+]	2	3	2	2	1
Economic Efficiency [+]	2	2	3	1	3
Transaction costs [-]	-2	-3	-2	-2	-1
Economic impacts after support mechanisms[-]	-1	-2	-2	-2	0
Technical requirements [-]	-2	-3	-1	-3	-2
Compatibility w/ NMM [+]	3	3	3	1	0
Political practicality [+]	3	1	1	0	2
Total (positive scores minus negative scores)	10-5=5	9-8=1	9-5=4	4-7=-3	6-3=3

4.3. Multi-criteria evaluation of policy instruments to reduce GHG emissions in the Oil and Gas Sector

The previously listed climate change mitigation policy instruments were assessed against broader assessment criteria, such as co-benefits of GHG emission reduction actions in the O, G&P sector, legal and institutional requirements, donor interest and political barriers to implementation.

4.3.1. Co-benefits of GHG emission reduction actions in the oil and gas sector

The recent literature review by the IPCC suggests that climate change mitigation policy instruments have positive and negative impacts on broader economic, social, and environmental objectives (IPCC, 2014).

Most of the studies carried out so far focus on the social and environmental objectives attained by climate change mitigation policy instruments which reduce local air pollution, and thus have positive impacts on human health, ecosystems, crop yields and buildings (OCDE, 2009)[7].

In the Oil and Gas industry, for instance, the new regulation issued by the EPA to avert leaks and vents in hydraulically fractured gas wells expects health benefits associated to reduced exposure to Hazardous Air Pollutants (HAP), volatile organic compounds (VOC), ozone and fine particulate matter (PM 2.5). The regulatory impact assessment reports recognize some negative effects due to the local air pollutants and CO_2 emissions associated with combustion of HAP and VOC, but the magnitude of these secondary air pollutant impacts is considered small (EPA, 2012).

[7]Even though natural gas is a cleaner fuel than other fossil fuels such as coal or heavy oils, its combustion produces polluting air emissions. For instance, when it is used for Fossil fuel combustion, for instance, the average emissions rates in the United States from natural gas-fired generation are: 0.1 lbs/MWh of sulfur dioxide, and 1.7 lbs/MWh of nitrogen oxides according to EPA (2000). Most of the documents reviewed provide figures which summarize the like between GHG emissions and local pollution. For a general review, see IPCC (2014) and OECD (2009). See EPA (2012) for a general diagram summarizing the environmental benefits of addressing venting and leaks of natural gas.

Climate change mitigation policy instruments that reduce energy-related CH_4 and CO_2 emissions will also have positive economic, social, and environmental impacts derived from energy security and energy efficiency improvements. Additional natural gas recovery through reduced leaks and venting will contribute to a more efficient exploitation of natural resources, thereby contributing to energy security. Reduced energy and CO_2 intensity in the petrochemical industry, in turn, will improve energy security, enhance competitiveness and productivity, and improve safety, working conditions and job satisfaction. Importantly, energy efficiency improvements in terms of electricity saving will reduce requirements for addition of new electricity capacity (IPCC, 2014).

The literature also discusses the technological spillovers related to climate change mitigation policy instruments in the industry. Multinational companies may try to avoid the probability of imitation and technology leakage leading to loss of intellectual property (patents). However, studies point out to the existence of technological spillovers that are related to new climate change mitigation policy studies, especially through supply-chain inter-linkages (IPCC, 2014).

Table 26. GHG policy instruments economic, social and environmental impacts
Source: Own elaboration

	Economic	Social	Environmental
Reduction of Local Air Pollutants due to reduced fuel combustion (CO_2)	Reduced material damages (corrosion) in built environment Reduced plant biological ageing in agriculture and forestry	Reduced health impacts related sulfur dioxide and nitrogen oxides Less expenditure on fuel subsidies, providing benefits for the society of T&T	Reduced acidification, eutrophication of ecosystems and water pollution
Reduction of Local Air Pollutants due to reduced leaks and venting (CH_4)		Less expenditure on fuel subsidies, providing benefits for the society of T&T	Organic PM vegetation effects, visibility effects
Increased energy efficiency	Energy security (via reduced energy intensity) Employment impact Competitiveness and Productivity Technological spillovers due to supply chain linkages	Safety, working conditions and job satisfaction Less expenditure on fuel subsidies, providing benefits for the society of T&T Creation of green jobs reducing dependence of the economy on oil sector	Ecosystem impact via reduced fossil fuel extraction

The economic, social and environmental co-benefits achieved by the different policy instruments available to reduce GHG emissions in the O, G&P sector will depend on the specific control techniques that are promoted by each policy instrument. Performance based standards have more control on the process/technology implemented, and are more suitable to lead to social and environmental benefits. General policy instruments like a carbon tax, by contrast, will have the virtue of abating GHG emissions cost-efficiently (i.e. abatement of tail gases), but the risk that GHG abatement would not address local pollution, energy efficiency or energy security. By targeting specific installations and GHG emission sources, quantity-based instruments like cap and trade can contribute substantially to economic, social and environmental co-benefits other than GHG reduction. With Voluntary Agreements and other non- binding instruments companies will implement the most cost-effective measures based on their particular circumstances, and the emission reductions may not be applied similarly nationwide and different communities will benefit differently depending on the locations of the operations where mitigation measures are applied.

Table 27. Co-benefits of the different GHG policy instruments
Source: Own elaboration

GHG Policy Instrument	Economic	Social	Env.	Average
Sectoral crediting	2	1	1	1
Cap and trade	2	2	2	2
Carbon tax	2	2	1	2
Performance-based standard	2	3	3	3
Voluntary standards	1	1	1	1

4.3.2. Legal and Institutional requirements

Climate change mitigation policy instruments require adequate institutional and legal frameworks to set up the system, address economic impacts, enforce the obligations related to the industry and (in case of some market-based instruments) issue trading units and regulate trading activities.

Policy thrust and coordination to set up and run policy instrument is a legal and institutional requirement relevant to any of the policy options discussed in this document. This function is likely to be carried out by the MEWR.

This entails the authority to establish and implement a penalty regime for non-compliance, both for entities covered by the instrument and for third-party auditors in charge of applying MRV systems transparently. Enforcement requirements will be high in policy instruments which require regular and mandatory GHG emission checks and control, such as cap and trades and carbon taxes; and reduced in policy instruments where GHG emission reductions are deemed to have taken place after the mandated process or technology change. Said functions would be likely to be assumed by the EMA, which appears to be the enforcement body in TT.

Some policy options like sectoral crediting require establishing a trading system. From the regulatory perspective, this will require several adjustments including (a) direct and indirect taxation and accounting guidance for companies generating, transferring, acquiring or surrendering trading units; (b) regulation of trading units, (c) rules to exchange financial instruments or rules to market energy products[8]. TT, a country with experience in commodities and financial services, appears to have an adequate legal and institutional capacity to regulate carbon trading activities, for instance through the TT Stock Exchange.

Finally, institutional and legal capacity will be required to establish compensation support mechanisms which address negative economic impacts. As discussed previously, carbon taxes and cap and trades have advantages when compared to sectoral crediting and performance-based standards, as (a) design options exist to introduce "safety valves" and reduce the compliance cost of covered entities; (b) they generate new revenue which can be used to offset negative economic impacts. The Ministry of Finance and the Economy has longstanding experience in taxing the TT's O, G & P sector.

[8] Over time, the EU ETS has developed a robust market oversight framework which provides valuable good practice for other cap and trades (EC, 2010).

Table 28. Legal and Institutional requirements, gap level and elements to build capacity
Source: Own elaboration

Building Block/Legal and Institutional	Description	Gap level	Existing elements to build capacity
Policy thrust and overall coordination	• Technical setup • Stakeholder consultation and political buy-in • Linking to international commitments	Medium	• Ministry of Environment and Water Resources is in charge of implementing TT's climate change policy
Enforcement	• Penalties to installations • Penalties to verifiers	Medium	• Existing body to perform third-party accreditation (ACCT) • EMA with environmental protection mandate
Issuance of trading units (sectoral crediting and cap and trade only)	• Ex-ante (cap and trade) or ex-post (sectoral crediting) issuance of trading units	High	• Nonexistent capacity with carbon registries
Regulating Trading (sectoral crediting and cap and trade only)	• Taxation • Accounting • Electronic exchanges • Financial services	Medium/Low	• Financial institutions with experience in commodities (e.g. TT Stock Exchange)
Addressing economic impacts	• Installation level incentives, as well as direct and indirect support programs to avoid loss of competitiveness • Measures to address distributional impacts	Medium/Low	• Ministry of the Finance and the Economy with experience in taxing the Oil and Gas sector

In line with other sections of this document, the analysis of the legal and institutional capacity suggests that performance-based standards are the policy options where legal and institutional requirements are more limited, followed by carbon taxes, sectoral crediting and cap and trade. For voluntary agreement the requirement is primarily political will to partner with industry and incentivize the undertaking of voluntary mitigation action by industrial entities. The success of such an approach is based on setting the rules for participation and firm guidelines for "claiming" reductions as well as making sure that companies accomplishments are recognized publicly.

Table 29. Enforcement and legal requirements of GHG policy instruments
Source: Own elaboration

GHG Policy Instrument	Enforcement Framework	Trading and trading regulation Framework
Sectoral crediting	-2	-2
Cap and trade	-3	-3
Carbon tax	-3	0
Performance-based standard	-2	0
Voluntary agreements	-1	0

4.3.3. Donor interest

In the implementation process of a climate change mitigation policy the upfront, operation and extra costs must be considered and their financing resolved beforehand. As to the upfront costs, a viable alternative would be to get financing from a foreign country or a multilateral entity (i.e. WB, IDB, and UNDP). This would be a more attractive alternative because even though it requires

additional accountancy to monitor the funds, it would also yield the benefit (in the case of the multilateral entities) of a broad experience in the subject (Bolscher, van der Laan, & Stephan, 2012).

Considering the latter, **international donors such as Multilateral Banks, Inter-Governmental Organizations, and Agencies for Development represent a plausible alternative for the host country to seek support when addressing the financial needs of the policy**. For instance, the World Bank is a United Nations banking institution that provides loans for developing countries to support their development, it has in fact executed several assessment projects in TT. In turn, the Natural Gas Star International program is a voluntary initiative that promotes a cost-effective technology-based mechanism to reduce the methane emissions in Oil & Gas sector internationally, it provides specific technical solutions for emissions reduction and serves as a platform for the report of emissions and knowledge exchange (EPA, 2014). Thirdly, the World Bank Global Gas Flaring Reduction Partnership provides a platform for information exchange and a potential portal for funding of CO_2 capture and utilization project. In turn, the IDB has the Sustainable Energy and Climate Change Initiative (SECCI), whose role is to support mitigation, adaptation and capacity-building projects related to climate change, and which has available financing mechanisms in the form of grants, and technical assistance to support this type of initiatives. Finally, the United States Agency for International Development (USAID) supports and implements projects for environmental sustainability among other subjects and has a strong presence in Latin America and the Caribbean.

The following is a list of funding alternatives that, in a preliminary appreciation, are attractive to TT and worth evaluating.

Table 30. Financing sources for the implementation of climate change mitigation actions.
Source: Own elaboration

Financing Scheme	Origin of funding scheme
The Green Fund	National
Public Sector Investment Program (PSIP)	National
Nationally Appropriate Mitigation Action (NAMA)	National and International
Clean Development Mechanism (CDM)	International
Global Environment Facility (GEF)	International
Global Environmental Facility Small Grants Program	International
Global Methane Initiative (GMI)	International
International Finance Corporation (IFC)	International
Sustainable Energy and Climate Change Initiative (SECCI)	International
Green Climate Fund (GCF)	International
Germany´s International Climate Initiative	International
Low Emissions Capacity Building Program	International

These entities tend to show a preference for certain types of measures and policies. The following table presents the observed preferences of the international donors depending on the region that they are based on.

It should be noted that there is already a programmatic Clean Development Mechanism (CDM) project activity "Petrotrin Oil Fields Associated Gas Recovery and Utilization PoA (9358)" registered on December 31st, 2012. The project aims to reduce GHG emissions related to venting and flaring of associated gases from producing oil fields. The initiative, operated by Petrotrin, will remove the

equivalent of approximately 82,282 tCO_2e annually from the credits however, up to date no requests for issuance have been submitted yet.

Table 31. Trends in the international support of GHG policy instruments
Source: Own elaboration

GHG Policy Instrument	EU	United States	IGOs	Average
Sectoral crediting	3	1	3	3
Cap and trade	3	1	2	2
Carbon tax	2	1	1	1
Performance-based standard	1	2	1	1
Voluntary agreements	0	3	1	1

International donors from the European Union tend to support the implementation of MBIs such as cap and trade, carbon taxes and sectoral crediting over regulatory measures. In a similar manner, IGOs are strongly inclined to support sectoral crediting mechanisms and cap and trade systems over taxes and performance standards. On the other hand, entities based in the United States, i.e. USAID, lean more towards non market-based instruments, such as performance-based standards and voluntary agreements.

In terms of attracting financing, elements such as a developed GHG emissions inventory, a robust and reliable MRV system, National Communications to the UNFCCC, international commitments and participation, institutional and legal stability and functionality will increase the probabilities of qualifying for international support (Kotov & Nikitina, 2003).

4.3.4. Political practicality

The implementation of a novel policy is likely to provoke reactions in the political and industrial spheres, particularly if they are to be implemented in a sector with a primary relevance to the economy. As it has been mentioned, the O, G&P sector in TT accounts for a significant share of the economy and the majority of the national exports volume and is predictably a sensitive area to changes.

Based on the information available under the Carbon Disclosure Project (CDP) initiative, the table below provides an overview of the GHG emissions and climate change profile of three major Oil and Gas companies which are active in Trinidad and Tobago. All the companies perceive future climate change regulation as an operational risk, and have in place internal tools and methods to drive emission reductions. BHP Billiton accepts mandatory GHG reporting with major exceptions, but opposes other policy instruments (BHP Billiton, 2013). Repsol, in turn, supports cap and trade, but raises several issues in terms of ambition and carbon leakage (Repsol, 2013). BP did not make any formal statement in its latest submission to the CDP (BP, 2013), but the literature has reported a clear preference of cap and trade relative to carbon taxes (Victor & House, 2005).

