Contract n°2014/352-852

EuropeAid/135600/DH/SER/MULTI

EU Technical Assistance Facility for the Sustainable Energy for All Initiative (SE4ALL)

Neighbourhood (East and South), Asia (including Central Asia), Latin America, Caribbean and Pacific

Providing Technical Support to EU Delegation to Trinidad and Tobago to organise and implement the Clean Energy Conference aiming at providing EU Expertise in the field of Sustainable Energy

Caribbean – GT#31/CSEE-EUDT&T (Trinidad and Tobago)

Sustainable Energy Implementation Plan 2021/2030 for Trinidad and Tobago
Final

Date: 15 September 2017

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Sustainable Energy Implementation Plan 2021/2030 for Trinidad and Tobago
Final

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Date: 15 September 2017

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List of Acronyms

CAPEX	Capital Expenditure
CCGT	Closed Cycle Gas Turbine
EDAB	Economic Development Advisory Board
ESCO	Energy Service Company
DSM	Demand Side Management
FiT	Feed in Tariff
GoRTT	Government of the Republic of Trinidad and Tobago
HDC	Housing Development Corporation
IDB	Inter-American Development Bank
IEA	International Energy Agency
IMF	International Monetary Fund
IPP	Independent Power Producers
IRENA	International Renewable Energy Association
MoEEI	Ministry of Energy and Energy Industries
MPD	Ministry of Planning and Development
MOF	Ministry of Finance
MPU	Ministry of Public Utilities
MGSi	Metallurgical Silicon
NDC	National Development Contributions
NGC	National Gas Company
OCGT	Open Cycle Gas Turbine
OPEX	Operational Expenditure
PolySi	Polysilicon
PPA	Power Purchase Agreement
RES	Renewable Energy Sources
RIC	Regulated Industries Commission
RPS	Renewable Portfolio Standards
SME	Small and Medium Enterprises
SPB	Simple Payback Period
SWH	Solar Water Heaters
SWMCOL	Trinidad and Tobago Solid Waste Management Company
TAF	Technical Assistance Facility

T&T	Trinidad and Tobago
T&TEC	Trinidad and Tobago Electricity Commission
TGU	Trinidad Generation Unlimited
UNDP	United Nations Development Programme
UWI	University of West Indies
VAT	Value Added Tax
WB	World Bank
WtE	Waste to Energy

List of units

tcf	Trillion cubic feet
kW	Kilo-watt
kWh/ sq m	Kilowatt-hours per square meter
kWh/kwp	Kilowatt-hours per installed kilo-watt peak
MW	Mega-watt
USD/mmbtu	United States dollars per million British thermal units

Executive Summary

Energy sector context and long term requirements

The energy sector of T&T despite its enormous contribution to the economy - with suffers respect to the promotion of sustainable energy - from certain structural inefficiencies that can be summarized as following: (a) low level of electricity prices, (b) low consideration of energy conservation among business and the public, (b) waste of energy and natural gas due to poor incentives and non-market driven mechanisms, (c) huge energy subsidies that lead to overconsumption of natural gas, (d) the absence of consistent energy policy, (e) delays in the implementation of certain reforms that promote sustainable energy.

Electricity sector subsidies have led to a cumulative deficit of T&TEC standing above 500 million US$ by the end of 2016. Moreover, there are large opportunity costs from the existing mode of natural gas utilization estimated between 1.7 and 3.2 billion USD until 2030.The two effects combined have an impact of at least 1% of GDP implying that there is a large room for more optimum utilization of indigenous resources.

After 2019 new generation capacity will have to gradually enter the system, while after 2022-2023 significant new capacity will be required to cover project demand (approximately 500 MW). In this respect a new CCGT plant of 300-350 MW might be required between 2022 and 2023 given the existing increasing trends of electricity demand. Renewables could play a major role in covering this demand. EE savings in the demand side should be introduced as they reduce the need for capital investments in power generation. Renewables and Energy Efficiency should be seen as complementary policies for decreasing emissions and decreasing the actual generation costs of electricity when taking into account opportunity costs.

Cross cutting issues in the energy sector

Two essential cross-cutting issues are related the enhancement of energy country planning capacities and on the establishment of an Energy Agency. In Trinidad and Tobago there is no solid National Energy Policy based on robust modelling background. This has adverse effects on the planning of the sector and leads to several structural inefficiencies and significant technical and financial losses and foregone revenues. In response, a least cost optimization model (such as the LEAP) has to be set-up for the long term planning of the energy sector of Trinidad and Tobago and based on that a National Energy Strategy has to be developed and regularly updated. Moreover, the establishment of a separate Sustainable Energy Unit within the MoEEI is an excellent step towards the promotion of Sustainable Energy. The enhancement of the capacities of this Unit is of utmost importance as currently Ministry staff working on RES and EE despite their strenuous efforts has to deal with a series of issues. The already established Renewable Energy Committee should be reactivated to provide advice and guidance to the Renewable Energy Unit. In the long run the establishment of an Energy Agency is advised so that the MoEEI can devote resources on the formulation of energy policy and planning other more technical functions required for the development of the RES/EE sub-sectors are fulfilled more effectively by the Agency.

Renewables and required actions

To satisfy the policy target of installed capacity of 283 MW by 2030 various RES mixes can be employed. The most promising technologies to be implemented in T&T are solar photovoltaics, onshore wind energy and SWH, as well as waste to energy. The optimum RES mix comprises 70% PV, 20% wind and 10% waste to energy. Other technologies could be also introduced in the longer run.

Feed in tariffs (including net-metering) are the most suitable support policy instruments for small and medium scale PV applications (e.g. up to 200 kW for PV) and for technologies that require support to enter the market. For large-scale RE investments (>2MW) the introduction of tendering processes is a more appropriate solution as they can lead to low contracted tariffs While there is a large variety of design options for auctions certain proposals for T&T include:

- The tendering procedure could be organized either by the RIC or more appropriately by TTEC, while the amendment if the respective Act has to take place.
- The tendering process should ensure that the maximum number of participants is attracted so that overall cost is minimized.
- Thorough attention should be paid to the inclusion of terms that ensure the utilization of local labour and components of the solar value chain.
- Responsibility for site selection could belong to the government due to pertinent land availability issues in T&T, as well as a means to overcome potential environmental issues.
- The introduction of a ceiling price should be seriously considered in the case of T&T as there is no primary experience of a similar process.
- A co-ownership scheme with a public authority or a Public Private Partnerships (with T&TEC) is worth assessing.
- A model PPA should be published in advance to inform market players.

Based on the existing legislation, the so-called "approved generator" is the classical Independent Power Producer who delivers all its electricity to the sole buyer under a negotiated Power Purchase Agreement (PPA). Currently, the T&TEC Act neither allows for smaller operators to feed electricity into the grid nor is self-generation or wheeling of electricity between power sources and demand sink permitted. The same accounts for the RIC Act. It will therefore be necessary to amend certain aspects of both Acts accordingly and allow access to the grid, although the extent and scope should be controlled by T&TEC in line with the Regulated Industries Commission (RIC) and made dependent on capacity demand and technical circumstances. In addition, it is recommended to simplify the permission process for operators of small distributed generation and minimize the licensing procedure. A simple request for registration and control by the electrical inspectorate should be sufficient. Specific elements to be introduced/amended in two Acts include:

- Introduction of RPS as mandatory obligations,
- Provisions regarding the establishment of a tendering scheme,
- Provisions to allow access to the grid for operators of RE generation facilities,
- Establishment of a FiT scheme (or net metering) for small and medium scale RES generation,
- (Potential) Provisions regarding the introduction of 4th tier in electricity tariffs,
- Provisions related to PPAs.

Energy Efficiency

With respect to Energy Efficiency, a large energy savings potential at the demand side is conservatively estimated at 10%, but should not be seen as uniform and its feasibility should more thoroughly assessed, as it entails large behavioral change from consumers. In any case the rapid implementation of EE measures is all economic sectors and more importantly in the industrial sector which comprises approximately 2/3 of domestic consumption is both necessary and cost-efficient. Initial estimates of the overall CAPEX costs can be up to 400 US million from all sectors (residential, hotels, industrial), which could/should be partially financed by the government as with the current electricity price levels incentives are limited.

Regarding the generation side, an ongoing discussion for the utilization of the 150% tax allowance scheme to allow for financing of the upgrade of OCGTs which could lead to energy savings of approximately 10%. This is not feasible for the time being as there is no process to certify ESCOs. The elaboration of a detailed feasibility study for the upgrade of OCGTs to CCGTs under various setups and financial mechanisms is strongly advised.

Apart from the bold financial support needed to promote EE, the adoption of an Energy Efficiency Act will foster a stable legal and financial catalyzing the involvement of the private sector in the EE investments in the country. The EE Act could regulate the following issues:

- Development of energy savings indicators (e.g. energy savings compared against a baseline, energy intensity, etc.),
- Definition and emphasis on the exemplary role of public buildings,
- Establishment of long term strategy for the mobilization of investments for the renovation of the existing public building stock,
- Set-up energy efficiency obligation schemes and provision of incentives to Utility companies in order to include Demand Side Management activities (DSM) in their least cost planning models and consequently to provide additional energy services,
- Provision of financial and tax incentives for EE investments in all sectors including: Residential, commercial, industrial, transport.

Financing option for Sustainable Energy

The large uptake of RES and EE will require bold financial support particularly at the early stages of deployment. The largest CAPEX requirements are required for the improvements of EE in the generation side i.e. the upgrades of OCGTs to CCGTs. The cumulative CAPEX required until 2030 is as following:

- All types of Renewables - 576 US million
- Construction of a Natural Gas plant (350 MW) - 357 US million
- EE improvements in the Demand Side - 366 US million
- EE improvements in the Supply Side - 520 US million

The introduction of a RES surcharge in electricity bills could finance the additional cost incurred by a tendering process and a FiT/net metering scheme. The RES surcharge in general does not have to be uniform for all tariff categories thus the burden could be different for the 3 tiers. The common international practice is that the RES surcharge is collected by the electricity utility and deposited to a special account. Onwards, the utility reimburses the RES producers according to the PPA they have. The relevant legal provisions can be included in the T&TEC Act.

Currently, the Green Levy is defined in the legislation as 0.3% on gross income which is applicable to companies and partnerships doing business in Trinidad and Tobago. Despite the difficulties related to the disbursements of funds either part of this amount could be used to directly finance RES and EE policies or a small increase of this tax could be sufficient for financing sustainable energy. Moreover, it would offer the advantage through special provisions in the legislation that a separate for RES and EE could introduced in the Green Fund’s activities.

Given the existing institutional arrangements in the energy sector and more importantly the extremely low electricity prices, it is unlikely that any commercial ESCO scheme could be sustainable in the longer run in T&T. Moreover the deployment of the 150% tax allowance despite its prospect to catalyze large investments is stagnated. Nonetheless, any amount of energy saved in the demand side could lead to considerable NG savings and subsequently to large savings of foregone revenues from natural gas sales in the international market and would gradually alleviate T&TEC from the financial burden of the large energy subsidies could serve as the founding principle of an EE mechanism. Exactly this principle could be used as the driving force for the establishment of an EE fund that could be financially sustainable in the longer run through the additional revenues from NG sales. A variation of the typical EE Fund could be an option according to which a third party (an EE utility) could undertake through a special agreement the responsibility of technical and financial functions from the EE Fund. This utility could be also legally obliged to achieve certain annual EE targets that could be included in an EE Act. This option despite being lengthy and more complex than other options could offer a long term and sustainable mechanism for fostering EE in the country.

Long term benefits and business opportunities for the private sector

The large scale deployment of RES and EE can create large impact on economic growth and job creation. If the prescribed targets are to be achieved this could lead to investments in RES and EE of 600 US million and 400 US million respectively up to 2030. Such investments could create up to 10.000 of direct and indirect new jobs throughout the total value chain of technologies. The deployment of large scale RES and EE applications could create considerable business opportunities for the private sector. Even though a detailed value chain analysis is required to identify these opportunities in a comprehensive way international experience from emerging markets and a rough assessment of the structure of market players indicate that significant business opportunities throughout the RES and EE value chain. Several opportunities can arise for EPC firms, RES developers, SMEs and retailers of residential and small scale PV and SWH. Similarly opportunities can arise for EE business and especially Components in the EE supply chain (LED, CFL, pumps, etc.), Companies doing energy audits and design Construction companies, doing facility management companies and building operators Energy intensive industries (e.g. distilleries, breweries, etc.), hotels, etc.

Especially, the development of a PV manufacturing cluster could lead create at least 4,500 permanent jobs, mostly skilled (management, administrative, engineers, production Operators, maintenance trades, operations support. And the country has many competitive advantages to become manufacturer and exporter an exporter of green technologies. Trinidad has close proximity to attractive end-markets with positive outlooks, also suggesting that the country could position itself as a supplier for solar panels in growing markets like Brazil Mexico and other South American countries. It offers also a highly competitive cost advantage for the manufacture and supply of solar modules. The country has the extremely low electricity prices and one of the lowest in the Caribbean region. Moreover adequate availability of local ports for export of solar PV cells, especially at Pt. Lisas, could serve as an exporting hub. The existence of a strong industrial base in Trinidad and Tobago has allowed Trinidad and Tobago technical labour force to acquire experience and competencies in technical field.

1. Introduction

1.1 Implementation Plan Context

The present document has been prepared for the Ministry of Energy and Energy Industries aiming to highlight the required actions for the realizing the policy targets presented in the Sustainable Energy Action Plan 2021/2030. It has been prepared through an intensive participatory process reflecting the views of all major energy stakeholders in T&T that commenced prior to the Clean Conference that could place on the 8th and 9th of June 2017. These include:

1. Ministry of Energy and Energy Affairs (MoEEI)
2. Economic and Development Advisory Board (EDAB)
3. Ministry of Public Utilities (MPU)
4. Ministry of Finance (MOF)
5. Ministry of Planning and Development (MPD) - Environmental Policy and Planning Division
6. Regulated Industries Commission (RIC)
7. Trinidad and Tobago Electricity Commission (T&TEC)
8. Trinidad and Tobago Bureau of Standards (TTBS)
9. Ministry of Education (MoE)

Apart from the policymaking and institutional stakeholders a series of other actors was also consulted to obtain their views. These include:

10. Energy Chamber (EC)
11. University of Trinidad and Tobago (UT&T)
12. University of West Indies (UWI)
13. Inter-American Development Bank (IDB)
14. United Nations Development Programme (UNDP)
15. Carbon Zero Initiative of Trinidad and Tobago
16. European Business Chamber in Trinidad and Tobago (EUROCHAMT&T)
17. Independent Energy Experts

The consultation process was completed with an event that took place on the 4th of September, 2017 at the premises of MoEEI. The comments (and their respective replies) of the MoEEI, MPD, MOF and TTBS, on the Working Draft version of the Sustainable Energy Implementation Plan are provided in Annex I of the present Report.

1.2 Brief overview of the energy sector of T&T

T&T's economy is heavily reliant on oil and gas. Approximately 40% of GDP and 80% of total exports account for energy and energy products. Without going into further details, these figures frame the general context of a country that is enormously based on oil and gas. The energy sector of the country in general suffers from some structural in-efficiencies that fossil fuel-based countries suffer from, as well as lack of economic diversification despite the high level of industrialization. Furthermore, the 2015 Natural Gas Reserves Audit showed a reduction of proved gas reserves from 11.5 tcf to 10.6 tcf, while the probable and possible reserves have decreased to 3.24 tcf and 1.15 tcf respectively.

Similarly, the oil and gas production in T&T is steadily decreasing since 2010. Specifically, natural gas reserves have been steadily decreasing by around 1 tcf annually. This decline poses significant challenges for an economy heavily reliant on oil and gas like TT. In addition, high energy consumption depletes rapidly country's fossil fuel reserves to the detriment of the economy and the society.

The lack of efficiency in demand and supply as well as the low energy tariffs have as result the consumption of large amounts of NG for electricity generation, while this amount of natural gas could be channeled internally for methanol production or to the international market at higher prices. The opportunity costs as a result of this mode of utilization are ranging from 1.7 to 3.2 US billion up to 2030.

Moreover, electricity sector subsidies have led to a huge deficit of T&TEC standing at 516 million US$ by the end of 2016[1]. The two effects combined have an impact of at least 1% of GDP implying that there is a large room for more optimum utilization of indigenous resources. These considerations pose significant challenges which are important for the energy sector but also for the formulation of the sustainable energy policy.

Key facts and figures about Trinidad and Tobago

Economy
GDP $43.57 billion (2016 est.)
GDP per capita $31,900 (2016 est.)
GDP - composition, by sector of origin:
Agriculture: 0.5%
Industry: 13.9%
Services: 85.6% (2016 est.)

Energy Sector
Electrification rate: 99.8%
Electricity generation: 9.3 billion kWh (2014 est.)
Installed capacity:2.353 million kW (2015 est.)
Electricity from fossil fuels:100% (2015)
Crude oil production:78,630 bbl/day (2015 est.)
Crude oil exports:30,800 bbl/day (2013 est.)
Crude oil imports:78,340 bbl/day (2015 est.)
Crude oil proved reserves:700 million bbl (2016 est.)
Natural gas production:41.59 billion cu m (2014 est.)
Natural gas consumption:24.67 billion cu m (2014 est.)
Natural gas exports:17.41 billion cu m (2014 est.)
Natural gas proved reserves: 325.7 billion cu m (2016)
CO_2 emissions from energy:48 million Mt (2013 est.)
Source: *CIA World Fact book, 2017*

1.3 Promoting sustainable energy within the specific T&T context

The analysis of the energy sector and the systematic interaction and consultation with stakeholders has generally identified the efforts, willingness and political commitment to promote sustainable energy. Nonetheless, there are certain chronic structural inefficiencies that hamper the deployment of EE and RES can be summarized as following: (a) extremely low level of electricity prices below cost-reflectiveness levels; (b) the enormous waste of energy and natural gas due to poor incentives and non-market driven mechanisms; (c) the huge energy subsidies that lead to over-consumption of natural gas; (d) the absence of consistent energy policy and fragmentation of responsibilities, (e) the lack of political commitment to implement certain reforms.