Table 32. GHG emissions Climate Change Profile of selected companies active in TT
Source: Carbon Disclosure Project 2013 submissions

	BHP Billiton	REPSOL	BP
Base year and global base year emissions (section 7.1)	Scope 1: 21,900,000 Scope 2: 25,300,000 Total: 47,200,000 (2005)	Scope 1: 15,103,527 Scope 2: 638,672 Total: 15,742,199 (2005)	Scope 1: 61,820,000 Scope 2: 8.970,000 Total: 70,790,000 (2011)
Global emissions data (section 8)	Scope 1: 20,200,000 Scope 2: 20,000,000 Total: 40,200,000 (2012)	Scope 1: 14,062,806 Scope 2: 811,243 Total: 14,874,049 (2012)	Scope 1: 59,830,000 Scope 2: 8,3600,000 Total: 68,190,000 (2012)
Emissions data in Trinidad and Tobago	Scope 1: 320,000 Scope 2: 1,000 Total: 321,000 (2012)	Scope 1: 441,564 Scope 2: 570 Total: 442,134 (2012)	Scope 1: 2,510,000 Scope 2: 10,000 Total: 2,520,000 (2012)
Corporate position on legislative initiatives on energy and climate change (section 2.3.a.)	Support with minor exceptions to mandatory carbon reporting, support with major exceptions to cap and trade, carbon tax, energy efficiency and renewable energy generation regulation	Support with minor exceptions to cap and trade regulation, oppose to fuel quality directive (which establishes country-specific biofuel targets)	N.A.
Methods to drive emission reductions (section 3.3.c.)	Compliance with regulatory requirements/standards, internal price of carbon, internal incentives/recognition programs, employee engagement, marginal abatement cost curve	Compliance with regulatory requirements/standards, internal incentives/recognition programs, employee engagement, catalogue of emission reduction opportunities (CERO)	Compliance with regulatory requirements/standards, internal price of carbon, partnering with governments on technology development (US EPA Natural Gas STAR Program, WB Global Gas Flaring Reduction partnership)
Risks driven by changes in legislation (section 5.1.)	International agreements (successor of the Kyoto Protocol), cap and trade schemes, carbon taxes, inconsistency of regulations between developed and developing prices (i.e. carbon leakage)	Europe: structural market reforms and carbon leakage regulation in ETS, new EU energy taxation (20 EUR/tCO_2e), mandatory energy audits for plants >50 MW; Americas: new cap and trades in Canada, Brazil and México	General international and national climate change regulations: UNFCCC, Kyoto Protocol, EPA regulations (GHG mandatory reporting rule, NSPS Oil & Gas and Refinery Rule, GHG BACT requirements and increased energy efficiency mandates), EU regulation

As earlier discussed, cap and trade schemes and performance-based standards are likely to face very high political barriers to implementation, followed by carbon taxes, sectoral crediting and voluntary agreements.

Table 33. Political practicality
Source: Own elaboration

GHG Policy Instrument	Political barriers
Sectoral crediting	3
Cap and trade	1
Carbon tax	1
Performance-based standard	0
Voluntary agreements	3

4.3.5. Overview and Discussion

The table below shows a comparative analysis with a qualitative and preliminary approach of the different policy options addressed in terms of the multiple criteria evaluation conducted in this chapter. As in the previous section, policy instruments are assessed against different criteria and receive positive or negative scores ranging from 0 (inexistent) to 3 (high).

From a wider policy perspective, climate change mitigation policy instruments such as sectoral crediting mechanisms and non-market based instruments like voluntary agreements appear to be more appropriate to regulate GHG emissions in the O, G&P of TT.

Table 34. Comparative analysis of GHG policy instruments
Source: Own elaboration

	SCM	Cap & Trade	Carbon Tax	Standards	Voluntary Agreements
Co-benefits [+]	1	2	2	3	1
Compliance Framework [-]	-2	-3	-3	-2	-1
Donor interest [+]	3	3	1	1	1
Political practicality [-]	3	1	1	0	3
Total (positive scores minus negative scores)	7-2=5	6-3=3	4-3=1	4-2=2	5-1=4

5. Design and Assessment of Policy Options to reduce GHG emissions the Oil and Gas sector

TT can use different market and non-market based instruments to reduce GHG emissions in its O, G&P sector. Taking into account the critical design elements of the different GHG emission reduction policy instruments, as well as wider considerations such as the country's existing legal framework and institutional capacity, four alternative GHG policy options have been proposed: a country-wide voluntary sectoral crediting system (Option 1), and installation-based crediting system (Option 2), a carbon tax (Option 3), and a mandatory GHG reporting system (Option 4).

5.1. Policy Options to reduce GHG emissions in the Oil and Gas sector

5.1.1. Government crediting system (Option 1)

Under this option, GORTT will undertake internationally binding GHG emissions intensity targets for the O, G&P sector and would implement policy measures to achieve such sectoral targets. Attainment of these targets would be documented by implementing internationally agreed MRV procedures. The GORTT would then decide how to allocate the credits received internationally, which are typically destined to support GHG reduction actions and to incentivize covered entities to undertake them.

Individual entities will perceive this policy option like an opportunity to reduce GHG emissions, provided that the incentive passed-on by the GORTT is attractive enough to invest in GHG emissions reduction projects. From the technical point of view, development of strong, NAMA-like baseline and MRV procedures would be necessary to gain international acceptance and access international funding opportunities. Overall, the environmental effectiveness of this option will be low, but the political practicability will be high due to low opposition from covered entities, and reduced legal and institutional requirements.

Table 35. Government crediting system
Source: Own elaboration

Element	Description
Type of instrument	Sectoral crediting; sector-wide reporting of GHG emission and GHG emission reductions
Individual reporting	Voluntary GHG reporting (similar to CDM)
Individual incentives	"Bonus" (i.e. similar to CDM)
GHG abatement potential	Depends on each installation and the international carbon price (provided that is mirrored domestically)
International compatibility	Compatibility with NMM, but reduced ambition
Baseline setting	Carbon intensity benchmarks required
Compensation mechanisms	Not required

5.1.2. Installation-level crediting system (Option 2)

Under this option, all individual installations having GHG emissions above a predefined threshold would be required to submit annual GHG inventories, along with production or output data to enable determination of their carbon emissions intensity. Installations having carbon intensity levels above an agreed upon benchmark would be expected to either pay a carbon tax for the excess emissions, or to offset their excess emissions through the purchase of carbon credits. Alternatively installations with carbon intensity levels below the agreed upon benchmark will receive tradable carbon credits.

This policy option will require a strong MRV system, as well as commensurate allocation of authority and resources to the EMA, as all individual installations will need to be monitored on a recurrent (annual) basis. In addition, this policy option will require strong baseline studies, so that the carbon intensity threshold can be adequately established, as well as a full trading registry and regulation to allow trading of carbon credits.

This option is likely to accept wide international recognition as well as international sources of financing during the design and implementation phase. Political practicability will depend largely to the compensation mechanism introduced during the design phase.

Table 36. Individual crediting system
Source: Own elaboration

Element	Description
Type of instrument	Sectoral crediting; installation-level coverage above a GHG emitting threshold
Individual reporting	Mandatory GHG reporting
Individual incentives	"Bonus-malus"; best-in-class are able to get financial rewards ("bonus"), but inefficient companies pay a penalty or need to offset if above the benchmark ("malus")
GHG abatement potential	Will depend upon each installation; being limited to measures with a marginal abatement cost below the international carbon price.
International compatibility	Full compatibility with NMM
Baseline setting	Carbon intensity benchmarks required
Compensation mechanisms	Required for companies above the benchmark

5.1.3. Carbon tax (Option 3)

Under a carbon tax option, all individual installations having GHG emissions above a given threshold would be required to submit annual GHG inventories mandated to pay a carbon tax for each tCO_2e released to the atmosphere.

This policy option requires strong MRV as well as enforcement capabilities for the Ministry of Economy and Finance, who would be responsible for collecting the tax. Resistance to carbon taxes by the O&G sector has been traditionally very high, but design options (such as tax-free thresholds and allowing the use of offsets generated upstream) and revenue recycling can dampen environmental effectiveness and compliance cost, and improve political buy-in.

Table 37. Carbon tax
Source: Own elaboration

Element	Description
Type of instrument	Carbon tax; installation-level coverage above a GHG emitting threshold
Individual reporting	Mandatory GHG reporting
Individual incentives	C tax "malus" (adjusted with tax-free thresholds and national or international offsets)
GHG abatement potential	Will depend upon each installation; it is however limited to reduction measures with a marginal abatement cost below the carbon tax.
International compatibility	Full compatibility with NMM
Baseline setting	Required to establish adequate compensation mechanisms
Compensation mechanisms	Required to avoid economic impacts (offsetting, tax-free thresholds)

5.1.4. Mandatory GHG reporting (Option 4)

Under a mandatory reporting system all individual installations in selected sectors that are emitting above a predefined GHG emission threshold, would be required to submit annual GHG inventories. This option does not require mitigation or offset of emissions but it is essential to the implementation of Options 2 and 3 listed above.

Being a non-market based instrument with limited environmental effectiveness, however, this policy option only complies partially with the international climate change framework, which reduces the opportunity of the mechanism to be financed by international sources. Nevertheless, it may be a good starting point.

Table 38. Mandatory GHG reporting (Option 4)
Source: Own elaboration

Element	Description
Type of instrument	Non MBI; mandatory reporting above a GHG emitting threshold
Individual reporting	Mandatory GHG reporting
Individual incentives	Lack of specific individual, carbon-related financial incentives
GHG abatement potential	Uncertain.
International compatibility	Reduced compatibility (only with FVA)
Baseline setting	Not required
Compensation mechanisms	Not required

5.2. Common design elements

In terms of types of GHG covered, a given climate change mitigation policy instrument for TT's O, G&P sector can cover carbon dioxide only, all GHG covered by the Kyoto Protocol, or those GHG which are most relevant to a given sector (World Bank, 2012). The Petroleum Industry Guidelines, for instance, recommend that all significant emissions of each of the six original Kyoto GHGs are reported, which would be a first design option. Alternatively, the policy instrument may only focus on those gases which are more predominant, i.e. CO_2 produced by combustion and CH_4 produced by venting and fugitive emissions, as well as CH_4 and N_2O quantities released during combustion processes (IPIECA, 2011)[9].**A preliminary suggestion would be CO_2, CH_4 and N_2O gases only, as these emissions encompass a large fraction of all the GHG of the sector**.

Secondly, the upstream and downstream coverage will be crucial when designing a climate change mitigation policy instrument. This is so not just because the carbon content of the refined products and petrochemical products are many times greater than the direct GHG emissions of the Oil and Gas sector, but also because upstream (production and gathering) and midstream (transmission, distribution and processing) GHG emissions are concentrated, whereas further downstream, into the consumer chain, GHG emissions by end-users of fossil fuels involve a vastly larger number of entities.

A first design option in terms of upstream or downstream coverage would be to solely focus on large GHG emitting sources. The EU ETS, for instance, covers all facilities involving combustion of fuels in installations with a total rated thermal input exceeding 20 MW, as well as specific petrochemical processes such as refining of mineral oil, production of ammonia (European Parliment, 2009). A second option (favored for instance by California's cap-and-trade regulation as of 2015) would be to also cover the GHG emissions implied in the carbon content marketed by fuel distributors (natural gas, liquefied propane gas and transportation fuel providers), so as to address emissions from transportation fuels (CARB, 2012).

[9] It may be interesting to note that the Global Warming Potentials (GWP) of different GHGs have been reviewed by the Fourth Assessment Report of the IPCC, and that the GWP of CH_4 and N_2O are now set at 25 and 298 respectively (instead of former 21 and 310).

Policy instruments will need to establish their level of detail concerning applicability and operational boundaries. Several options exist, which range from covering the whole sector, focusing on large emitting sources (and excluding those GHG emission points or facilities which do not reach a given threshold in terms of production capacity or output), or concentrating on particular technologies or processes (ECORYS, 2014). A blended option could entail focusing on large emissions sources but allowing them to undertake a narrowly defined set of in-country offset projects, which may provide emissions reduction credit towards obligations for covered major sources (Carbon Credit Capital, 2013).**Due to the fact that upstream operations appear to have a large GHG abatement potential in terms of reduced venting and flaring, a full scope including the entire sector (but excluding small emitters) is favored.**

Table 39. Design elements alternatives and proposals

Source: Own elaboration

Design element	Alternatives	Proposal
GHG covered	• All Kyoto Protocol Gases • CO_2, CH_4 and N_2O only	• CO_2, CH_4 and N_2Oonly
Upstream vs. downstream	• Upstream, midstream and downstream • Upstream and midstream including whole carbon content	• Upstream and midstream
Sector boundary	• Entire sector excluding small emitters, for example sources that emit less than 25,000 t CO_2e per year, which is the criteria followed applied by the EU ETS, the Californian cap and trade scheme and the Mexican emissions register. • Particular technology or process	• Entire sector excluding small emitters

Interestingly, the four options which are presented below share two important design elements:

- In terms of setting of GHG abatement objectives, all options establish carbon-intensity benchmarks and objectives allowing economic growth and an increase of absolute GHG emissions.
- In terms of the co-benefits of reducing GHG emissions in the O, G&P sector, all options acknowledge the positive contribution of GHG emission reductions to reduced local air pollutants and health/welfare improvements, as well as the increased energy efficiency and security.

5.3. Co-benefit Analysis

Climate change mitigation policy instruments may have positive and negative impacts in terms of their wider contribution to sustainable development. Positive effects are referred to as co-benefits, which are defined by the IPCC as "the positive effects that a policy or measure aimed at one objective might have on other objectives, without yet evaluating the net effect on overall social welfare" (IPCC, 2014).

Climate change mitigation co-benefits in the industry will largely depend on the local context where GHG reduction polices are implemented, as well as on the ambition level and scale of such policy. **In general terms, however, the literature highlights two different types of co-benefits associated with reducing GHG emissions in the industry. On one hand, social and environmental co-benefits which derive from reduced local air pollution (OCDE, 2009); on the other, economic, social and environmental co-benefits related to energy efficiency (IPCC, 2014)**.

As discussed in a previous report, TT's O, G&P sectors can reduce GHG emissions by reducing leaks and venting (avoided CH_4 emissions), as well as by introducing energy efficiency measures (avoided energy losses resulting in CO_2, CH_4 and N_2O emissions). Co-benefits of GHG reduction include improved competitiveness and productivity (economic impact), improved health and safety conditions (social impact), as well as better natural resource management and ecosystem protection (environmental impact).

5.3.1. Indicators to measure climate change mitigation co-benefits in the oil, gas and petrochemical sector

Policy options may be measured against a set of indicators reflecting the co-benefits (and wider contribution to sustainable development) of reducing GHG emissions in the O, G&P sector.

The UN Commission on Sustainable Development, for instance, has proposed a core set of 50 indicators clustered in 14 themes to measure progress towards nationally defined goals of sustainable development (UN, 2007)[10]. More recently, the Executive Board of the Clean Development Mechanism (CDM) of the United Nations Framework Convention on Climate Change (UNFCCC) has proposed a draft tool for describing sustainable development co-benefits of GHG reduction measures with a set of 12 environmental, social and economic criteria (EB CDM, 2012)[11].