As fossil fuel reserves are being gradually depleted in the forthcoming years the need for a more rational energy resources strategy will become imperative, fact which is being understood among all stakeholders, but also everyday citizens. Climate Change is definitely an important consideration, nonetheless, the true catalyst for promoting sustainable energy are the economic arguments according to which the existing mode of utilization of natural gas is far from

[1] Fuel and electricity prices in Trinidad and Tobago have been heavily subsidized with an estimated annual fiscal burden of 2.7 percent of GDP over 2011-2013, according to IMF estimates.

optimal. Enormous energy subsidies, large opportunity costs2 and more importantly the need for FOREX and the internal competition[3] between the electricity and gas industry over securing gas supply are the key drivers behind the sustainable energy transformation in T&T. In fact, reforms in the energy sector could have a combined effect and not only save gas but also self-finance to an extent RES and EE. The aforementioned facts and effects and business opportunities appear to be fully acknowledged by large part - if not all - of the private sector and part of the government.

It is also commonly accepted that the country is lagging with respect to the required actions for promoting RES and EE against the declared targets, but also international trends. Extremely low electricity prices remain the major hindrance for the promotion of EE/RES, while also solid political commitment to foster the required changes and reforms. While various energy mixes or technological options can be implemented emphasis should be put on the actions required to translate declared policy targets and plans into tangible results. In order to realize a sustainable transition this will be based on the following pillars:

- **Enabling regulatory frameworks** – The most critical factor for the success of this transformation is the implementation of the necessary changes in the legal and regulatory framework that could accommodate renewables and energy efficiency. Implementing the required changes in the forthcoming period in a clear manner would give the right signal to the market and stimulate investor interest. Moreover, it should be kept in mind that Trinidad and Tobago has certain particularities and these should be taken into consideration in advance to avoid path dependencies and lock-ins.
- **Availability new commercially viable technologies –** RES and EE technologies are available at competitive prices and technological costs will keep falling drastically over the years. Financing is also available by IFIs, but the role of the private sector is key for mobilising the scale of investment necessary to reach the ambitious regional targets, provided that the regulatory environment is in place.
- **Building solid business cases for investments in the EE and RES sector** – despite the availability of segmented business opportunities, the wider investment climate for EE and RES has to be built carefully by policy-makers and with the support of IFIs. The first step to attract the private sector's investments is to create an enabling financial and risk-free environment for low-carbon technologies. The introduction of blended 'grant-loan' funding approaches to offset part of the risk for financiers and industry and reduce the costs for investment to the benefits of end-users would act as a catalyst at the early stages of market development.
- **Involvement of the private sector and SMEs** - In general there is a common understanding of the T&T energy sector challenges and consensus on the optimum pathway to be followed, as well as the required actions for the medium and long term to promote EE and RES. Nonetheless, the sustainable transformation challenge and the large uptake of such technologies require the wide involvement of civil society and the private sector. This entails among others the development large awareness and dissemination programs and a systematic approach to involve the private sector and trigger investor interest particularly from SMEs.

1.4 Understanding and quantifying the future needs of T&T's energy sector

The analysis of TT energy sector reveals some in-efficiencies, the most important of which are the large energy subsidies and foregone revenues from natural gas. It was shown that any form substitution of existing capacity (at the existing electricity tariffs) leads to enormous financial benefits for the GoRTT due to opportunity costs. These are estimated between 1.7 and 3.2 billion USD until 2030.

The analysis has also indicated that after 2019 new generation capacity will have to gradually enter the system, while after 2022-2023 significant new capacity will be required to cover project demand (approximately 500 MW). Additionally, a new CCGT plant of 300-350 MW might be required between 2022/2023 given the existing trends for electricity demand. Renewables

[2] The opportunity costs have until 2030 have been estimated in the range of 1.7 to 3.2 billion USD, approximately 1% of GDP annually.

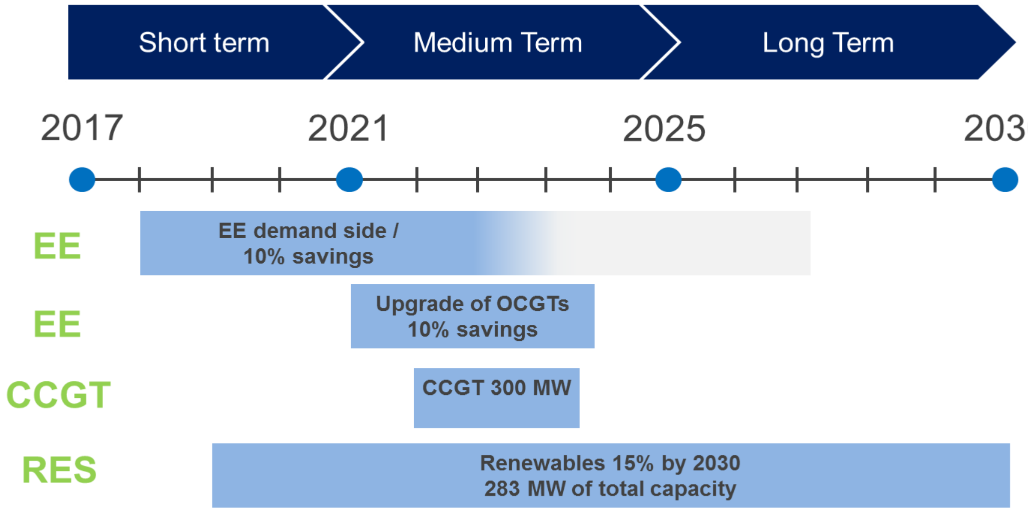
[3] The electricity sector has a legal priority on gas supply over the natural gas industry and essentially methanol. This is an important provision as natural gas is being gradually depleted.

could play a major role in covering this demand. EE savings in the demand side should be gradually introduced as they reduce the need for capital investments in power generation. Renewables and Energy Efficiency should be seen as complementary policies for decreasing emissions and decreasing the actual generation costs of electricity when taking into account opportunity costs.

The policy scenarios assessed including various energy mixes indicate that a conservative target of at least 15% RES in the power generation by 2030 (equivalent to 283 MW of installed capacity) is both cost-efficient and fully achievable. The achievement of the 2021 RES target is essential in various respects, however, given the significant ground that has been lost and all the actions required for enabling the environment it is questionable whether it is fully achievable. Nonetheless, significant emphasis at this stage should be placed on enabling the environment for the creation of a sustainable power sector through various actions (regulatory amendments, enhancement of capacities, etc.).

The Roadmap for Sustainable energy in T&T as well as the major targets is illustrated in Figure 1.1.

Figure 1.1: Roadmap for Sustainable Energy in Trinidad and Tobago until 2030



Source: *T&T Sustainable Energy Roadmap, 2017*

2. Renewables

2.1 Introduction

To satisfy the target of installed capacity of 283 MW various RES mixes can satisfy the achievement of the RES target. The optimum RES comprises 70% PV, 20% wind and 10% waste to energy. The installed capacity of the optimum mix of RES technologies in order to achieve the intermediate as well as the 2030 targets is presented in Table 2.1.

Table 2.1: Proposed Mix of RES Technologies

Technology	Installed Power (MW)		
	2017	2021	2030
PV	**0**	**137**	**198**
PV utility scale (>2MW)	*0*	*109*	*158*
PV small scale (5kW>, 20kW)	*0*	*14*	*20*
PV residential (<5kW)	*0*	*14*	*20*
Wind	**0**	**41**	**57**
W2E	**0**	**20**	**28**
Total	**0**	**195**	**283**

Source: *T&T Sustainable Energy Roadmap, 2017*

In the following sections the potential of different RES technologies is discussed (Section 2.2), as well the most important policy, legal and regulatory, institutional and capacity building requirements (Section 2.3).

2.2 The potential of different RE technologies in T&T

According to the author's analysis, as well as the analysis of existing studies for T&T[4] the most promising technologies to be implemented in T&T are solar photovoltaics, onshore wind energy and SWH, as well waste to energy. Below a brief assessment of the potential of various technologies is presented without going into exhaustive detail. This assessment does not pick winners, but rather presents the most cost-effective technologies taking into consideration the country needs and resources.

Wind Power

T&T has good wind energy resources that could accommodate large wind energy capacities at the eastern of the island. The GoRTT is undertaking a wind assessment[5] to define the exact potential locations for wind farms. Based on experiences in other Caribbean islands it seems likely that a capacity factor of at least 35% can be achieved.

An issue related to the large scale uptake of wind energy apart from the availability of land and resources is that in T&T installation costs could be higher than other countries, because of the extensive road network that might have to be opened in mountainous areas for the transportation of equipment. As more wind turbines are installed in the Caribbean as well as in T&T those costs will reduce very quickly, however, it is a cost factor that needs to be taken into account.

Offshore wind power could be a significant source of electricity in the future, but before T&T can start to explore this resource, the onshore market should be developed, as experience gained with onshore wind turbines is essential. It should be also considered that as offshore wind energy is still in its early development, it requires strong and long lasting technology support schemes by governments, as well as very strong engineering skills to overcome technical challenges. It is therefore not advisable for T&T to invest into offshore development at the current stage.

[4] The study "A Unique Approach for Sustainable Energy in Trinidad and Tobago", Natacha C. Marzolf, Fernando Casaquo Cañeque, Johanna Klein, Detlef Loy (2015) offers a comprehensive assessment of the potential of all EE and RES technologies in T&T.
[5] At the moment of the elaboration of this study the Wind Resource Assessment Program (WRAP) has been paused due to absence of funding but there is a clear intention to be completed as soon as possible.

Solar PV

Solar photovoltaics is the most promising renewable energy technology in the case of Trinidad and Tobago. It is relevant to note that hardware costs are no longer the determining factor for the overall installed costs. Particularly for small residential systems, the so-called soft costs for sales taxes, permission fees, labour, transaction, etc. by far outweigh those for the combined costs of modules, inverter and cabling. This leads to the important remark that a high percentage of the total value chain is raised, and remains within the local economy, despite the fact that most hardware needs to be imported.

Solar energy could be developed both at residential/medium and utility scale under different support schemes and considerations. While a Feed in Tariff Scheme (or net metering) appears to be the most appropriate for small and medium scale installations competitive tendering is definitely the most suitable scheme for utility scale PV. Capitalizing on the available experience from tendering procedures in neighboring countries it would be possible to achieve levelized costs in Trinidad and Tobago below 10 US cents per kilowatt-hour (kWh), depending on the size of the plant and the design elements of the auction process.

Solar Water Heating

In comparison to other islands in the Caribbean, the deployment of SWH in T&T is very limited. Currently, it is estimated that there are only a few hundred SWH systems in the entire country. All SWH systems in T&T are imported models as there are currently no local manufacturers. However, besides its limited application, the potential for SWH is extremely favorable, as solar irradiation levels are high, which guarantees optimal performance of solar energy systems and high energy yield.

To encourage uptake of SWH, the GoRTT has developed a number of fiscal incentives, such as a 25% tax credit, 0% VAT on SWH, a 150% wear and tear allowance, as well as condition- al duty exemptions for manufacturers. While these incentives have stimulated some growth, general uptake has been slow from a commercial, as well as from a domestic user perspective. The major barrier for the uptake of SWH remains to be financing. The low cost of electricity, coupled with insufficient incentives make the cost of SWH prohibitive, especially for low income households.

In order to make a significant impact in terms of avoided cost for electricity for water heating and also in terms of CO_2 emissions, a penetration of about 10,000 SWH systems[6] in the first instance would need to be realized. This could take approximately two years to materialize. Using the incentive scheme that Barbados adopted, T&T could see a similar growth to that which took place in the 1980’s in Barbados. To achieve such an objective, the Government should enroll a specific programme for the market introduction of SWH that contains different elements: incentives, capacity building, awareness raising, standards, testing etc.

Waste-to-Energy

Like most Caribbean countries, T&T faces increasing problems with its disposal of Municipal Solid Waste (MSW). The existing disposal facilities are simple dump sites without proper environmental protection, leading to increasing pollution of surrounding surface and ground water. At the same time, the establishment of new landfills is a major challenge due to limited land availability.

An ideal solution to solve the municipal solid waste (MSW) problem while providing T&T with an additional source of RE or alternative energy would be the conversion of the MSW into energy. A first feasibility analysis shows that a moving grate incinerator combined with steam turbines for electricity generation might be a solution for T&T, as it is a long established and well understood technology.

Major existing obstacles are the low price for electricity generation, as well as very low waste disposal fees. The existing informal sector would need to be integrated, as a WtoE plant would eliminate their source of income. However, waste to energy projects cannot only be assessed on their economic feasibility, but need to take the overall waste management situation in a country into account.

It is recommended to undertake a comprehensive waste characterization study, as well as a study of the composition and status of the waste at the existing landfills. It has also to be analysed, in how far an incinerator plant could be built locally and how much of the equipment would need to be imported.

Other technologies

Most ocean power technologies are still in their infancy and none of the existing technologies is perfectly suited for application in T&T. Due to maturity of technology and location, only tidal power stream plants may present a sensible opportunity. Ocean Thermal Energy Conversion (OTEC) has great potential and an international or at least a regional approach in the Caribbean should be sought. However, with no

[6] According to IDB estimates

larger projects globally in existence, OTEC still needs a significant R&D push before it can provide a sizable contribution.

2.3 Selected actions for promoting Renewables

In this section the key proposed actions to take-off Renewables are presented. For each action implementation details are given in Chapter 6.

Development of Consistent National Energy Planning (Code RES.CB.1)

It is widely accepted that a comprehensive energy sector policy should be based on least-cost planning scenarios and considerations, while RES and EE should be a component of this. Nonetheless, in Trinidad and Tobago there is no solid National Energy Policy[7] based on robust modelling background, while policy decisions are not fully substantiated on the basis of solid figures. This has adverse effects on the planning of the sector and leads to several structural inefficiencies and significant technical and financial losses and foregone revenues. Moreover, data availability and reliability issues undermine the robustness of policy decisions made, which are sometimes based only on high level considerations. In response, a least cost optimization model has to be set-up for the long term planning of the energy sector of Trinidad and Tobago and based on that a National Energy Strategy has to be developed and regularly updated.

An option for a following assignment could include the set-up of a LEAP (Long-range Energy Alternatives Planning) model[8] for instance and the provision of relevant training to government officials or more preferably a technical or academic institute (such as UWI which has already commenced similar efforts or an Energy Agency). A key benefit of LEAP and the main reason why it is proposed for T&T is its low initial data requirements, as per its description and existing experience on energy modelling. Many modeling tools require very particular and often quite complex solution algorithms such optimization, and so tend to have highly inflexible data requirements. Developing the datasets and policy scenarios for such models is a time-consuming task, requiring relatively high levels of expertise. Another factor that simplifies the analysis of island systems is the absence of interconnections such as oil and gas pipelines and transmission lines. By contrast, because it provides a choice of modeling methodologies and many aspects of LEAP are optional, it therefore has much lower initial data requirements and allows its users to get started building models based on relatively simple accounting principles. Last but not least because of its low initial requirements apart from being relatively easier to set it up such a model would have lower maintenance requirements.

Amendment of the Trinidad and Tobago Electricity Commission Act and the RIC Act (Code RES.LR.1)

Based on the existing legislation, the so-called “approved generator” is the classical Independent Power Producer who delivers all its electricity to the sole buyer under a negotiated Power Purchase Agreement (PPA). Currently, the T&TEC Act neither allows for smaller operators to feed electricity into the grid nor is self-generation or wheeling of electricity between power sources and demand sink permitted. The same accounts for the RIC Act. It will therefore be necessary to amend certain aspects of both Acts accordingly and allow access to the grid, although the extent and scope should be controlled by T&TEC in line with the Regulated Industries Commission (RIC) and made dependent on capacity demand and technical circumstances. In addition, it is recommended to simplify the permission process for operators of small distributed generation and minimize the licensing procedure. A simple request for registration and control by the electrical inspectorate should be sufficient. Specific elements to be introduced/amended in two Acts include:

- Introduction of RPS as mandatory obligations (TTEC Act),
- Provisions regarding the establishment of a tendering scheme (TTEC Act),
- Provisions related to PPAs (TTEC Act),
- Provisions to allow access to the grid for operators of RE generation facilities (TTEC Act),
- Establishment of a FiT scheme (or net metering) for small and medium scale RES generation (TTEC Act),

[7] Currently, there is a Draft National Energy Strategy based on the “Green Paper” developed by IDB.

[8] LEAP, the Long-range Energy Alternatives Planning System, is a widely-used software tool for energy policy analysis and climate change mitigation assessment developed at the Stockholm Environment Institute. LEAP has been adopted by thousands of organizations in more than 190 countries worldwide. Its users include government agencies, academics, non-governmental organizations, consulting companies, and energy utilities. It has been used at many different scales ranging from cities and states to national, regional and global applications. More information about the model can found here:

http://www.energyplan.eu/othertools/national/leap/

- (Potential) Provisions regarding the introduction of 4th tier in electricity tariffs (RIC Act).

It should be explicitly noted that the T&TEC Act does not currently prevent the implementation of Utility-Sized PV projects by interested parties. Such projects can be in principle implemented immediately. In any case a detailed and step-by-step review of the legislation should be made ensuring that all the modalities of such a process are settled and do not hinder the implementation of projects.