None of these approaches seems appropriate to measure co-benefits of policy options in the O, G&P sector. On one hand, the approach proposed by the UN may not be applicable because it focuses on the development agenda of least developed nations (not to the sustainability of a carbon intensive sector like the oil and gas sector), and because it refers to the notion of sustainable development in general, but not to positive impacts or co-benefits of GHG reduction. On the other hand, the approach proposed by the EB CDM is not appropriate because it refers to measures rather than to policies, and because it has been designed to encompass GHG emission reduction measures in areas which exceed the realm of the oil, gas and petrochemical sector (i.e. including areas like energy, agriculture, waste, or forestry).

Because developing countries regard sustainable development outcomes as the main driver and selling point of climate change mitigation policies and measures, efforts to capture the co-benefits

[10]The 14 themes are: poverty; governance; health; education; demographics; natural hazards; atmosphere; land, oceans, seas and coasts; freshwater; biodiversity; economic development; global economic partnership; and consumption and production patterns.
[11]Including: air, land, water, and natural resources; job, health and safety, education, and welfare; and growth, energy, technology transfer and balance of payments.

of NAMAs provide a better approach for measuring the co-benefits of GHG emission reductions in the oil, gas and petrochemical sector. Based on the recent work of the Centre for Clean Air Policy (CCAP, 2012), **a set of 10 indicators is used to measure economic impacts (such as energy intensity improvements, modernization, productivity, and technology transfer), social impacts (such as job creation, quality of employment, and health and safety), as well as environmental impacts (such as environmental protection, natural resource exploitation, and health benefits due to better air quality)**.

Table 40. Indicators to measure climate change mitigation co-benefits in the oil, gas and petrochemical sector
Source: adapted from CCAP, 2012

	Dimension of SD	Indicator
Economic	1. Industrial energy intensity	Reduced energy consumption per unit of output (MMBtu/bbl, Mcf)
	2. Modernization	New investment (USD)
	3. Productivity	Improved GVA per unit of energy ($/MMBTU)
	4. Technology transfer	New RD&D investments (USD)
Social	5. Job creation	New jobs created (no.)
	6. Quality of employment	Increased per capita income (USD) in workforce
	7. Health and safety	Prevalence of respiratory infections in workforce
Env.	8. Environmental protection	Reduced impacts to local ecosystems
	9. Natural resource exploitation	Increased lifetime of proven reserves
	10. Air pollution / health benefits	NOx and PM reduction (tons/day)

The economic indicators used are:

- **Industrial energy intensity** refers to the reduction in the relative use of energy per unit of output. The indicator is designed in physical units (MMBtu/bbl or Mcf) and not in output value, to avoid market price changes.

- **Modernization** refers to the replacement of obsolete equipment with modern technology. Measuring the investment in new capacity (USD) indicates how a firm is modernizing its processes.

- **Productivity** refers to the impact of each policy option by reducing the cost of inputs, building a higher-skilled workforce, or improving product quality. It is measured by determining the gross value added per unit of energy consumed (GVA/MMBtu).

- **Technology transfer** refers to the technical improvements induced by each policy option. It is measured in terms the value of investment in joint research, development and demonstration (RD&D).

In turn, the social indicators used are:

- **Job creation** refers to the impact of each policy option in the creation of employment opportunities through manufacturing, operation and maintenance of energy efficient equipment, energy management and auditing. It is measured by the number of jobs created.

- **Quality of employment** refers to the benefits derived from the creation of a skilled and formal range of workers typically needed to install, maintain and operate the new

processes/technologies. It is measured in terms of the increase in per capita income of the workforce.

- **Health and safety** refers to the positive health impacts derived from each policy option. It is measured by the prevalence of respiratory infections in the workforce and the local population.

Finally, the environmental indicators used are:

- **Environmental protection** refers to the positive effects of each policy option in avoiding the adverse effects caused by the industry to the environment. It is measured by the reduction of impacts to local ecosystems.

- **Natural resources exploitation** refers to the reduction of natural resource consumption. It is measured in terms of the increase in the lifetime of proven natural resources reserves.

- **Air pollution** refers to the impact of each policy option in reducing the amount of local air pollution. It is measured in terms of NO_X and PM reductions in tons per day.

5.3.2. Assessment of different policy instruments to reduce GHG in the oil, gas and petrochemical sector

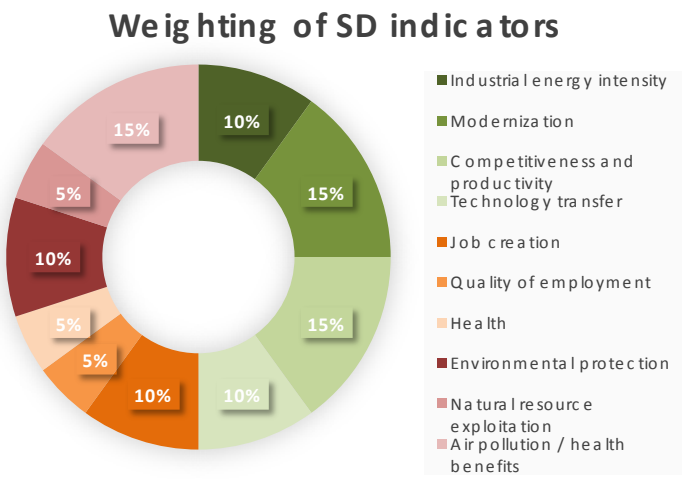
Methodological remarks

The four policy options to reduce GHG emissions in TT's O, G&P sector can be assessed against the indicators defined above. Obviously, a holistic approach needs to be undertaken, due to differences in magnitudes and relative importance of the different criteria. In other words, a multi-criteria approach is necessary, especially considering that analyzing policies is always more complex than evaluating individual measures.

In order to cover all the indicators, a ranked evaluation method has been developed. With this method, each policy option is analyzed and evaluated according to each criterion. Policy instruments first receive scores of 0 (no contribution), 1 (low contribution), 2 (medium contribution) or 3 (high contribution). It is important to highlight the fact that each policy option cannot be evaluated in an independent manner and that scores must be understood in a holistic manner.

Once this has been done, the preliminary results are then weighted according to the relevance of each indicator. The proposed relevance of the different indicators is shown in Figure 6.

Figure 6. Weighting of Sustainable Development indicators
Source: Own elaboration



Even if reducing emissions is not being analyzed here, obviously it is the most important focus of the analysis. Those measures that are more effective in terms of reducing emissions are in a better position to produce the co-benefits that are considered here.

Evaluation

When measured against economic sustainable development indicators, individual crediting (Option 2) and a carbon tax (Option 3) received the highest scores. Being mandatory mechanisms, both policy options are likely to drive more GHG abatement *investments*, *energy intensity improvements* and *productivity gains* when compared with government crediting (Option 1). Interestingly, innovation and *technology transfer* is more likely to occur in general carbon pricing instruments such as carbon taxes than in individual crediting. In contrast, mandatory GHG reporting alone (Option 4) results in relative low economic co-benefits, given the limited ability of information alone to result in investments, reduce energy intensity and improve competitiveness and productivity, and where only partial technology transfers are expected (due to new information technology, reporting tools, and monitoring and measurement instruments).

In the same vein, individual crediting (Option 2) and the introduction of a carbon tax (Option 3) are the policy options with highest potential for social co-benefits. *Job creation*, for instance, will be directly linked to the occurrence of new GHG investments, and will be restricted to MRV tasks under the mandatory GHG reporting option (Option 4), and also limited under the voluntary Government crediting (Option 1). *Increased per capita* income will be limited in all the policy options, and it will be contingent upon productivity gains. Finally, *health and safety conditions* are more likely to improve under individual crediting (Option 2) or the introduction of a carbon tax (Option 3), i.e. to the extent that new investments are made effectively. In any case, respiratory problems associated with the O, G&P sector are considered limited if compared to health impacts associated to burning other fossil fuels, such as coal or biomass.

Again, individual crediting (Option 2) and the introduction of a carbon tax (Option 3) are the policy options with the highest potential to contribute to environmental sustainable development indicators. Because they are able to drive new investments, both options have the ability to improve the exploitation of natural resource, and to reduce negative environmental impacts. Interestingly, individual crediting (Option 2) has a competitive advantage against carbon taxes (Option 3), due to the ability of this policy option to target specific installations and specific GHG emission sources differently. Government crediting (Option 1) will have a very limited contribution to environmental protection, but will still perform better than mandatory GHG reporting, that may (if only) induce partial air pollution related to some GHG emission reductions carried out to protect company image and reputation (Option 4).

As shown in the table below, **the co-benefits of individual crediting (Option 2) and the introduction of a carbon tax (Option 3) clearly exceed those to be obtained from a government crediting (Option 1) or mandatory GHG reporting (Option 4)**.

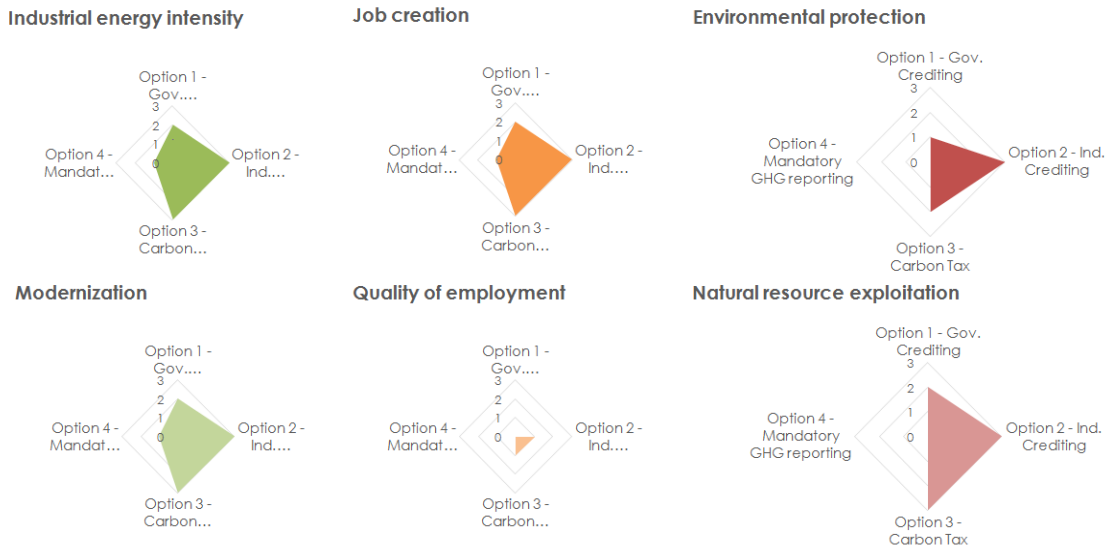
Table 41. Co-benefits of climate change mitigation policy instruments the oil, gas and petrochemical sector. (non-weighted)

Source: Own elaboration

Dimension of Sustainable Development	Maximum score	Option 1 - G. Crediting	Option 2 - I. Crediting	Option 3 - Carbon Tax	Option 4 – Reporting
Economic					
1. Industrial energy intensity	3	2	3	3	1
2. Modernization	3	2	3	3	1
3. Productivity	3	2	3	3	1
4. Technology transfer	3	1	2	3	1
Total	12	7	11	12	4
Social					
5. Job creation	3	2	3	3	1
6. Quality of employment	3	0	1	1	0
7. Health and safety	3	1	2	2	0
Total	9	3	6	6	1
Environmental					
8. Environmental protection	3	1	3	2	0
9. N Resource exploitation	3	2	3	3	0
10. Air pollution	3	1	3	2	1
Total	9	4	9	7	0
Grand Total	30	14	26	25	5

Figure 7. Co-benefits of climate change mitigation policy instruments the oil, gas and petrochemical sector. (non-weighted)

Source: Own elaboration

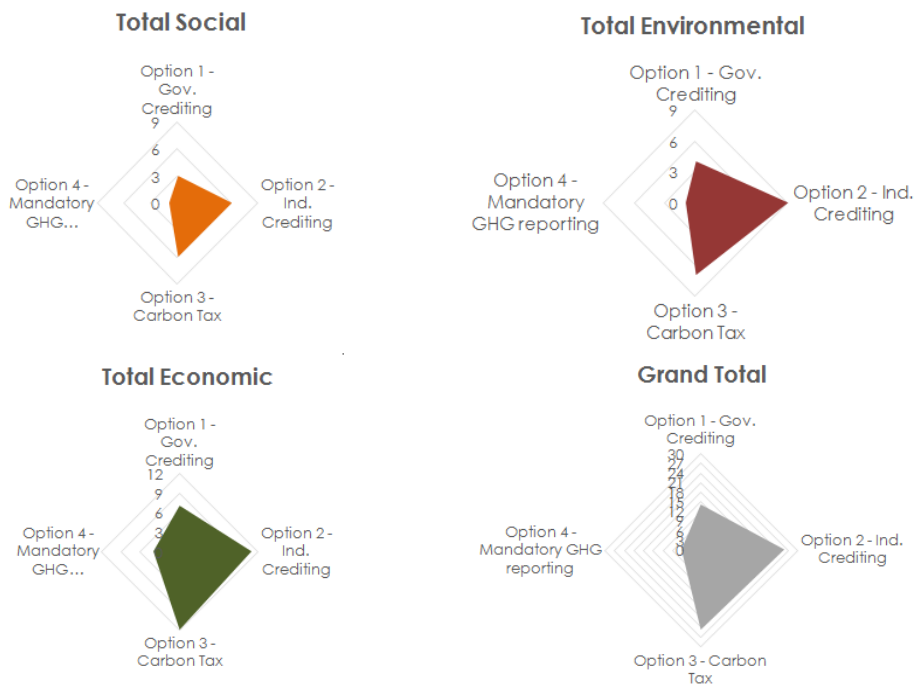


As indicated above, the preliminary results can be weighted according to the relevance of each indicator. **Given TT's relatively high social and environmental standards, the table below proposes weights to prioritize economic criteria (50%) over environmental criteria (30%) or social criteria (20%).%).**This weighted approach confirms the preliminary results discussed above, highlighting the ability of individual crediting (Option 2) and carbon taxes (Option 3) to achieve significant co-benefits.

Table 42. Co-benefits of climate change mitigation policy instruments the oil and gas sector (weighted)
Source: Own elaboration

Dimension of Sustainable Development	Weight	Option 1 - G. Crediting	Option 2 - I. Crediting	Option 3 - Carbon Tax	Option 4 - Reporting
Economic					
1. Industrial energy intensity	10%	7%	10%	10%	3%
2. Modernization	15%	10%	15%	15%	5%
3. Productivity	15%	10%	15%	15%	5%
4. Technology transfer	10%	3%	7%	10%	3%
Total	50%	30%	47%	50%	17%
Social					
5. Job creation	10%	7%	10%	10%	3%
6. Quality of employment	5%	0%	2%	2%	0%
7. Health and safety	5%	2%	3%	3%	0%
Total	20%	8%	15%	15%	3%
Environmental					
8. Environmental protection	10%	3%	10%	7%	0%
9. N Resource exploitation	5%	3%	5%	5%	0%
10. Air pollution	15%	5%	15%	10%	5%
Total	30%	12%	30%	22%	5%
Grand Total	100%	50%	92%	87%	25%

Figure 8. Co-benefits of climate change mitigation policy instruments the oil, gas and petrochemical sector. (weighted)
Source: Own elaboration



5.4. SWOT Analysis

5.4.1. Approach and methodology

The SWOT methodology is a well-known strategic tool used to assess the different factors which are relevant to a given project or objective. In this section, it is applied to each of the climate change policy options under assessment.

The SWOT analysis proposes a simple method that classifies relevant factors into external and internal "components" and into four different categories (called "elements"): internal positive factors will be "strengths", internal negative factors will be "weaknesses", external positive factors will "opportunities" and external negative factors will be "threats".

The SWOT methodology has been applied to the assessment of the climate change mitigation policy options as follows:

- External Component. The external component refers to the context in which the policy option will be implemented. This is a crucial element, since the wider economic, social, and political background and conditions will impact the probabilities of success heavily. This part of the analysis is formed by two elements:
    - Opportunities. The external, positive elements that can contribute to the successful implementation of the policy option.
    - Threats. Environment situations or conditions that may affect the policy implementation in a negative way.

- Internal Component. The internal elements analyzed in this component include the inherent features of the policy option, like the resources available to its implementation, or its political practicability.
    - Strengths. All those features of the policy that differentiate it from others and give the particular policy option a competitive advantage.
    - Weaknesses. The elements of the policy that would constitute a barrier for its successful implementation. They are internal issues that once identified should be considered in the strategy developed in order to reduce their incidence.

5.4.2. Analysis of policy options

Government crediting system (Option 1)

The main *strength* of the government sectoral crediting derives from its appeal and political buy-in from involved stakeholders. In addition, when compared to other alternatives, this option presents reduced administrative framework requirements, as no annual compliance cycle and no carbon registry is required. Another strong point of this alternative is that (at least in theory) this option will achieve GHG abatements for all opportunities below the carbon price.

The development of a government crediting system can build on national and international *opportunities*. At national level, Petrotrin's programmatic CDM Project Activity provides a remarkable country experience that can be used as a starting point to build this policy option. Also, there are different candidates in TT that can become the scheme's Coordinating Entity, including governmental and non-governmental organizations (NGO), like the Energy Chamber, or an academic center such as the Center for Engineering Systems at the University of TT. At international level, the government crediting system can build on international sources of finance to set up the system.

As to the negative aspects of this option, it must be said that despite it being compatible with NMM, one of its *weaknesses* is that its environmental effectiveness is rather limited; in addition, this option requires complex baseline setting studies (development of carbon intensity benchmarks for the different upstream, midstream and downstream operations, which poses technical difficulties, especially in the upstream sector).

Finally, this option faces a few external *threats*. First, pitfalls in the design of this policy option may result in insufficient incentives (from the Government) to individual operators to reduce GHG emissions. Secondly, a weak international post-2020 climate change mitigation scenario will result in difficulties to raise international financing for the scheme. As it has been seen in the Conference of the Parties (COP) held in December 2012 in Lima, the difference between industrialized and developing countries is blurring, with Annex I countries no longer expected to be the only contributors to climate change protection in terms of GHG abatement targets and climate finance (Wuppertal, 2014). Finally, any attempt to address environmental concerns through strict additionality checks (thereby excluding GHG abatement considered "business as usual", either because they are mandated by law, or because they make financial sense without any government support) will also pose a threat to this policy option.

Table 43. SWOT analysis of a Government Crediting System
Source: Own elaboration

Strengths	Weaknesses
• Political buy-in from stakeholders (voluntary system) • Reduced administrative framework (no annual compliance cycle, no carbon registry) • GHG abatements for all opportunities below the carbon price	• Low environmental effectiveness (voluntary system) • Complex baseline setting required (carbon intensity benchmarks)
Opportunities	**Threats**
• Country experience (Petrotrin's CDM); several candidates to become Coordinating Entity (incl. Energy Chamber) • International sources of finance to set up the system (i.e. WB)	• Lack of transfer of financial incentives from Government to installations • Scheme is dependent on external sources of financing. A lack of international funds to finance the scheme means the end of it. • Strict additionality checks may put the instrument at risk of failure

5.4.3. Installation-level crediting system (Option 2)

This policy option will require a strong MRV system, as well as commensurate allocation of authority and resources to EMA in collaboration with the Petroleum Inspectorate of the Ministry of Energy and Energy Affairs, as all individual installations will need to be monitored on a recurrent (annual) basis. In addition, this policy option will require strong baseline studies, so that carbon intensity thresholds can be adequately established; a full trading registry and regulation to allow trading of carbon credits; a mandatory GHG reporting scheme; as well as the design of appropriate compensation mechanisms for the companies located above the emission threshold. Said threshold should refer to capacity rather than to operation or performance data since the use of the latter might result in adverse incentives (e.g. increasing production during data gathering for the determination of a baseline and ceasing or decreasing production after the baseline has been agreed) or may vary from year to year with the result of an installation may then fall only in some years under the SCM agreement.

Being an installation based scheme, to avoid incentives to transfer production from more efficient larger installations to a pool of smaller and usually less efficient installations, several similar installations on the same site should be considered as one installation (Cames & Schneider, 2009).

This option is likely to accept wide international recognition as well as international sources of financing during the design and implementation phase. Political practicability will depend largely on the compensation mechanism introduced during the design phase. It is fully compatible with NMM and has high probabilities of receiving international financing.

In the case of implementing this option, careful consideration must be made to allocate the EMA with sufficient authority and resources, since it will be the fundamental institution supporting the policy.

Table 44. SWOT analysis of an Individual Crediting System
Source: Own elaboration

Strengths	Weaknesses
• Environmental effectiveness • Political buy-in from stakeholders (balanced approach of rewards and penalties)	• Adverse economic impacts for companies below the benchmark • Baseline setting required (carbon intensity benchmarks) • MRV system and annual enforcement required • Additional infrastructure required (carbon registry)
Opportunities	**Threats**
• Country experience (several companies with own GHG inventories) • International sources of finance to set up the system and full compatibility with NMM • Prospects of linking to other systems like the EU ETS	• Success will depend on the ability of the competent authority (EMA?) to enforce legislation • Early bias of the instrument towards a future national Emission Trading Scheme

5.4.4. Carbon Tax (Option 3)

The policy option consisting in the implementation of a carbon tax has high environmental effectiveness since it emits a consistent price signal throughout the whole economic chain. It is a straightforward measure that would be established on the existent tax collection scheme for the sector in TT, which simplifies the implementation and poses as an advantage besides the fact that it would generate revenue for the Government, provided that the collected tax exceeds support mechanisms such as revenue recycling or tax shifting. Also, this measure does not require the establishment of a carbon registry nor setting a baseline; and, through the adequate compensation mechanisms it is possible to calibrate the installation level impacts it would produce. Finally a carbon price setting would motivate companies to implement reduction strategies, driving efficiency improvements in the sector's facilities.

As to the weaknesses of this measure, it presents the following characteristics: First, the calculation of the adequate value for the tax is a sensitive process since the reduction projects that the measure will affect are those with a marginal abatement cost below the tax signal; said calculation requires thorough preliminary studies. Secondly, the operation of this scheme would require a strong and reliable MRV system together with the allocation of sufficient resources and capacity to the collecting entity in order to annually enforce the policy and effectively gather in the resulting tax payments. Finally, this policy option poses potential adverse economic impacts for low-income households[12] and companies in the sector; to minimize this condition appropriate support mechanisms must be designed and implemented. This policy option is fully compatible with NMM, and is predisposed to attracting international sources of funding.

In terms of the background for the implementation of the measure, an important aspect to consider is the historic tendency of companies in the O, G&P sector to reject this type of policy, mainly because of the fear of consequent economic impacts.

Table 45. SWOT analysis of a Carbon Tax
Source: Own elaboration

Strengths	Weaknesses
• Environmental effectiveness • Straightforward (e.g. no carbon registry required) • Compensation mechanisms (e.g. use of national offsets) can calibrate installation-level impacts • It creates revenue for the Government • Clear incentive to drive efficiency and reduce GHG emissions for the government and companies in the private sector.	• Adverse economic impacts for companies if support mechanisms are not properly calibrated • Preliminary economic studies required to fix the carbon tax level • MRV system and annual enforcement required • Distributional impacts for low-income households (unless mitigated by tax and dividend schemes)
Opportunities	Threats
• Existing system to collect tax • International sources of finance to set up the system and full compatibility with NMM	• Opposition from Oil and Gas companies to environmental levies can put implementation at risk (e.g. threats of putting new investments on hold) • Lack of political will to levy new taxes • A coincidental rise in the price of oil and gas with the implementation of the carbon tax would potentially provoke public opposition (unless mitigated by tax and dividend schemes)

[12]Low-income households tend to spend a higher proportion of their economic resources in carbon-intensive goods than household in other economic strata.

5.4.5. Mandatory GHG reporting (Option 4)

A mandatory data collection program presents several strengths. Firstly, it is a flexible measure that does not limit the evolution of the regulatory framework of TT since it would set the foundation for more ambitious regulations to be introduced in the future (see Figure 8). Secondly, it is a regulatory scheme that, due to its simplicity does not need neither baseline setting nor allocation of resources to collect taxes or handle carbon credits, and therefore has quite reduced related administrative costs. Finally, this policy option will propel price discovery of mitigation projects with a marginal abatement cost located below zero.

On the downside, this measure requires an effective entity to enforce compliance among the companies in the sector, a solid and reliable MRV system, and an annual reporting cycle; these needs would, of course, imply a necessary resource allocation to cover them. Also, due to its regulatory and non-market based nature, this policy option does not offer economic positive or negative incentives to the companies for GHG emissions reduction, therefore provoking a limited environmental effectiveness.

Regarding the implementation background conditions, it is positive that several installations in the sector are already familiar with the required data gathering and analysis process, and have also undertaken actions, such as developing their GHG inventories, that would facilitate implementation. As to funding, there are international sources of financing available to finance the implementation of the measure e.g. EPA´s Natural Gas International.

On the other hand, this policy option is likely to raise some concerns from companies in the sector, mainly because of fear of future regulations implemented and due to the general concern regarding the confidentiality of the information provided to the regulatory entity by the company. Also, this scheme presents limited compatibility with a strong post-2020 global regime.

Table 46. SWOT analysis of a Mandatory GHG Reporting
Source: Own elaboration

Strengths	Weaknesses
• Reduced administrative costs compared to other options (no baseline setting, no administrative framework to handle carbon credits or collect taxes) • Economic efficiency (it will elicit price discovery for negative marginal abatement cost projects) • Flexibility regarding more ambitious regulation	• Limited environmental effectiveness (no economic positive or negative incentive to reduce) • MRV system and enforcement of annual reporting cycle required
Opportunities	**Threats**
• Country experience (several companies with own GHG inventories) • International sources of finance to set up the system	• Limited compatibility with a strong post-2020 global regime • Industry concerns due to fear of future regulation; confidentiality concerns

5.4.6. Summary and Conclusions

Based on the individual analyses conducted in the previous section, it is possible to summarize the key strengths, weaknesses, opportunities and threats of each of the options, as observed in the table below:

- The main *strength* of a Government crediting system (Option 1) is the political buy-in it would get from the industry, along with the reduced administrative framework it requires; the main *opportunity* would be the existing country experience to develop such a policy option (e.g. Petrotrin, Energy Chamber), as well as the availability of international sources of finance to its implementation. On the downside, this option has the *weakness* of a limited environmental effectiveness, and faces the *threats* that the system may not be designed in a way to pass-on financial incentives to individual installations, or be able to capture international sources of finance in a weak post-2020 global regime.

- An individual crediting system (Option 2) has the *strength* of its high environmental effectiveness, and (as a result of this effectiveness) it would present the *opportunity* to link to other market mechanism like the EU ETS, as well as the fact that in TT several companies already have experience in developing their GHG inventories. Its main *weakness* is that it is a rather complex policy option, with high requirements in terms of preliminary work (baseline setting) and specific infrastructure (e.g. a carbon registry) to function. One of the threats perceived under this policy option is that it would largely rely on the EMA's enforcement power to succeed.

- A carbon tax (Option 3) is a straightforward policy option to achieve GHG emission reductions and environmental effectiveness (*strength*). This option can build upon an existing national framework to collect taxes, which may provide additional revenue for the government (*opportunity*). On the downside, unless adequate compensation mechanisms are put in place, this policy option may generate adverse economic impacts (*weakness*); in addition, this policy option will face strong resistance from companies in the sector (*threat*).

- Flexibility is the biggest *strength* of a mandatory GHG reporting system (Option 4), as it may be implemented as a preliminary step towards a more ambitious policy regulation of GHG emissions. In addition, an *opportunity* for this policy option may be not only the existing national experience in certain companies, but also the existing international support to improve energy and GHG data collection. Given that it does not provide economic incentives for reduction, this option has rather *weak* environmental effectiveness. Unless it develops into a more ambitious climate change mitigation instrument, this policy option will be under the threat of a strong post-2020 international climate change mitigation policy regime, which will demand additional action from TT.

Table 47. Summary of SWOT analysis of different policy options
Source: Own elaboration

Option	Strengths	Weaknesses	**Opportunities**	**Threats**
Government Crediting System	Political buy-in from industry	Limited environmental effectiveness	e.g. Petrotrin experience and Energy Chamber	COP 21 failure and lack of international funds
Individual Crediting System	Environmental effectiveness	Complexity	Carbon market advocates (EU)	EMA's power to implement
Carbon Tax	Environmental effective and straightforward	Economic impacts	Existing national FW to collect taxes	Opposition from the industry
Mandatory GHG reporting	Flexibility, reduced administrative costs	Transitional, limited effectiveness	Country experience and intl. donors (EPA)	Incompatible with strong post-2020 regime

The four designed policy option were subject to a co-benefit analysis which produced the following conclusions:

- Mandatory GHG Reporting (Option 4) alone has little economic, social and environmental co-benefits; however it provides a unique flexibility which allows it to be designed as a preliminary stage towards a more ambitious climate change mitigation policy instrument.