Introduction of Renewable Portfolio Standards (Code: RES.LR.1.a)

Renewable Portfolio Standards (RPS) are legally binding targets imposed typically on utilities or distribution system operators or suppliers to either generate, sell or purchase certain quantities of their total electricity volume from RES. The rationale for RPS in liberalized electricity markets is that the additional costs incurred because of the legal imposition of a RES target is gradually transposed throughout the electricity value chain to the final consumers, which in the case of T&T is not a straightforward case. Setting legal targets for T&TEC to diversify its electricity mix away from the current 100% dependency on natural gas, would be α way to achieve the Government's renewable energy objectives for two reasons: (a) there would a legal obligation to achieve RES targets and (b) a steadily growing market would be developed thus providing the appropriate stimulation and market signals. Under the RPS obligation, T&TEC would have the possibility to either generate renewable electricity through its own investments or purchase the power from IPPs.

For the design of the RPS there are broadly 2 options. According to the first and simplest one there is no differentiation between various RES while specific annual objectives could be set for contributions from each technology. According to the second targets are technology specific. The exact level of RPS targets needs to be realistic and cover at least a long period of at least five years into the future with progressive increases to allow for long-term planning. Close monitoring of progress achievements will be necessary and mechanisms need to be considered in case that targets are not being met. The most feasible and reasonable option is that T&TEC (or RIC) takes over responsibility for tendering RE projects for private investors, in case that T&TEC is not capable of meeting the Government's objectives. Given that Trinidad and Tobago now has new Procurement Legislation (Act No. 3 of 2017), there could be an option that the process could regulated by the Procurement Regulator. In any case, this an issue that should be discussed more thoroughly by policymakers in T&T.

Power Purchase Agreements for Renewables (Code: RES.LR.1.c)

Power Purchase Agreements (PPAs) are contracts between operators of generation facilities and transmission or distribution operators for the purchase of electricity fed into the grid. These contracts are required for large scale installations. It is recommended that model PPA contracts are designed in order to make potential investors aware of their future duties and to allow for a rapid non-negotiable agreement between operator and utility. Minimum clauses of a PPA contracts include:

1. Subject of the contract;
2. Duration and termination;
3. Information on privileged generator and power plant;
4. Manner of submission and use of data;
5. Metering and method of reading;
6. Incentive prices/price support schemes;
7. Method of transfer of guarantees of origin;
8. Billing and payment method;
9. Dispute resolution.

Other relevant points also include:

- Preconditions for setting the PPA into effect
- Obligations of the seller to operate in accordance with the market rules, regulations and codes
- Charges for reactive power provided to or absorbed by the system
- Obligations related to power factor of the generation installation
- Access to the generator's premises
- Obligations for operational data record keeping by the generator, etc.

Draft/model PPAs for RES have already been developed. These will have to adapted to existing legislation once this have been properly amended.

Establishment of a RES tendering scheme (Code: RES.LR.1.b)

For large-scale wind and solar plants the introduction of tendering schemes is the most appropriate support policy scheme. Tendering schemes range from technology-specific to technology-neutral, include varying levels of capacity (some setting volume caps), occasionally set price ceilings and often include various criteria for project selection, so that price is not the only or most important factor. There is a large variety of design options which is discussed in larger detail below.

Calls can be site and capacity specific, so that they fit perfectly into generation expansion plans and use existing resources adequately. Of course, there is a risk of price dumping among competitors and the possibility of realization failures or delays, if financing is not secured. Nonetheless, there is wide evidence that competitive processes can lead to low prices of RES projects with constantly declining trends as illustrated in Figure 2.1.

Figure 2.1: Latin America and Caribbean auction design history

Source: *GTM Research, Latin America PV Playbook Q4 2016 Market Update – Executive Summary*

A general overview of the key advantages and disadvantages of tendering schemes is presented in Table 2.4.

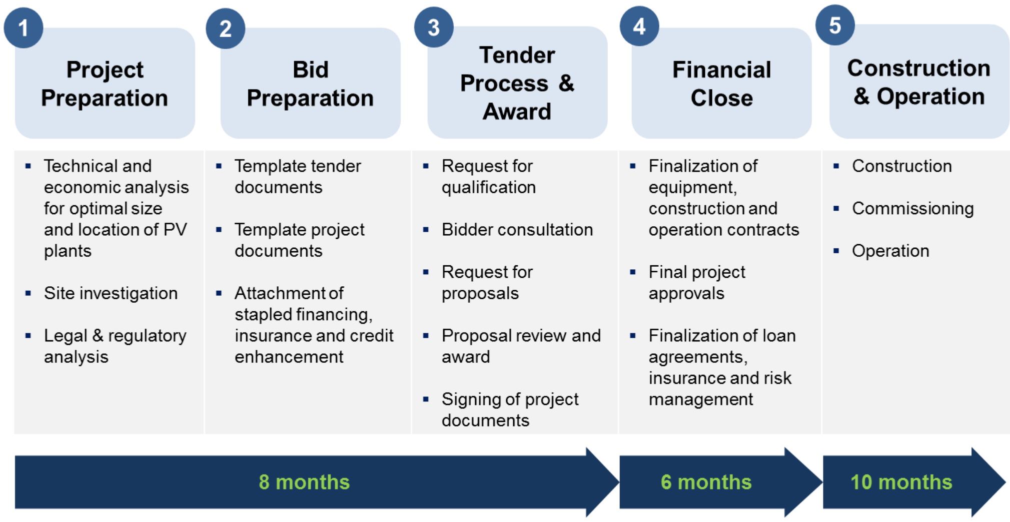
Table 2.2: General overview of the key advantages and disadvantages of tendering schemes

Advantages	Disadvantages
• Guaranteed purchase at fixed price. • Long term guarantees lead to better financing options and potentially lower PPA prices. • Intensive competition results in high cost efficiency and reveals the true market price of different technologies. • Bids can be selected according to specific criteria. This allows for multiple country policies to be considered. • Limits can be set by the government for the capacity and the budget. • Due to the fixed schedule, electricity generation from RES becomes more predictable, which constitutes future power planning easier.	• When not scheduled regularly auctions can lead to discontinues (stop start) market development. (consideration for larger markets). • Difficult for small/medium sized bidding companies due to the high transaction costs (project proposals need planning, feasibility study, risk assessments) and the risk of not getting a return on these investments in case they are not chosen. • Auctions have administrative and transaction costs both for participants and governments. • High competition can lead to underbidding which results in low financial returns, contract failure or attempted post-auction price raises by successful bidders. • If there is not enough competition offers might be too high or there is a risk of collusive behaviour between bidders.

Source: *Author's elaboration based on various literature sources*

Attention should be paid to the fact that bidding procedures require primarily a good preparation on the side of the inviting entity (typically the Regulator or the incumbent utility) and good knowledge of the subject for assessing the technical and financial proposals. Thus, considerable expertise is required to organize properly such a process especially at the legal and financial aspects of the tender, which is usually outsourced. Nonetheless, the long experience of T&T on oil and gas tenders guarantees the smooth organization and implementation of such tenders. The basic steps are illustrated in Figure 2.1 The most resource consuming stage it typically the project preparation and the preparation of tender documents. If an open tendering process would be procured today in less than one a half year a utility scale PV project could be completed.

Figure 2.2: Steps for the organization of a tendering process



***Source**: The World Bank, 2016.*

For a successful auction, its design should ensure the existence of increased competition among participating bidders in order to bring the prices down, but also that the participation in the auction is limited to bidders that have the capacity to implement projects at the contracted price in the given timeframe while contributing to the broader development goals. In order to ensure these two objectives there is a series of design elements that need to be considered. An overview of these design elements is presented in Table 2.3 based on the existing literature and international experience.

Table 2.3: Key design elements of tendering schemes

Category	Variations of design
Auction demand	• Number and frequency of bidding rounds • There are three main ways to set the volume auctioned: capacity, generation or budget. - Electricity generation targets. In this case, bids are awarded per kWh or MWh and there is a goal of a total amount of MWh. - Capacity targets. A total quantity in terms of MW is auctioned. - Budget targets. There is an overall amount of support to be provided. It can be combined with the other two alternatives. • Option for possibility of cancellation with no prior notice
Winner selection process	• Auctions could be organized using only a criterion (the bid price) or combining this criterion with others, such as local content requirements, environmental requirements, obligations for local employment, etc. which constitutes them very useful policy tools. • Determination of design alternatives (the sealed-bid, descending clock and hybrid) • Decision on maximum price to protect the auctioneer in case low competition and minimum price to mitigate winners curse and ensure damping of price • Seller concentration rules can be justified in order to enhance competition and actors' diversity: - Setting a minimum number of bidders under which the auction will not be carried out. - The size of bids per bidder can also be limited - Limiting the number of rounds in which bidders can participate - Cancel the bidding procedure if the bidding price is excessively high • Information could be provided by the Regulators or by an responsible independent body to potential bidders

Category	Variations of design
	• Requirement for resource measurements (mostly wind) and site selection by the government or the bidders. • Bidders in auctions could submit their bids through a web-based procedure or in person: - Web-based auction procedure. - Letter-based auction procedure (for sealed bid static auctions) - In-person auction procedure.
Qualification requirements	• Legal, financial and technical requirements • Site selection: - A location-neutral auction is organized. - Pre-selection of sites. - Location-specific tendering schemes, e.g. different bidding procedures for different sites would be organized. - location-specific differentiation of ceiling prices - differentiation of remuneration according to local resource conditions • Project requirements: - Proven technology: winning bids can be required to use a technology that has been successfully demonstrated. - Land secured: ensuring developers already have rights to develop the land they need prevents this becoming a reason for project failure. - Environmental licence obtained: for the same reasons as the land requirement, environmental permits may be required in advance of bids winning approval. - Building permit obtained. • Requirements for project developer: - Deposits and other guarantees: for a winning bid to be approved, developers may be required to provide capital up front, to be returned on completion of the auctioned contract, as an indemnity against project failure. Several alternatives in this context include bid bonds, bid guarantees, performance bonds, project completion bonds and contract termination clauses in case of delays. - Financial capability requirements: for a winning bid to be approved, the bidder may be required to have a specified amount of cash-on-hand, or fulfil other balance sheet requirements, to determine that they are in sufficient financial health to complete the auctioned contract. There might be minimum rating requirements (e.g. Standard & Poor, Moody's, rating) - Experience: in some markets, winning firms are required to demonstrate experience in delivering the kind of project being auctioned. • Degree of stringency of qualification requirements, to allow only big and experienced players • Local content requirement: - A percentage of the renewable energy equipment being manufactured by local firms. - Organizing two auctions, one for domestic content requirement, and the other without
Investor risk	• Contracts currency and indexing to inflation/CPI • Contract duration • Compliance and penalties: - Requiring a bid bond (potentially as a percentage of total project cost) to avoid the risk of the winning bidders not signing the PPA under the terms at which they bid; - Requiring a project completion bond (potentially as a percentage of total project cost) to avoid the risk of projects not coming to completion; - Penalising developers for electricity shortfall or paying an agreed tariff for overproduction to avoid the risk of projects not delivering the planned quantity of electricity; - Imposing penalties for delays, to avoid the risk of facing setbacks at various stages (IRENA 2014)Inclusion or not of terms leading to an auction open to small and large, national and foreign enterprises • Co-ownership project with public authority

Source: *Author's compilation based on the following Reports: Overview of Design Elements for RES, October 2015, Authors: Pablo del Río (CSIC), Marie-Christin Haufe (TAKON), Fabian Wigan (ECOFYS), Simone Steinhilber (Fraunhofer-ISI) and, Renewable Energy Auctions – A Guide to Design, IRENA and CEM (2015)*

Some high level proposals for the design of auctions in T&T taking into consideration the existing structure of the market and sector needs:

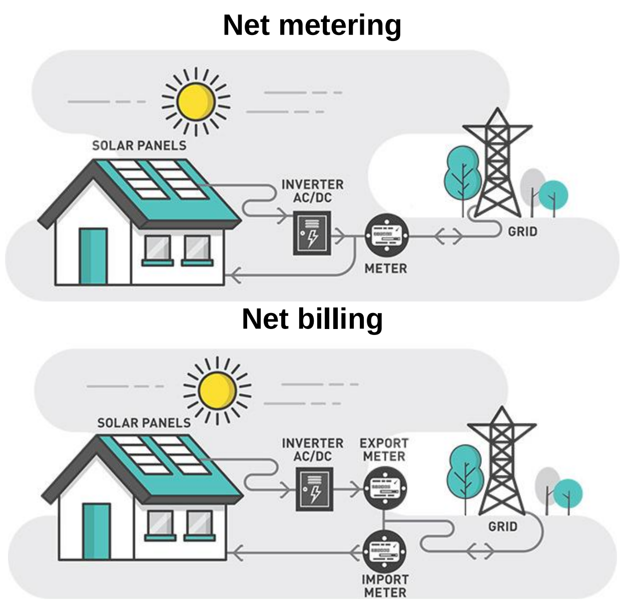
- The tendering procedure could be organized either by the RIC or more appropriately by TTEC, while the amendment if the respective Act has to take place.
- The tendering process should ensure that the maximum number of participants is attracted so that overall cost is minimized.
- Thorough attention should be paid to the inclusion of terms that ensure the utilization of local labour and components of the solar value chain.
- A model PPA should published in advance to inform market players.
- Responsibility for site selection could belong to the government due to pertinent land availability issues in T&T, as well as a means to overcome potential environmental issues.
- The introduction of a ceiling price should be seriously considered in the case of T&T as there is no primary experience of a similar process.
- A co-ownership scheme with a public authority or a Public Private Partnerships (with T&TEC) is worth assessing.

Establishment of a FiT scheme for small scale RES generation (Code: RES.LR.1.e)

A Feed in Tariff (FiT) scheme provides a guaranteed premium price to the renewable electricity producer and puts an obligation on the grid operators to purchase the generated electricity output. The price is typically guaranteed for a long period in order to encourage investment in new renewable energy sources for power generation. The biggest advantage of FiT schemes is the long-term certainty of financial support, which lowers investment risks considerably.

Net metering is an electricity policy which allows utility customers to offset some or all of their electricity use with self produced electricity from RES-E systems. Net metering works by utilizing a meter that is able to spin and record energy flow in both directions. The meter spins forward when a customer is drawing power from the utility grid (i.e., using more energy than they are producing) and spins backward when energy is being sent back to the grid (i.e., using less energy than they are producing). Another way is when each channel is metered separately and the one is subtracted from the other. In both cases at the end of a given month, the customer is billed only for the net electricity used.

Figure 2.3: Schematic representation of net metering and net billing



Source: *Proteus technologies, 2017*

For the utility, a well-designed net metering policy provides a simple, low cost, and easily administered way to deal with PV residential systems. Utilities obtain electricity and capacity from small, distributed PV installations. This is electricity they do not have to generate themselves or purchase on the market. For PV systems, this generation takes place every day of the year with a very high correlation with utility peak loads. Thus, utilities obtain the benefit of additional capacity in their service territory paid for by their customers.

PV residential systems can also strengthen the distribution grid, especially in rural areas. This is because voltage tends to drop at the end of long distribution lines when loads are high, and if it drops below a threshold level, the breakers will trip and a temporary blackout occurs. Grid connected PV systems tied to the distribution grid strengthen voltage and improve overall service. And this grid support can defer maintenance and upgrades in the power distribution system, which is a tangible benefit to utilities. Customers benefit from net metering of PV residential systems because they obtain a long-term guarantee of low utility bills. Communities benefit from the investment in local generation. This investment not only increases local property values but increases local business opportunities as well. It is the difference between paying rent and paying a mortgage.

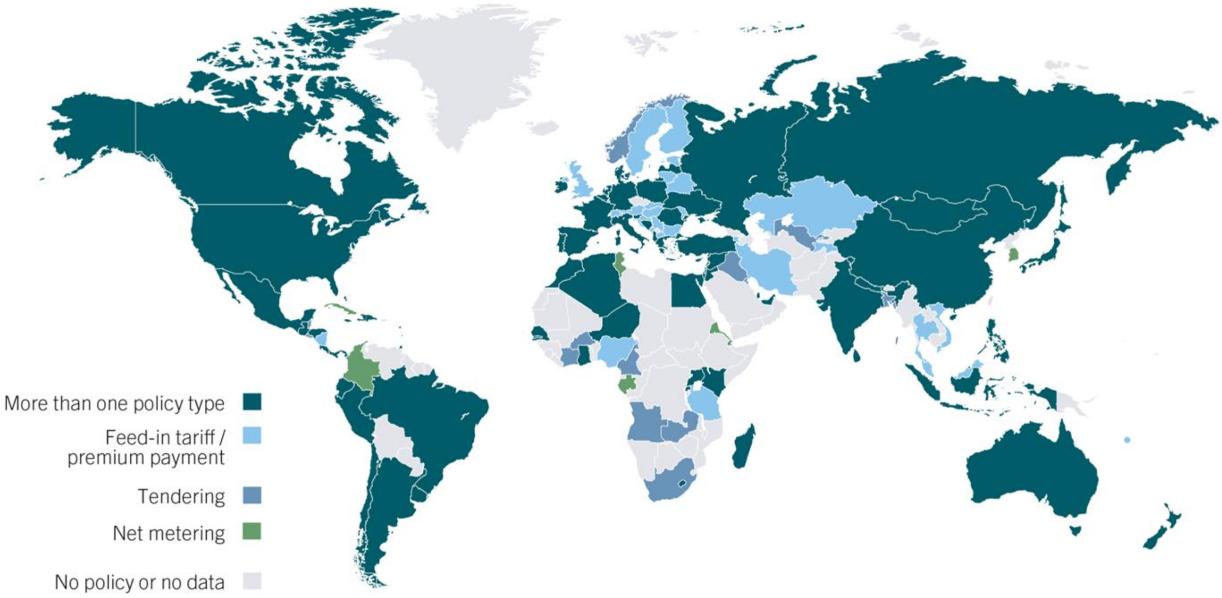
Net billing is an alternative approach to net metering. Like net metering, end-users are able to offset retail electricity purchases under net billing. The primary difference between net billing and net metering is that there are differing rates used to value the excess energy fed into the grid and energy received from the grid under net billing. A wide variety of net metering, net billing and FiT policies is in place, as well as hybrid approaches that integrate various elements of these policies.