- The contribution of Government crediting (Option 1) to co-benefits is limited when compared to mandatory options like individual crediting (Option 2) or the introduction of a carbon tax (Option 3).

- From the perspective of co-benefits, individual crediting (Option 2) performs slightly better than a carbon tax (Option 3), due to its ability to better influence outcomes at installation level.

- If adopted transitionally, mandatory GHG reporting (Option 4) could incorporate co-benefit indicators from the early stage.

On the other hand, the main conclusions of the SWOT analysis are:

- Options which are environmentally effective and able to reduce GHG emissions by introducing a carbon price (i.e. an individual crediting system and a carbon tax, Option 1 and Option 2) will face important threats, such as the opposition from the industry or the need to allocate sufficient power and resources to the public body responsible for implementing the regulation. By contrast, policy options which do not introduce an obligatory carbon price will enjoy political buy-in from industry.

- Options which do not automatically lead to GHG emission reductions (i.e. a Government Crediting System and mandatory GHG reporting, i.e. Option 1 and 4) are "paths of least resistance" and will be comparatively easy to implement. However, the ability of these options to become a more fully fledged GHG policy instrument varies from one instrument to another. Mandatory GHG reporting has the potential to transform into individual sectoral crediting, and eventually into an Emissions Trading Scheme. The same cannot be said about Government crediting, which has the flexibility to become mandatory individual sectoral crediting, but not into a carbon tax policy instrument.

Considering the conclusions presented, the best suited option for TT in the present context and conditions of its O, G&P sector is **Option 4: A Mandatory GHG Reporting Program.** This option presents the highest execution feasibility, adapts the best to the country's actual conditions, and, extremely important, will allow the evolution of the policy into the design of a Carbon Tax, or the implementation of an Individual Sectoral Crediting scheme, which in turn, will have the potential to transform into an emissions trading scheme.

6. Towards a Mandatory GHG Reporting Program

One of the key findings of studies addressing design options for sectoral carbon market mechanisms is that **"consistent and reliable data on emissions from installations in a specific sector is crucial for the design and operation of the new international market mechanisms"** (ECORYS, 2012).Therefore, it is imperative to take into account the need for such reliable, installation level data. Any potential policy, future carbon crediting scheme, or carbon tax policies should rely on actual GHG emissions data in order to be able to affirm the future attainment of in-country GHG emissions reduction. Hence, effective MRV of GHG emissions is critical for tracking progress towards the achievement of national targets including its emissions reduction goals.

It is clear that any possible future policy instrument to reduce GHG emissions should be designed to be complementary to future introduction of market based mechanisms to attain GHG emissions reduction. **In other words, developing a Mandatory GHG reporting Program provides the necessary basis to proceed to a more ambitious policy scenario, while maintaining full flexibility in the design of such future market-based mechanism.**

Mandatory GHG reporting can play an important role before the transition towards a full-fledged market mechanism. Prior investigations have determined that there is an important link between GHG measurement and reporting and the wider GHG management cycle (ERM, 2010). Leading GHG reporting methods and initiatives enable companies to connect to the drivers for emissions reduction (i.e. cost, regulation, reputation and innovation).

6.1. Key factors

A number of key factors to consider in developing the policy option for mandatory reporting include:

- Importance of considering the point of view of the various stakeholders groups (e.g. companies, investors, NGOs, policy makers and customers);
- Modalities of closing the existing legislative and regulatory gaps to enable promulgation of a mandatory reporting program;
- Careful consideration of the burden that may be imposed on the regulated entities as well as the governmental institutions that would be required to oversee implementation;
- Design considerations to maximize participation rates, ensuring a level playing field while minimizing risks and maximizing benefits;
- Creating a path toward identifying key emitting sources and maximizing the potential for future emissions reduction or mitigation.

6.2. Building Blocks of a Mandatory GHG Reporting Program[13]

One of the key enabling steps towards the implementation of market based mechanisms is the development of a Mandatory GHG Reporting Program, which would enable the systematic collection of installation level GHG emissions data. The establishment of such a program would rely on three main building blocks, including:

- Legal and institutional framework, including assignment of legal compliance responsibilities including responsibilities for managing the GHG reporting program;
- Policy and regulatory implementation, including descriptions of policy goals, government oversight, installations responsibilities and timeline for data collection;
- Technical infrastructure, for both the implementing agency and the reporting installation. This would include knowledge of the industrial sectors covered and their key emitting sources; applicable monitoring and measurement methods; reporting tools; training and outreach to industry to facilitate compliance and modalities for reporting and verification of GHG data.

Accurate and timely information on GHG emissions is essential for informing future policy decisions. The data collected under a mandatory reporting program should be designed to provide useful information for a variety of polices and allow the government of TT better understanding of the relative emissions of specific installations in the O, G&P industry sectors. Acquiring installation specific data would improve the decision makers understanding of the factors that influence GHG emission rates and actions that facilities could take to reduce them.

6.2.1. Legal and institutional framework

A mandatory reporting program ought to be based on a **legislative act** that defines which governmental department has responsibility for its implementation and the authority to demand periodical reporting from installations. The legal authority should also clarify the **budgetary allocation** for implementing the program, establish a process for protection of confidential business information and require the development of tools and tracking mechanism for reporting back to the legislature to enable assessment of program implementation progress and its effectiveness.

6.2.2. Policy and regulatory implementation

The governmental department that is assigned responsibility for the program by the legislature should publish specific policy directives and regulations to advise the affected installations about their reporting obligations. The policy directives or regulations should specify the target sectors that are required to report, define the boundaries of reporting installations, specify the GHG to be reported for each of the sectors and establish a reporting, verification and data release cycle. The rules should also include provisions to ensure the accuracy of emissions data through monitoring, recordkeeping and verification requirements.

[13] As defined by OECD/IEA (2010) guidance there are three main building blocks for the implementation of market based policies for climate change mitigation, which consist of technical readiness; policy readiness, and legal/institutional readiness. The OECD recommends a phased approach that begins with assessing mitigation potential and feasibility studies of different policy instruments, followed by the establishment of the technical framework. Some of the lessons learned from the CDM process are the capacity building challenges encountered in developing the appropriate market tools, and the time it takes to overcome them.

In developing the mandatory reporting system a key decision would be validation of reported data. Some typical approaches may include:

- Self-certification of data validity by high ranking company officer;
- Validation of reported data by responsible governmental entity which may include calculation checks and/or site visits;
- Third party validation of reported data by accredited verification bodies.

6.2.3. Technical considerations

Designing and implementing a mandatory reporting program would probably require the government of TT to consider capacity building for both government entities and their staff that would oversee the program, as well as the regulated industry sectors.

In order to minimize reporting burden there is a need to develop an easy-to-use GHG reporting tools and streamlined guidance. It ought to be considered that there is likely to be a trade-off between the robustness/accuracy of the GHG reporting method and its ease of use.

Collection of high quality data depends on the availability of detailed guidance for measuring GHG emissions from different emission sources such as:

- Stationary emission sources.
- Process specific emission sources.
- Venting and flaring emissions.
- Fugitive emissions from process equipment leaks.
- Incidental emissions due to malfunctions or maintenance.

In order to facilitate reporting, ensure data consistency and protect confidential business information it is recommended that several technical calculation tools be made available such as:

- Installation GHG emissions threshold models to determine applicability to be included in the reporting program.
- Electronic reporting systems that allows for the calculation of GHG emissions based on standardized methods and which includes a flagging system for indication of confidential data that ought to be protected from release.
- Electronic checks of data reported to the government to detect and allow investigation of errors and outliers.
- Data system for public release of applicable information after data verification.

Table 48. Building Blocks for a Mandatory GHG Reporting Program
Source: Own elaboration

Building Block	Element
Legal	o Legislative Act o Competent Authority o Budgetary Allocation
Institutional	o Target sectors o Installations covered o GHG covered o GHG reporting boundary o Data release cycle o Validation of reporting data o Enforcement
Technical	o MRV reporting tools for different GHG emission sources o Data system for public release

6.3. Overview of Risks and Benefits of Mandatory Reporting

Based on the evidence that has been collected and analyzed in previous studies (ERM, 2010) there are both risks and benefits associated with implementing a mandatory GHG reporting program.

6.3.1. Risks and Costs of GHG Reporting

Key risks associated with a reporting program are linked to the companies' reputation if their large emissions become known and the burden that it may impose, as explained below:

- There is increased global expectation for GHG emissions disclosure by investors, insurance companies, and several stakeholders. Therefore, lack of quantification of emissions raises concerns of wealth redistribution due to large GHG emissions;

- Data disclosure, if not managed carefully, may cause competitive harm by enabling competitors to "reverse engineer" company's capacity and operational readiness if the reporting scheme requires reporting of throughput and product quantities in addition to the GHG emissions data;

- Focusing on GHG reporting and mitigation might entail ignoring other environmental impacts (e.g. using biofuels to reduce emissions, without considering land use issues);

- There is also the potential of trade-offs between future GHG reduction targets and other environmental objectives.

There seems to be a wide range of costs associated with GHG reporting due to inconsistency of reporting programmes, lack of uniform requirements and legal system in the different countries where they are implemented. Some findings include:

- Private sector costs quoted in different instances may range from €2,000 (2,520 USD) to € 15,000 (18,900 USD) per site per year (base year: 2008), and for authorities between €3,000 (3,700 USD) and € 10,000 (12,600 USD) per site per year (Aether, 2010).

- Company-wide reporting to the CDP by a large multinational corporation may sum to €800,000 per annum.

- Similarly, the range of costs of internal data assurance to external third-party verification has been quoted as €5,000 to €500,000 per annum.

6.3.2. Benefits of GHG Reporting

Clearly some of the benefits of GHG reporting arise from addressing the risks related to non-disclosure. The benefits of GHG reporting appear to vary according to the size of the company, sector and reporting scheme concerned. Benefits for SMEs appear to be of a lower order of magnitude than for larger companies.

Key aspects of a reporting program that maximize its benefits include:

- Alignment of a company GHG reporting with the leading methodologies allows inter-comparison of reported GHG data (benchmarks);

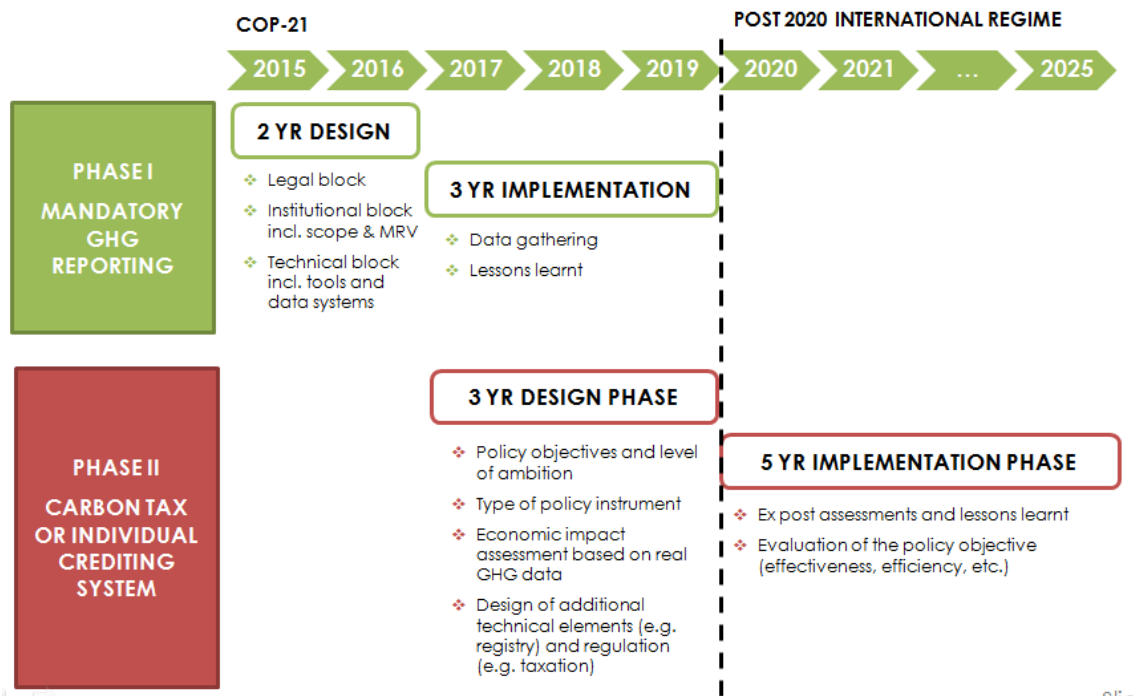
- GHG reporting is recognized as a crucial first step in achieving benefits from GHG management processes, allowing companies to analyze their emissions and set meaningful internal GHG targets ahead of regulatory control requirements or levying of a carbon tax;

- GHG reporting of a direct emissions programme can be augmented by national sustainability criteria and incorporated into a broader framework of assessing indirect emissions in order to understand the full life-cycle impact of companies' operations.

6.4. Sequencing and Next Steps

The mandatory GHG reporting program proposed for TT's O, G&P sector will anticipate a full market mechanism to reduce GHG emissions. As such, the design and implementation of the mandatory GHG reporting programme will provide valuable information and experience for the design and implementation of more ambitious policy instruments like a carbon tax or an individual crediting system (see Figure 10).

Figure 9. Roadmap for sequencing & transition into a fully-fledged market mechanism
Source: Own elaboration



The next steps to build the mandatory GHG reporting program should avoid duplication with the initiatives that are currently developing TT's capacity and technical infrastructure in terms of Measurement, Reporting and Verification of GHG emissions. These initiatives include a Low Emission Capacity Building Program promoted by the UNDP, and the ongoing work of the Energy Chamber, who is pre-designing an Emissions Trading Scheme with the support of the European Union.

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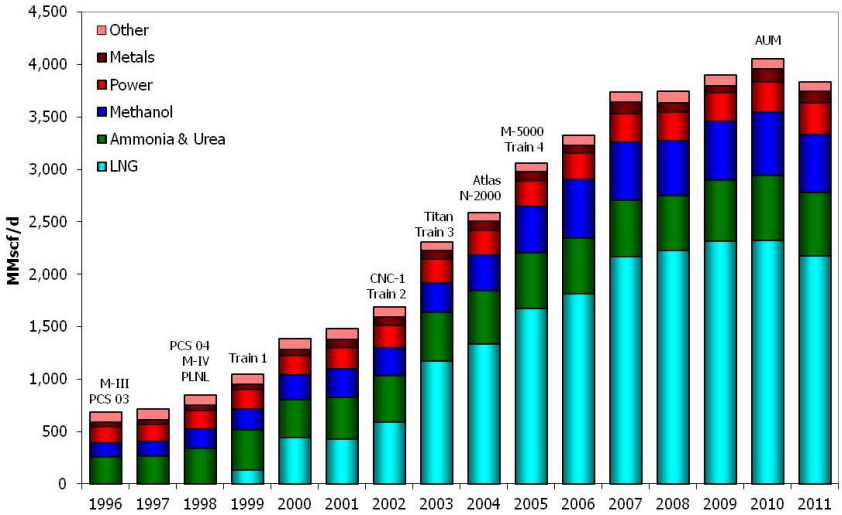
8. Annex 1: Definition of TT's Oil and Gas Sector

Unlike other Caribbean states, TT is endowed with hydrocarbon reserves. Trinidadians and Tobagians have built on these natural resources to shape their economy. According to the 2012 Annual Economic Survey of the Census Bureau of TT, the energy sector represented 43.7% of the Gross Domestic Product, 54.3% of the total revenue and 81.4% of total exports (Jobity, 2013).