Comparison of FiT and auction mechanisms

The main difference between FIT and auctions is the price discovery mechanism. For FIT the price is fixed by the policy makers, however, in auctions the industry determines the price for the project through competitive bidding between the bidders. If the country does not have much experience with setting prices for a certain renewable energy technology and there is not enough cost data available, then auctions are a useful way of discovering the true cost of the technology. However, for auctions to be successful they need to be competitive. This means that there needs to be enough interest amongst project developers in the country to invest in the technology. Another point that should be considered is that auctions are open to everyone. Usually auctions are better for large scale projects and established technologies. On the other hand, FIT are less risky from the project developers point of view, which is why they help support small scale projects as well as emerging technologies.

There is an increasing trend, world-wide, to move away from ridged support mechanisms models. As the energy market becomes more and more complex so do the energy policies in many countries. Hybrid support mechanisms are also gaining in popularity. Most of the times having two different types of support mechanisms ruining in parallel, or even combining elements from different policies into one can be advantageous as also illustrated in Figure 2.3.

Figure 2.4: Countries with Renewable Energy Policies by type (2015)



Source: *Renewables 2016 Global Status Report, REN21*

Thus, FIT and auctions can well be implemented in one country at the same time. In these cases, the conditions under which the two support mechanisms can be applied need to be well defined. For example, in many countries which have implemented both FIT and auctions, the FIT are targeted towards small projects while the auctions are limited to large project developers. The country has to carefully choose and define the thresholds for the projects, deciding which project classify as small scale.

A comparative assessment of FiT and auctions is presented in Table 2.4.

Table 2.4: Comparison of FiT and Auctions

Actor	Category	FIT	Auctions

Government	Risk	Risk is shifted towards the government	Lower risk for government
	Cost	Can be very costly, however, if funded by consumers then there is no burden of the public budget.	Project costs are set far in advance, offering, more control and certainty over the final total cost. However, high transaction costs.
	Setting Target Groups	Easier to target the policy towards certain groups (ex: farmers, private households, industry).	Should be open to all. Difficult to target towards certain groups.
Project Developers	Risk	Lower risk for project developers	Risk is shifted towards project developers.
	Cost	Lower costs for project developers.	High planning and transaction costs due to pre-auction requisites.
	Small/New Project Developers	FITs make it easy for new companies to enter the market and allow small companies to be competitive.	Difficult for small/new companies due to high risk as well as large planning and transaction costs.
Innovation	Promoting New Technologies	Good at providing support for new technologies.	Suited for slightly more established technologies
Market Development	Discovering True Market Price	Especially in fast changing markets the FIT often does not reflect the true market price.	If designed well and there is enough competition, then actions are a good way of discovering the true market price
	Long-Term Stability	FITs offers very stable condition during their running time.	Offers very stable conditions for the phase of the projects, however, time gaps between auctions can lead to discontinuity.
	Adaptability	Changing/Adapting the policy is very complex	For each new auctions the terms can be adapted to reflect the present circumstances.
	Growth/Achieving RE Targets	Provides incentive for maximizing generation.	More control over new installation capacity.

Source: *Compilation of information from the following sources: (Wuester, 2016), (Passey, et al., 2014), (Laumanns, 2014) , (Laumanns, et al., 2015), (Lucas, et al., 2013)*

Establishment of Energy Agency (Code: RES.I.1)

At the time this report was written an approval was acquired for the establishment of a separate Sustainable Energy Unit within the MoEEI which is an excellent step towards the promotion of Sustainable Energy. The enhancement of the capacities of this Unit is of utmost importance as currently Ministry staff working on RES and EE despite their strenuous efforts are have to deal with a series of issues.

Whereas the Sustainable Energy Unit could have a leading role in promoting all issues at the policy and technical level the already established Renewable Energy Committee should be reactivated to provide advice and guidance to the Renewable Energy Unit. The membership of the former RE Committee comprised stakeholders from Government/Education/Private Sector/NGO/Utility Company and was able to digest the complex issues involving RE.

Nonetheless, in the long run the establishment of an Energy Agency is advised so that the MoEEI can devote resources on the formulation of energy policy and planning other more technical functions required for the development of the RES/EE sub-sectors are fulfilled more effectively by the Agency. The mandate of such an Energy Agency could include:

- The provision of technical guidance on EE and RE and the development of new technical expertise. The Energy Agency could prepare of series of studies and conduct research on energy policy related matters in close collaboration with existing universities,
- The creation of knowledge on the efficient use of energy and management of national energy resources through appropriate strategies,
- Coordinate and attract funds from international donors and financing institutions including both grants and technical assistance programs,
- Act as intermediate/liaison/facilitator between the public sector, banks and financial institutions as well as the private sector for catalysing investments,
- Develop and implement information and awareness raising programs for consumers, including the implementation of public awareness campaigns and public education services,

- Develop and maintain statistical services on energy supply and consumption,
- Develop and implement capacity building and training programmes for different energy-related aspects. Specific focus should be paid at designing and implementing training programs for engineers and technicians,
- Conduct studies and real time measurements for the assessment of energy resources (hydro power, wind, biomass, solar, etc.),
- Advise the wider public sector and municipalities in assessing energy saving potentials and purchasing energy-efficient equipment,
- Develop technical guidelines in cooperation with TTBS, as well as public procurement procedures.

The establishment of an Energy Agency could offer - among others - the following advantages:

- Typically Energy Agencies have a semi-autonomous character and thus higher flexibility than the narrow public sector itself.
- Act as umbrella organization and facilitate coordination government authorities and line ministries and the private sector
- Offer insulation from political influence during everyday operations and higher independency.

Review and rationalization of electricity tariffs – Introduction of a 4th tier (Code: RES.P.1)

Electricity tariffs in T&T are among the lowest globally. It has been widely observed that extremely low electricity tariffs despite some alleged social character, typically lead to waste of natural resources and large subsidy costs for the society as a whole. Moreover, low electricity tariffs despite the fact that originally are meant to support the less benefited parts of the society in most cases create benefits for parts of the population that need no subsidization. Simply put, the essence of this problem is that poor consumers get a disproportionately small portion of the public support (as they consume less energy than rich) and a disproportionately larger share of the burden as the burden to the poorer parts of the society arises from the fact that fuel subsidies drain government budgets of funds.

In the case of T&T a rough analysis of the structure of electricity tariffs indicates that only a very small fraction of the population - approximately 1/5 - lies at the first lowest tier enjoying low electricity tariffs as it can be obtained from Table 2.5. On the contrary, more than 40% of the population consumes electricity close EU and US levels while it enjoys subsidized electricity prices. This part of the society in fact receives the largest part of electricity subsidies which accumulates as large deficits at T&TEC standing at 516 million US$ by the end of 2016 with increasing trends.

Table 2.5: Electricity tariffs and population under each category

	1-400 kWh	401-1000 kWh	>1000 kWh
Price	0.26	0.32	0.37
% of households	19%	38%	43%
Average bi-monthly consumption	221	682	2142

***Source**: Source: Energy Chamber, 2017*

Despite the fact this is only a high level analysis the structural issues related to the tariff design and its adverse effects are evident. Nonetheless, a detailed tariff study could lead to proposals for minor in the existing tariff structures leading to a more rational internal structure and without affecting the less benefitted parts of the society - rather the contrary.

More specifically, according to analysis and proposals made by the Energy Chamber an affluent part of the society could carry the burden of a rationalization of tariffs by splitting the 3rd tier and introducing a 4th tier which could be priced close or equal to cost-reflectiveness levels. According to these estimations the introduction of the 4th pricing tier results in a 10% reduction in the third tier residential consumption (245GWh), will result in savings of 8mmscf/d of natural gas which is equivalent to 25% of an average sized ammonia plant's gas consumption. An alternative option would be the increase of the rates of the 2nd tier as the introduction of a 4th tier would lead to a longer legislative process.

A detailed study will be needed to assess in detail potential tariff designs and the impact of the adoption of such policy measures. In any case further actions related to the review of electricity tariffs are strongly advised as they constitute a major hindrance for the promotion of RES and EE and the overall health of the sector.

Amendments in the Green Fund to finance RES and EE projects (Code: RES.LR.6)

The Green Fund was established in 2000 as the National Environmental Fund. The fund's grants are available to community groups and organizations engaged in activities focusing on remediation, reforestation or conservation of the environment. The fund collects capital by a tax of 0.3% on gross income which is applicable to companies and partnerships doing business in Trinidad and Tobago. This levy is payable quarterly and is neither a deduction in computing chargeable income nor a credit against corporation tax due. Only few projects have been financed and none with an EE focus. Currently the Green Fund is only eligible for community groups, non-governmental organizations and non-profit companies or bodies engaged in activities related to the objectives of the Green Fund.