The Oil & Gas (OG) Sector in Trinidad and Tobago (TTOG) is very dynamic. Over time, apart from the extraction and processing of oil and natural gas, TT has not only developed energy-intensive industries aimed at replacing foreign imports with domestic production (e.g. steel and cement manufacturing), but also an export-oriented and vibrant hydrocarbon-based industry (exports of LNG, ammonia/urea and methanol, ranking world's no. 6th exporter and first single site exporter in the world respectively) (Jobity, 2013 – see diagram below). Ultimately, natural gas is increasingly displacing oil as a source of economic growth. Today the economic value of the natural gas sector exceeds the economic value of the oil sector (UNEP Risø Center (2013).

Figure 10. Natural gas production in Trinidad and Tobago, 1996-2011
Source: Jobity (2013)



TTOG upstream sector is made up of a combination of state companies (The Petroleum Company of TT, The National Gas Company of TT, National Energy, The National Petroleum Company of TT), as well as independent companies (e.g. BPTT, BGTT, BHP, Ego Gas, Chevron TT Resources), international service companies and local service companies.

The country also has a very important petrochemical sector[14]. The main locations are the Point Lisas Industrial Estate located in Central Trinidad and The Union Industrial Estate located in La Brea, South West Trinidad. Also located in South Trinidad is Atlantic (Formally Atlantic LNG). This is one of the largest LNG processing facilities in the hemisphere.

[14]In 2012, the Energy Based Plants 2012 included: 1 Natural Gas Liquids Processing Facility; 4 LNG Trains; 10 Ammonia Plants; 1 Ammonia, Urea and Melamine plant; 7 Methanol Plants; 1 Urea Plant; 4 Direct Reduced Iron (DRI) Modules; 4 Power Generation Plants; 1 Petroleum Refinery; 1 Cement Manufacturing Plant; and Over 120 Light Industrial and Commercial Customers (Jobity, 2013)

Throughout this document and the project, the O, G&P sector in TT will cover:

- Traditional Oil and Gas activities: upstream activities (such as exploration, production and compression), midstream activities (such as transportation, distribution and processing), and downstream activities (such as LNG exports).

- The Petrochemical Sector (such as refining, ammonia, methanol).

In addition, the economic analysis will also cover important industrial sectors which are energy-intensive and heavily reliant on TT's natural gas:

- Electricity production, which is fired at 99% by natural gas, and where there are options to abate GHG emissions cost-effectively (conversion of single-cycled turbines to combined-cycle turbines).

- Steel production, which (according to the 2008 CO_2 inventory of the University of T&T) accounts for 20% of the emissions from the petrochemical sector.

- Cement production.

9. Annex 2: Abatement Cost Study: Methodology, Assumptions and Results

Information on the methodology used, assumptions made and results obtained from the MAC study performed to estimate the O, G&P sector's abatement potential and investment needs is provided in this section.

Step 1: Identification of mitigation measures. According to the specific characteristics and needs of the sector, a set of preliminary measures has been screened and proposed for further analysis.

The following measures were identified in close consultation with local energy experts such as Dr. Zaffar Khan, as well as O&G experts such as Mohammed Riard. Nevertheless, this is a first approach to the reduction of GHG measures in these sectors. Before any of these measures are implemented, they should be analyzed in detail discussed with the LNG, methanol and ammonia plant operators to validate them.

> **Measure 1 (M1).** The implementation of energy audits in LNG and methanol plants, for instance, is regarded by local experts as an effective way not just to reduce GHG emissions, but also to increase competitiveness and improve their bottom line.
> **Measure 2 (M2).** The improvement in the use of heat considers the implementation of a Combined Heat and Power (CHP) technology through the installation of turbo-expanders to increase the useful energy obtained from fossil fuels and thus diminish the emissions associated to its use.
> **Measure 3 (M3).** The revamping of ammonia plants, also endorsed by local experts, considers the upgrade of 5 facilities in 5 years (2016-2020).
> **Measure 4 (M4).** The measure of reduction of venting and flaring emissions consists in the implementation of a Gas Capture and Recovery system to collect and compress the gas emissions from the oil extraction process for further utilization.
> **Measure 5 (M5).** Finally, the electric generation technology measure proposed considers the upgrade of 2 simple-cycle turbines to combined-cycle in a lapse of 2 years, considering the investment and maintenance needs as well as the energy savings associated.

Step 2: Cost-efficiency analysis. The cost-effectiveness of the selected measures is assessed individually, estimating each measure's GHG emissions reduction potential, and calculating its net present value (NPV) for comparison with the BAU scenario applying a societal discount rate of 7% (EPA, 2010).

Several other important assumptions are made in this stage of the analysis, primarily regarding the energy prices and emission factors for processes in the sector. The energy price assumed as a basis is that of the year 2011 (26 TTD/kWh for electricity and 25.45 TTD/million BTUs for Natural Gas). The costs in the projections were all translated to NPV in order to correctly compare them.

The analysis also assumes a steady rise in TT's O, G&P production, taking into account the country's current capacity (i.e. assuming that existing O&G reserves are sufficient to feed the sector until 2030).

Step 3: Aggregated activity data for a given ambition level. The aggregated activity data was estimated for the period comprised from 2016 up to 2030, considering the effects of the five mitigation measures designed. The following table shows the mitigation potential of each measure aggregated for the time lapse defined (the time lapse of each measure varies slightly due to the time of implementation/construction each requires before it begins actually reducing emissions).

Table 49. Aggregated measures' reduction data
Source: Own elaboration

Code	Measure	Amount	Units	Time lapse
M1	Implementation of energy audits in LNG and methanol plants	24,426,656	tCO_2e	2015 - 2030
M2	Improvement in the use of heat	896,069	tCO_2e	2014 - 2030
M3	Revamping of ammonia plants	9,499,232	tCO_2e	2016 - 2030
M4	Reduction of venting and flaring emissions	12,630,537	tCO_2e	2014 - 2030
M5	Electrical Energy generation technology	5,419,269	tCO_2e	2016 - 2030

Step 4: Results. The results show that the GHG emission reduction potential of the measures analyzed up to 2030 exceeds 55 $MtCO_2$, and that these GHG reductions can be achieved at an average cost of 10.84 US$ per tCO_2.

Table 50. Measures' GHG emission reduction potential and capital investment up to 2030
Source: Own elaboration

Code	GHG emissions reduction per capita (tCO_2e/inhab.)[15]	GHG emission reduction up to 2030(tCO_2e)	Capital Investment (USD)	Mac 2030 (USD/tCO_2e)
M1	19.95	24,426,656	$0	5.45
M2	0.73	896,069	$157,611,635	85.88
M3	7.76	9,499,232	$37,710,634	-9.84
M4	10.31	12,630,537	$2,854,539,843	12.99
M5	4.43	5,419,269	$425,674,985	53.96
Total	43.19	52,871,763	3,475,537,097	Average: 10.84

The required capital investment amounts to more than 2,700 million USD, which may strike as exaggerated, however it must be recalled that is an investment for the next 15 years and includes infrastructure development (with a useful life of 25 years) and maintenance.

This information is expressed in figure 2, where a mitigation critical route for the GHG reduction actions is depicted up to year 2030. The measures are prioritized based on their marginal abatement cost (MAC). When the MAC of a measure is a negative value, it means that its implementation would generate revenue rather than expenses; when it has a positive value, this

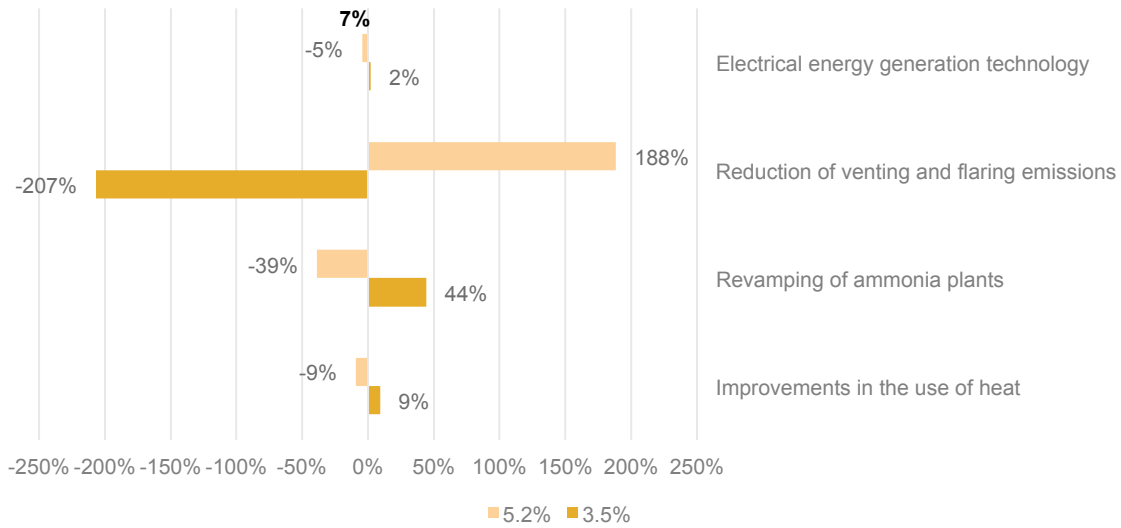
[15]Population of Trinidad and Tobago estimated in July 2014 is 1,223,916 inhabitants, according to the CIA World Factbook.

represents the cost in USD for the reduction of one tCO_2e under that given measure. In this sense, the MAC graph shows on its x-axis the accumulated GHG emission reduction product of the sequential implementation of the measures up to year 2030, beginning with the less costly measure, followed by the second less costly and so on. The y-axis on the chart shows the MACfor any given measure.

Step 4: Sensitivity test. The following graph shows the sensitivity tests done for the GHG emission reduction measures included in this report. The discount rates used were taken from an economic analysis study done for Petrotrin by John C. Whitehead (2011). Given that in this study several companies are included, the best option would be to use the Company Specific Risk Premium. However, since that information is not available at the moment and considering that Petrotrin is one of the leading companies in the national oil and gas sector, the same approach used by the company in previous studies was selected.

As for Whitehead's explanation for choosing these rates, he states, "we use two discount rates for the present value calculations. The first is the discount rate of 12% prescribed by the Inter-American Development Bank guidelines for cost-benefit analysis. The second is the social discount rate of 3.5% advocated by Moore et al. (2004)".

Figure 11. Sensitivity test
Source: Own elaboration



These results show how the Net Present Value for all of the measures changes, according to the discount rate used in the analysis, which is. For some of the measures, even if the discount rate is modified, the results Net Present Value do not vary highly. However, for other actions, significant changes take place in the Net Present Value results when the discount rates are modified. This is caused by the cash flows of every action, which have a great influence on the Net Present Value. Therefore, for the actions in which the Net Present Value is expected to change to a large extent, a careful recalculation of the economic valuation of the measures would be advisable, using, if possible, the Company Specific Risk Premium.

Table 51. Breakdown by concepts of capital investment needs

Source: Own elaboration

CODE	CONCEPT	2014	2015	2016	2017	2018	2019	2020	2021	2022
M5	Cost of Construction	$34,666,667	$34,666,667	$34,666,667	$34,666,667	$34,666,667	$34,666,667			
M4	Capex Costs	$1,239,201,630								
M3	Revamping costs			$15,084,253		$7,542,127		$15,084,253		
M2	TurboExpander Installation	$15,500,000	$15,500,000							
M2	CHP Installation	$12,350,000	$12,350,000							
-	**TOTAL**	**$1,301,718,297**	**$62,516,667**	**$49,750,920**	**$34,666,667**	**$42,208,793**	**$34,666,667**	**$15,084,253**	**$0**	**$0**

CODE	CONCEPT	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
M5	Cost of Construction									$208,000,000
M4	Capex Costs									$1,239,201,630
M3	Revamping costs									$37,710,634
M2	TurboExpander Installation									$31,000,000
M2	CHP Installation									$24,700,000
-	**TOTAL**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$1,540,612,264**

10. Annex 3: Policy instruments in Latin America and the Caribbean

10.1. Use of Market-Based Instruments in Latin America

Latin American countries such as Chile, Brazil and Argentina are using different MBIs to reduce GHG emissions. Oil and gas countries such as Venezuela as well as the Caribbean countries such as Jamaica, Cuba and Dominican Republic are using mainly environmental taxes. Whereas countries like Mexico are using both taxes and emissions trading to address GHG emissions.

Table 52. MBIs in different Latin American countries
Source: own elaboration

Market Based Instruments	Venezuela	Brazil	Chile	Argentina	Mexico	Cuba	Jamaica	Dominican Rep.	TT
Environmental Taxes									
Quantity Based instruments									
Emissions Trading									
Dividend Schemes									
Pollution Fees									
Feed in Tariffs (FIT)									

From the table above it can be seen the main MBIs currently being used across Latin American countries. However, countries are at different levels of implementation regarding MBIs and have also faced different challenges. **Venezuela** for example, applies environmental taxes to activities such as fishing, exploitation of forests for wood production (Villafañe, 2008) whereas **Cuba** has applied since 2002, a tax on harbour users in order to promote conservation in Havana Bay (CBD, 2014).

México has started to apply a tax on pesticides to reduce its use (Fernandez, 2014) and recently passed a tax on fossil fuels' carbon content, which ranges from $1-$5 USD per tCO_{2e} depending on the fossil fuel used. It is also projected that companies may be able to use carbon credits to offset the tax, as soon as the rules for the offsetting are drafted and published by the Ministry of Finance. The application of the carbon tax in Mexico has been the result of many years of work however, the original level of the tax was greatly reduced due to strong industry lobbying, and posed the question of whether such a tax level may be able to achieve environmental effectiveness. Mexico is also assessing the implementation of an emissions trading scheme for its electricity sector. In terms of pollution fees, the Federal Law for Government fees established certain fees for the use, exploitation and consumption of national water as well as for wastewater dumping (López-Velarde, 2013).

In October 2014, **Chile** passed a tax that will target the power sector, particularly generators operating thermal plants with an installed capacity equal or larger than 50 MW. The tax amounts to $5 USD per tCO_2 released. Thermal plants fueled by biomass and smaller installations will be exempted (Reuters, 2014). Nevertheless, in 2013 under the PMR Chile received funding to develop a roadmap for the design and eventual implementation of an ETS for reducing GHG emissions in the energy sector.

Brazil on its behalf, applies a tree replacement fee to timber companies targeted for reforestation; an environmental compensation scheme in which companies financially compensate for projects' unavoidable environmental impacts (e.g. testing chemicals at sea for drilling oil) and use these funds

to invest in conservation projects (López-Velarde, 2013);offered subsidies for industrial pollution abatement investments, as well as income tax and value-added tax rebates for clean technology adoption (Stavins, 2001). Also, some Brazilian cities have established a tax on goods and Services (ICMS), whereby 5% of the 25% of the revenue tax that the state passes to the city, may be invested in environmental protection projects (Mey, 2009). As part of its activities under the PMR the Brazilian government is exploring market instruments that may be implemented to meet their voluntary GHG emission reduction commitment and reduce overall mitigation costs. Options assessed include a domestic ETS as well as sectoral crediting approaches and a carbon tax.

Argentina implemented in 1999 a feed-in tariff for wind energy generation, and in 2006 it expanded it to all Renewable energy sources (IRENA, 2010). However, initially implemented tariff increases were rescinded due to exceptional circumstances; tariffs were frozen after the financial crises in 2002 and 2008, well beyond the emergency period of the crises.

Dominican Republic implemented a feed in tariff in 2008 that mandated a price to be paid for power produced from renewable energy resources. The Dominican FiT fixed a premium payment on top of the wholesale electricity price for a period of 10 years and up to 2018. However, a major barrier has been uncertainty regarding implementation and regulation of the FiT laid out in Law 57-07, particularly for solar development (Fu-Bertaux, 2011).

According to the International Carbon Action Partnership (ICAP), the development of an ETS is currently under consideration in Brazil, Chile and Mexico.

The Partnership for Market Readiness (PMR)

The World Bank established the PMR in 2010, to support, facilitate and build "readiness" for carbon market instruments, to scale up emissions reductions in a cost-effective way and foster financial flows.

The PMR is gaining momentum in different countries across Latin-American, as it has become a major global platform for discussions on new market instruments, generating an open dialogue on lessons learned from previous successes and failures. The PMR is a grant-based, global partnership of developed and developing countries that provides funding and technical assistance for the collective innovation and piloting of MBIs for GHG emissions reductions. PMR participants include Contributing Participants, that pledge financial resources to the PMR, Implementing Countries Participants such as Brazil, Chile, China, Colombia, Costa Rica, India, Mexico, among others and Technical Country Partners such as Kazakhstan, which have made the decision of implementing a market-based policy but may need further technical support.

In order to join the PMR developing and emerging countries submit an expression of interest to the PMR Secretariat. However, currently the PMR is not actively looking for new Implementing Country Participants. TT´s government would need to check directly with the PMR whether it´s still possible to apply as Implementing Country. Another alternative would be for TT´s government to apply as Technical Country Partner but it would need first to have made the decision to implement a market-based policy and then request technical support from the PMR.

The PMR supports four main objectives:

- Provide grant funding for building market readiness components such as GHG registries, Monitoring, Reporting and Verification (MRV) systems, data collection and management tools, and regulatory frameworks.
- Pilot and test innovative market instruments (e.g., domestic emissions trading schemes or new crediting mechanisms).
- Provide a platform for technical discussions and knowledge creation, South-South and North-South exchanges, and collective innovation on new market instruments.
- Share lessons learned & best practices.

Some of the activities performed under the PMR include providing support to enhance technical and institutional capacities for MBI implementation such as domestic ETS, carbon taxes or scaled-up crediting mechanisms. Given that countries are at different stages of development and market readiness, some activities focus on building key components such as MRV systems, data collection, and baseline setting, among others. Other activities go further, working on pilot domestic or international market-based schemes (PMR, 2013).

10.2. Use of non-Market-Based Instruments in Latin America

As shown in the table below, in terms of voluntary pledges and GHG emission reduction targets, **Mexico** acquired international compromises for the voluntary reduction of its GHG emissions reductions, it has pledged to reduce its emissions in 30% to the year 2020 and 50% to the year 2050. The General Climate Change Law was enacted in 2012 and includes among its main objectives to comply with these goals. While in **Dominican Republic** Law No. 1-12, which covers the country's National Development Strategy, established a binding commitment to achieve an absolute reduction in the country´s GHG emissions of 25% for 2030, compared to 2010 levels (IPM).

As for **Venezuela**, it has actively participated and ratified several international voluntary agreements, among which stand the Kyoto Protocol, The 1992 Rio Declaration on Environment and Development (Item 21), and the Millenium Development Goals; also, it has enforced several regulations on environmental issues such as pesticide control, noise, wastes, among others (Embassy of the Bolivarian Republic of Venezuela). Whereas **Jamaica** is a State Party to over 30 international and regional voluntary agreements such as The Convention on International Trade in Endangered Species of Wild Flora and Fauna, The Montreal Protocol, The BASEL Convention, the International Convention for the Prevention of Pollution from Ships, and the Cartagena Convention, among others.

In terms of command and control regulations, **Brazil** has implemented several command and control regulations in environmental areas such as water use, making it subject to licensing by public authorities (Article 12, I, Federal Law No. 9,433/1997) and also prohibiting specific activities (Article 49, I, Federal Law No. 9,433/1997) such as discharges. Whereas in **Cuba**, environmental command and control regulations are widely used, Law 81 depicts the main environmental regulations, even though the conditions and sanctions framework are not entirely enforced (Travieso-Díaz, 1999).

As for performance standards, the **Chilean** legislation has implemented them inspired by the country´s mining operations regulating sulfur dioxide emissions, as well as particles and arsenic with a national jurisdiction (Jaksic & Ojeda). While in **TT's** national environmental policy it is stated that water pollution control will be managed through a system of permits for facilities that release pollutants, based on performance standards. This type of standards will also be set for air, noise, water, waste and hazardous substances, and may include environmental monitoring and reporting requirements, according to the document (GORTT).

Table 53. Non MBI in Different Countries
Source: Own Elaboration

Non Market- Based Instruments	Venezuela	Brazil	Chile	Argentina	Mexico	Cuba	Jamaica	Dominican Republic	TT
Voluntary Agreements	√	√	√	√	√	√	√	√	√
Voluntary Pledges		√	√	√	√	√	√	√	√
GHG emission reduction targets					√	√		√	
Information Programs	√	√	√	√	√	√	√		√
Command and Control Regulations	√	√	√	√	√	√	√	√	√
Technology Standards		√	√	√	√	√			
Performance Standards			√	√	√				√

11. Annex 4. EPA Natural Gas Star and use of Direct Inspection and Maintenance programs for GHG emission reduction

11.1. Introduction to EPA Natural Gas Star and Natural Gas Star International

The United States Environmental Protection Agency (EPA) launched the Natural Gas STAR Program as a U.S. domestic public-private partnership in the 1993. In 2006, the Natural Gas STAR Program was expanded to include oil and natural gas companies throughout the world as part of the Global Methane Initiative. The Global Methane Initiative (GMI) is a voluntary, multilateral partnership that aims to reduce global methane emissions and to advance the abatement, recovery and use of methane as a valuable clean energy source. GMI is an international network of partner governments, private sector members, development banks, universities and non-governmental organizations that aim to build capacity, develop strategies and markets, and remove barriers to project development for methane reduction in Partner Countries.

Companies decide the level of participation that best suits them, and make a commitment to evaluating mitigation options on either a company-wide, site-specific, or pilot projects basis. The **key steps to joining Natural Gas STAR International** include:

- Signature and submission of a one-page Memorandum of Understanding to initiate partnership and demonstrate company's commitment to the program.
- Evaluation of current and future voluntary activities that reduce methane emissions.
- Preparation and submission of an Implementation Plan that summarizes how the results of its evaluation using tools and technical assistance by the secretariat experts.
- Reporting of the results of implemented activities after one full calendar year of participation and on an annual basis thereafter.

In terms of **sector activities addressed**, international O&G activities focus on methane recovery and use opportunities, including: changing-out existing equipment; improving maintenance practices and operational procedures; and studies to evaluate new capital project.

Example of relevant projects that have been implemented in Partner countries include: Directed Inspection & Maintenance (DI&M) to identify and quantify methane emissions; converting centrifugal compressor wet seals to dry seals; reduced emission completions to reduce venting of natural gas during the completion of hydraulically fractured wells; and vapor recovery unit installation to capture methane and other hydrocarbon emissions from crude oil storage tanks.

The **participation benefits** include:

- **Information Sharing and Technology Transfer.** Technology Transfer and Annual Implementation Workshops and publication of detailed Lessons Learned Studies and Fact Sheets, including technical reports of studies, and a quarterly newsletter.
- **Program and Technical Assistance.** Program support and technical assistance to partners via project and operational-level analyses, technical workshops, and administrative support.
- **Peer Networking.** Partners can participate in Technology Transfer Workshops, Annual Implementation Workshops, and Web-based communications to build strong networks with industry peers and keep up on industry trends, initiatives, and the latest technologies.
- **Voluntary Record of Reductions.** Through program participation and reporting, companies create a permanent record of their voluntary accomplishments in reducing methane emissions.
- **Annual Awards.** In the US EPA provides recognition, honors, and distinctions to highlight partner achievements at an annual awards ceremony. It highlights companies' achievement in articles, public service announcements, and technical studies and fact sheets. EPA also helps partners communicate program achievements to shareholders, customers, and the public.

Observed **barriers** to participation are:

- **Resources.** Joining Natural Gas STAR International requires partners to commit time, personnel, and resources to sustain their program activities.
- **Technical expertise.** Partners are expected to have access to technical expertise to analyze and implement projects that adopt global knowledge to their country's circumstances.
- **Share of information.** Partners should be willing to prepare and submit annual reports with an understanding that their findings may be shared among partners (which could be competitors) as "lessons learned".
- **Share of information.** Companies may be reluctant to share information with governments for fear of data being used to justify future regulations.

11.2. Direct Inspection & Maintenance programs

11.2.1. Overview

Fugitive equipment leaks are a major source of total hydrocarbon emissions including CH_4 emissions from oil and gas facilities. Methane is a potent greenhouse gas with a global warming potential that is over 25 times more than CO_2 over a 100-year time horizon. Most of these fugitive emissions are from a few big leaks rather than small or medium sized leaks. Experience has shown that 75-85% of the emissions from such leaks are cost-effective to fix (often with a payback of <6 months). Components in gas service leak more than those in liquid service and components in 'sweet crude' service are more likely to leak than those in 'sour crude' or odorized gas or liquid service.

Leak potential tends to increase with time and usage and different types of components and service applications have different leak potentials (i.e., leak magnitude and probability). Fluctuations in pressure, temperature, and mechanical stresses on pipeline components, such as valves and seals, eventually cause them to leak methane. It has also been observed that components in vibration, cryogenic or thermal cycling service have an increased leak potential.

Implementing a DI&M program is a proven, cost-effective way to detect measure, prioritize and repair equipment leaks to reduce methane emissions and gas losses. The design of a DI&M program should concentrate on components that are prone to leak enough methane to make repairs cost-

effective. Such components include valve packing, pneumatic controllers and open-ended lines such as vent and drain connections, blow-down lines, pneumatic engine starter motors, and pressure relief valves.

11.2.2. Methane leakage potential

Based on many previous surveys it is clear that a relatively small number of leaking components are the source of the majority of fugitive methane emissions. For example, in natural gas processing plants valves are the largest source (30%), followed by connectors (24%), and compressor seals (23%). The remaining 23% of methane losses are primarily from open-ended lines, crankcase vents, pressure relief devices, and pump seals.

For example, estimated methane savings based on data reported in EPA's Natural Gas Star (EPA, 2011) indicate that without DI&M, valve stem packing leakage ranges from 1 to 24 Mcf per year; and open-ended blow-down valve leakage averages 350 Mcf per year, although values as high as 14,500 Mcf per year have been reported. When implementing DI&M programs NG Star Partners reported methane emission reductions of 1,200 Mcf, which reflects DI&M at 12 remote sites, and 31,000 Mcf per year reduction, resulting from DI&M of 647 remote components.

A recent survey by the Canadian Petroleum Producers Association (CAPP) has concluded that after seven years of implementation of the industry Best Practices Guidelines in Canada (CAPP, 2007), the emissions due to fugitive equipment leaks have decreased by 75% since the implementation of DI&M programs. These results are a strong indication that DI&M programs and CAPP's best management practice for management fugitive emissions at upstream Oil and Gas facilities" (CAPP, 2014) are effective in controlling fugitive equipment leaks.

11.2.3. Design considerations for DI&M

A typical DI&M program is implemented in four steps:

- A baseline survey is conducted;
- Results of the survey are recorded to identify candidates for cost-effective repair;
- Repairs are made and data analyzed to estimate methane savings; and
- A survey plan is developed for future inspections and follow-up monitoring of leak-prone equipment.

Once the initial DI&M baseline survey is performed it is possible to identify and quantify leaks and repairs can be staged and prioritized based on cost-effectiveness considerations. Subsequent surveys would be based on data from previous surveys, allowing operators to concentrate on the components that are most likely to leak and are profitable to repair.

The table below provides a compilation of several leak screening techniques that are commonly used. In additional to a brief description of each technique the table also provides an evaluation of the rate of screening, the techniques effectiveness in identifying leaks and the costs associated with its implementation.

Table 54. Description of Different Screening Techniques for DI&M programs.
Source: Own elaboration

Screening Technique	Description	Rate of Screening	Comments	Effectiveness	Costs
Soap Bubble Screening	A fast and easy and very low-cost leak screening technique. Soap bubble screening involves spraying a soap solution on small accessible components such as threaded connections.	Operators can screen about 100 components per hour by soaping.	Effective for locating loose fittings and connections, which can be tightened on the spot, Effective for quickly checking the tightness of a repair.	++	$
Electronic Screening	Use small hand-held gas detectors to detect accessible leaks. Devices are equipped with catalytic oxidation and thermal conductivity sensors that detect the presence of specific gases.	Electronic screening averages about 50 components per hour.	Electronic gas detectors can be used on larger openings that cannot be screened by soaping Pinpointing leaks can be difficult at high ambient concentrations of hydrocarbon gases.	+	$$
Vapor Analyzers (OVA or TVA)	Portable hydrocarbon detectors that identify leaks. OVA is a flame ionization detector (FID), measuring organic vapors in the range of 9 to 10,000 ppm. A TVA has an additional photo-ionization detector (PID) and measures sure organic vapors in excess of 10,000 ppm.	Portable analyzers can screen about 40 components per hour.	Concentrations measured by OVAs and TVAs can be used to quantify leaks using EPA methodology TVAs and OVAs measure the concentration of methane in the area around a leak.	++	$$$
Infrared (IR) camera	Hydrocarbon emissions absorb IR light at certain wavelength. The IR camera can detect in real time gas emissions from equipment. Gas plumes are visible due to their absorption of IR light	IR cameras can screen hundreds of components per hour	IR cameras have the ability to screen inaccessible equipment. IR cameras can be hand-held for walking surveys. It can be mounted on trucks or airplanes for long distance surveys.	+++	$$$

11.2.4. Estimated Leak Survey Costs

Costs will differ from facility to facility depending on location and complexity. Typical costs that can be used a guide are:

- **Cost of complete screening survey using high volume sampler to quantify emissions (processing plant)**. Ranges US$15,000 to US$20,000 per medium-size plant (Rule of Thumb: US$1 per component for an average processing plant; Cost per component for remote production sites would be higher than US$1).
- **Follow-up surveys.**25 to 40% cost reduction for follow-up survey; Focus on higher probability leak sources (e.g. compressors).

11.2.5. Lessons Learned from Global Experience

- The costs of the initial baseline survey can be recovered in gas savings during the first year. The cost of subsequent surveys can be reduced by focusing the survey efforts on those components that were identified through earlier studies as the most likely to leak.
- A DI&M program should target the five categories of equipment components that contribute to the majority of methane losses: block valves, control valves, connectors, compressor seals, and open-ended lines.
- If possible, the most severe leaks should be repaired first.
- Typically only a few leaking components are responsible for the majority of fugitive methane emissions.

11.2.6. Example: Cost of Repair

This DI&M practice, if carefully implemented, can provide a payback in less than a year when considering leaks that are cost effective to find and fix, and minimizing transaction costs. Valve stem packing, open-ended blow-down and engine starter vents and pressure relief valve leaks are frequently found to be cost effective to find and fix, with repair often requiring only valve or packing tightening. Implementation of DI&M at remote sites would also lead to safer operation and increased reliability.

The table below provides a numerical example of estimated costs for repairing of components with a short payback. Please note that these costs represent cost for the actual repair once the leaking components have been identified and do not reflect the survey costs – to identify the leakers - that were elaborated above.

Table55: Repair Costs Example.
Source: Hydrocarbon Processing, May 2002

Repair the Cost Effective Components Component	Value of lost gas (US$)	Estimated repair cost (US$)	Payback (months)
Plug Valve: Valve Body	8,428	200	0.3
Union: Fuel Gas Line	8,104	100	0.2
Threaded Connection	6,964	10	0.1
Distance Piece: Rod Packing	5,100	2,000	4.8
Open-Ended Line	4,640	60	0.2
Compressor Seals	3,856	2,000	6.3
Gate Valve	3,152	60	0.3

Note: value of lost gas adjusted to US$ 70.63/Mm^3 gas price

12. Annex 5: Workshop Report

1. Workshop Fact-Sheet

- **Date and time:** Monday 24th November 2014, from 9:00 AM to 15:30
- **Venue:** Environmental Management Authority's Head Office Conference Room, #8 Elizabeth Street St. Clair, Port of Spain, Trinidad and Tobago
- **Number of Participants:** 25, including public officers from different public institutions, representatives of the country's main energy companies, and academia
- **Topics covered:**
    - Literature review and Policy Options to reduce GHG emissions in Trinidad & Tobago
    - Successful best-practices to reduce GHG emissions in the Oil & Gas Industry
    - Group Discussion and Plenary Discussion on Options to reduce GHG emissions in Trinidad and Tobago's Oil, Gas and Petrochemical sector
- **Presenters:** Mr. Gerard Alleng (IDB), Prof. John Agard (University of the West Indies), and Mr. Iker Larrea (Factor CO_2)

2. Development of the Workshop

The Workshop took place as planned. The participants had received the agenda together with a background paper before the meeting. After the workshop, all participants received a copy of the background report, and were invited to provide written feedback.

The workshop included a group discussion where participants were divided in three different groups, and were asked to fill-in a questionnaire comprised of five questions. For each of the question, the participants first ranked their preference with regard to the four GHG policy options discretely (i.e. Option 4-Option 2-Option 3-Option 1), and then justified their answers.

A summary of the answers given is provided below.

Question 1 (environmental effectiveness) - Which policy option can best contribute to reducing GHG emissions in absolute terms? Why?

Group	Ranking	Reasoning/comment(s)
Group #1	3 > 2 > 1 > 4	• The carbon tax (Option 3) establishes the clearest price signal to reduce GHG emissions. Effectiveness is however achieved at a cost (low economic efficiency) • The effectiveness of the carbon tax will depend on how the tax is effectively levied (Option 3)
Group #2	2 > 3 > 1 > 4	• Individual crediting (Option 2) is the best Option, as if offers both "punishment" and "incentive"; a Carbon tax (Option 3) is the 2nd best option • Government crediting (Option) 1 is impractical (sic) • Within the timeframe of one year it may be wise to start by Mandatory GHG reporting (Option 4) and then proceed to Individual Crediting (Option 2)
Group #3	2 > 3 > 1 > 4	• Individual crediting (Option 2) is the best Option, balanced approach to getting to the target • Carbon taxes (Option 3) can be effective provided that they are properly structured • Mandatory GHG reporting (Option 4) has no mechanism for reduction

Question 2 (economic efficiency) - Which policy option is able to achieve low-cost GHG emission opportunities? Why?

Group	Ranking	Reasoning/comment(s)
Group #1	2 > 3 > 1 > 4	• N.A.
Group #2	3 > 2 > 1 > 4	• Carbon tax (Option 3) is the most suitable option to achieve low-cost GHG emission reductions. Tax system is already in place, and the Government would receive carbon tax revenues from GHG emitting companies
Group #3	1 > 2 > 3	• Government crediting (Option 1) has potential for benefit (sic) and is the best Option for getting to the target • Individual crediting is the most costly to create, implement and monitor (Option 2) • Mandatory GHG reporting (Option 4) creates no opportunity

Question 3 (economic impacts) - What are the potential adverse economic impacts of each policy option and what would be the necessary support mechanisms to address these economic impacts?

Group	Ranking	Reasoning/comment(s)
Group #1	N.A.	• Impacts of Government crediting (Option 1) – inflation, source of "bonus" would derive from taxes, hence distributional impacts in terms of GDP and employment (company vs. country) • Impacts of Individual crediting (Option 2); same as before; depending on the level of "punishment", companies may leave the country with impacts on GDP, employment, tax collection, etc. • Impacts of Carbon tax (Option 3); same as before; a carbon tax will clearly impact the feasibility of new projects and investments, however it will all depend on the magnitude of the tax (no major impacts provided that the overall tax regime remains competitive for companies)
Group #2	N.A.	• Individual sectoral crediting (Option 2) and Carbon tax (Option 3) can put companies at risk of losing competitiveness, so the government should introduce support mechanisms • Mandatory GHG reporting under all options except Government crediting (i.e. Option 2, Option 2 and Option 3) may act as a disincentive for companies to remain in Trinidad and Tobago (fear of wealth redistribution)
Group #3	3 > 2 > 1	• Carbon tax (Option 3) would be the policy option with the biggest adverse economic impact, followed by Individual crediting (Option 2), Government crediting (Option 1) and Mandatory GHG reporting (Option 4) • For all options: support mechanisms could consist on financial incentives such as accelerated depreciation on equipment and tax breaks

Question 4 (data needs, technical requirements and capacity gaps) - What are the data needs, technical requirements and capacity gaps of each policy option?

Group	Ranking	Reasoning/comment(s)
Group #1	2 > 3 > 1	• Individual crediting (Option 2) is the technically most demanding option, followed by Carbon tax (Option 3) and Government crediting (Option 1) • For all options: data needs in terms of baseline setting and MRV • For all options: supporting framework in terms of administrative framework (coordination of different ministries), infrastructure (carbon registry) • For all options: needs in terms of capacity building and information sharing (dissemination of best practices, continuous improvement, etc.)
Group #2	N.A.	• For all options: data needs in terms of baseline GHG Inventories and MRV systems • For all options: capacity gaps in terms of reduced local expertise and skills for GHG Inventories, MRV systems, analysis and energy audits
Group #3	N.A.	• For Individual Crediting (Option 1) and Government Crediting (Option 2): technical capacity to set the carbon price • For Carbon tax (Option 3): data and skills required to set adequate tax levels, structure and regime

Question 5 (barriers to implementation) - What are the barriers foreseen during the implementation of each policy option?

Group	Ranking	Reasoning/comment(s)
Group #1	N.A.	• For all options: political barrier in terms of lack of political will, economic climate, company "buy-in", public understanding/awareness raising, distributional issues and increases of price of energy in Trinidad • For all options: lack of technical capacity • For Carbon tax (Option 3): opposition from covered entities if tax is not progressive
Group #2	N.A.	• For all options: lack of technical capacity and supportive administrative framework • For all options: political barrier in terms of lack of political will to introduce climate change mitigation regulation • For Government Crediting (Option 1): financial barrier in terms of lack funds of finance to fund support mechanisms
Group #3	N.A.	• For all options: technical barrier in terms of capacity • For all options: political barrier in terms of lack of political will, economic climate, company "buy-in", public understanding/awareness raising

3. Summary of the group discussion

Taken together, the group discussion provided the following feedback to the project

Question	Ranking	Summary
Question #1 (environmental effectiveness) - Which policy option can best contribute to reducing GHG emissions in absolute terms? Why?	2 > 3 > 1 > 4	• Individual crediting (Option 2) is the best Option, balanced approach to getting to the target (incentive and punishment) • Carbon taxes (Option 3) can be effective provided that they are properly structured • Mandatory GHG reporting (Option 4) is regarded as a preliminary phase of a more effective policy option
Question 2 (economic efficiency) - Which policy option is able to achieve	1 > 2 > 3	• Government crediting (Option 1) is regarded more cost-effective than Individual crediting (Option 2), or Carbon tax (Option 3); Mandatory GHG reporting alone (Option 4) is regarded as insufficient to lead to GHG emission reductions automatically.

low-cost GHG emission opportunities? Why?		
Question 3 (economic impacts) - What are the potential adverse economic impacts of each policy option and what would be the necessary support mechanisms?	3 > 2 > 1	• Likely impacts for all options except Mandatory GHG reporting alone (Option 4) will be distributional impacts ("winners" and "losers", transfers from "losers" to the State and from the State to "winners") and possibly a disincentive for new investments. • Support mechanisms could consist on financial incentives such as accelerated depreciation on equipment and tax breaks
Question 4 (data needs, technical requirements and capacity gaps) - What are the data needs, technical requirements and capacity gaps of each policy option?	2 > 3 > 1	• Data needs in terms of baseline setting, establishment of GHG Inventories and MRV systems • Capacity gaps in terms of reduced local expertise and skills for GHG Inventories, MRV systems, analysis and energy audits; need of platforms for information sharing • Supporting administrative framework required (coordination of different ministries, carbon registry)
Question 5 (barriers to implementation) - What are the barriers foreseen during the implementation of each policy option?	N.A.	• For all options: political barrier in terms of lack of political will, adverse economic climate, company "buy-in", public understanding/awareness raising, distributional issues and energy price increases in Trinidad • For all options: technical barrier in terms of lack to capacity and supportive administrative framework • For Carbon tax (Option 3): opposition from covered entities if tax is not progressive • For Government Crediting (Option 1): financial barrier in terms of lack funds of finance to fund support mechanisms

4. Conclusions and next steps

The key feedback provided by the group discussions and written comments to the background paper can be summarized as follows:

- Mandatory GHG reporting (Option 4) is regarded as a preliminary phase towards a more effective policy option, such as Individual crediting (Option 2) or a Carbon Tax (Option 3).
- Compared with Carbon taxes (Option 3), Individual crediting (Option 2) is regarded as a more balanced approach (a combination of incentives and disincentives), but at the same time more demanding from a technical and administrative and managerial perspective.
- Importantly, the negative price signal introduced by the climate change mitigation option (in Individual Crediting –Option 2– or in a Carbon Tax –Option 3–) has to be carefully calibrated so as to avoid adverse economic impacts, such as damaging the profitability of existing companies, as well as the financial attractiveness of new investments.
- Common barriers to the implementation any GHG policy instrument have been identified, including political barriers (lack of political will, a potentially adverse economic climate, company "buy-in", public understanding/awareness raising, distributional issues and energy price increases in Trinidad), technical barriers (lack to expertise and skills for GHG Inventories, MRV systems, etc.), as well as institutional gaps (increased coordination among ministries, specific infrastructure such as a carbon registry).

Composition of Groups

Group	Industry	Government	Academia
Group #1 [Total: 7]	Mr Rajesh Bududass (Petrotrin); Ms Natalie Edghill (REPSOL); Mr Jason Maitland (Methanex) **[3]**	Ms. Jewel Batchasingh (MEWR); Mr Gerard Rodriguez (TT Electricity Commission); Mr Ryan Assiu (EMA) **[Rapporteur] [3]**	Mr Pascal Marcelin (UWI) **[1]**
Group #2 [Total: 6]	Mr Gary Clyne (Energy Chamber); Ms Orissa Forde-Carrington (BG); Mr Curt Rackal (Methanex) **[3]**	Ms Mary-Rose Narayane (M Energy) **[Rapporteur]**; Ms Janelle Spencer (Central Bank of TT) **[2]**	Mr. Mariano Browne (UWI) **[1]**
Group #3 [Total: 7]	Mr Tyrone Kalpee (BP); Ms Karen Ragoonannan-Jalim (BP) **[Rapporteur]**; Mr. Shyam Dyal (Petrotrin) **[3]**	Ms Candace Leung Woo Gabriel (MEWR); Mr Arden Rodriguez (National Energy Corporation);Ms Sindy Singh (MEWR); Mr Timothy Woolford (Central Bank of TT) **[4]**	

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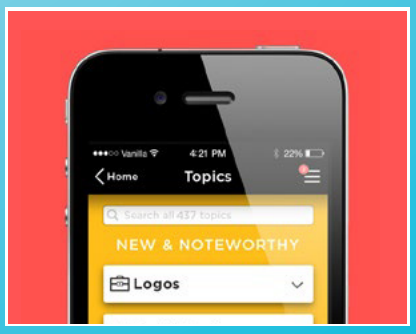
WHAT IS YOUR **CLIMATE I.Q.?**



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