Broadening the scope of the fund through an appropriate regulatory intervention would provide the ability to support viable EE and RE projects. To utilize funds from the Green Fund the necessary amendments in the legislation will have to take place[9].

Overview of proposed measures

While net-billing and net-metering could be in principle feasible options in practice they may not provide appropriate financial incentives for a competitive operation of smaller-scale RE technologies, given the extremely low electricity costs and tariffs, adequate and high enough feed-in-tariffs could pave the way for entering into the renewable energy age. Such FiTs could and should be at least technology-specific, if not even depend on the size and energy yield of individual installations, but in any case be terminated for a certain period of market entry and appropriately adjusted, if installation costs move downward.

Therefore, feed in tariffs should be limited only for small and medium scale applications (e.g. up to 200 kW for PV) and for technologies that require support to enter the market. For large-scale RE investments (>2MW) the introduction of tendering processes is a more appropriate solution as they can lead to low contracted tariffs while for small scale PV and residential PV similar FiT schemes are more appropriate for reasons of simplicity and in order to provide the required certainty to small scale investors. These are illustrated in Table 2.6.

Specifically for T&T and the application of a net metering policy could have the following advantages:

- Net-metering will allow for the production of additional electricity, freeing up other generation resources for T&TEC. Moreover, consumers are incentivized to consume less energy. Thus, it is an approach similar to demand side management / energy efficiency measures.
- Decentralized generation and modern inverters can assist in stabilizing the grid.
- Net-metering is a light-handed regulation with low transaction costs that can be easily applied by T&TEC.
- If the additional cost of metering is covered through a RES surcharge then it will have no additional cost for T&TEC.

There are however also challenges or risks associated with net metering:

- The utility could lose revenues as consumption from the grid is replaced by self-generated power.
- The increased use of variable power sources could in extreme situations threaten grid stability. Net metering will therefore have to feature in overall power system planning if it is to be implemented on a large scale.
- Both technical and regulatory capacity is needed to ensure that net-metering systems are installed correctly, that distribution networks are able to accommodate net-metered systems and that the appropriate regulation is developed and implemented.
- If tariffs are set based on the avoided cost of generation then they would be extremely low and thus unattractive.

Given the ambitious targets set by the Government for the promotion of RES and EE the establishment mandatory annual portfolio standards (RPS), either for individual RE sources or for all RE technologies combined would give a huge boost as it would set a legal requirement on TTEC to invest either to either invest into RE projects on its own or purchase RES electricity power from third parties. From preliminary discussions with T&TEC it is quite evident that TTEC has full capacity to develop such projects, so the exact RES portfolio and who develops it becomes more an issue of business strategy.

[9] The Green Fund was first established under the Finance Act 2000 through the Miscellaneous Taxes Act, Chapter 77:01 Part XIV - Green Fund Levy - by the Government of the Republic of Trinidad and Tobago (GoRTT). This was amended by Act No. 5 of 2004 and was followed by the Green Fund Regulations, 2007 and the Green Fund (Amendment) Regulations 2011.

In any case, the involvement of the private sector in the development of RES is the critical factor that will unlock the large RES potential of the country. Apart from essential amendments to allow for electricity generation by other actors than T&TEC or licensed power producers and definition of modalities for grid access and interconnection, modifications and additions to the existing grid code will be necessary to allow for a smooth parallel operation of RE facilities under defined and controlled technical conditions, in particular in the case of larger scale generation plants.

While RES in most mature markets are equally competitive with conventional power generation modes in countries where the deployment of RES is still at an infancy stage and development of a critical market is essential to reduce installation costs and promote knowledge diffusion among all participants. Thus the introduction of additional fiscal schemes such duty exemptions for all types of RES equipment that will make RE technologies more competitive and curb high initial costs that are inherent for the market entry of new innovative products is strongly advised.

Table 2.6: Preferred Financial Incentives for the Launch of RES in TT

Technology/Class	Competitive tendering	Feed in Tariffs/ Net metering	Duty exemptions	Capital sub-sidies
PV utility scale (>2MW)	✓		✓	
PV small scale (5kW>, <20kW)		✓	✓	
PV residential (<5kW)		✓	✓	
Wind	✓		✓	
Waste to Energy	✓		✓	

Source*: T&T Sustainable Energy Roadmap, 2017*

3. Energy Efficiency

3.1 Introduction

The very low retail energy prices subsidized, the low levels of public awareness, as well as the low institutional capacity on EE issues are the most important barriers for the launch of EE in the country. This has as consequence that all sectors (residential, commercial and industrial) are facing large difficulties for the achievement of significant energy savings. Furthermore because of the oil curse the Country has already became reliant on Oil and Gas not giving the necessary importance to other industries such as RE and EE Technologies.

Previous country's specific elaborated studies as the 2008 report prepared by the Inter-American Development Bank's Sustainable Energy and Climate Change Initiative (IDB, 2008) reveals that there are significant EE opportunities in the country. According to that report "if T&T were to improve the EE by 10% over the next 10 years, it would save the equivalent of 980 GWh of electricity per year by 2018". The cost for these interventions estimated around 115 million USD over this period. The alternative scenario to build two gas fired open cycle generation plants for the production of the same 980 GWh of electricity/year has as CAPEX of 365 million USD. From the aforementioned it is understood that EE is the quickest, cheapest and cleanest method in order to achieve the goals of reduced carbon emissions.

In that framework the GoRTT with support from EE experts has carried out exemplary energy audits in public buildings and the results reveal that there is a high energy savings potential in the selected buildings. Specifically more than 22% energy savings can be achieved by the implementation of EE and RES measures having a Simple Payback Period (SPB) less than five years. The audits also evidenced the need for capacity building and training for energy auditors as well as for transfer of expertise in the field of thermal improvement of buildings' envelope.

The large energy savings potential at the demand side is conservatively estimated at 10% but should not be seen as uniform and its feasibility should more thoroughly assessed as it entails large behavioral change from consumers. In any case the implementation of EE measures is both necessary and cost-efficient. Initial estimates of the overall CAPEX costs can be up to 400 US million from all sectors (residential, hotels, industrial), which could/should be partially financed by the government as with the current electricity price levels incentives are limited (see

Table **3.1**).

Table 3.1: The impact of EE measures per sector (demand side)

	Residential	Hotels	Industrial	TOTAL
5-Year budget CAPEX, US$ million	12.95+366	1.75	8,622	**389**
Aggregate Energy Savings, GWh	929,986	10,286	32,604	**973**
Cost Savings, '000 US$	46,499	514	1,630	**49**
CO2 Emissions avoided, kt	651	7	23	**681**

Source*: IDB, and author's estimates (June 2017)*

According to the analysis conducted by IDM and adjustments made by the author:

- A potential of 9.2 % of savings exists in the demand side up to 2022 very conservatively (compared to 2016 levels), but should not be seen as uniform and its feasibility should more thoroughly assessed, as it entails large behavioural change from end users;
- Initial estimates of the overall CAPEX costs can be up to 300-400 US million from all sectors (residential, hotels, industrial), which could/should be partially financed by the government as with the current electricity tariffs incentives are limited.

In this context the Regional Project Team (RPT) is currently developing the CARICOM Regional Energy Efficiency Building Code (REEBC) in order to be implemented in the member states of CARICOM. The REEBC will include among others Minimum Energy Performance Standards for buildings as well as for parts of the envelop and technical building systems (HVAC, SWH) and will transposed to the National T& legislation after stakeholders consultation taking into account the specific Country's needs and characteristics.

As concerns the generation side the EE upgrades (i.e. the conversion of specific OCGT units to CCGT units) can lead to significant fuel savings estimated at approximately 10%. Currently, there is no incentive to IPPs to proceed with these upgrades as there is no mechanism to recollect this amount. Part of this cost can be recovered by fuel savings and sales of NG to the international market. Thus, in total a 20% potential from the demand and generation side is fully achievable.

From the aforementioned it is concluded that the launch of EE in the country faces several challenges and combined efforts are needed in the following fields:

- Amelioration of institutional framework concerning EE;
- Development of legal/regulatory framework with respect to EE;
- Training on EE topics mainly for engineers and blue collar workers as well;
- Capacity Building activities in institutional and private stakeholders.

Thus, it is well understood that the rapid launch of EE technologies and behavioral changes will become true only through a specific combination and interplay between an amended regulatory framework and incentives set by the authorities. In the following sections a series of existing and proposed actions and amendments are presented for the promotion of EE in T&T.

The GoRTT has already adopted some EE actions in the demand side namely in the industry, hotel and residential sector. These actions have as target the engagement of ESCOs for implementing EE measures. As concerns the general public, the GoRTT has already reduced or removed import duties on specified products having low energy consumption.

In order to promote EE in the residential sector the GoRTT has already developed a full Global Environment Facility (GEF) proposal and the relevant Project Information Form (PIF) was approved at 2014. The GEF project aims to promote the EE in the social housing by the provision of assistance to low income residents of this kind of housing in order to save energy and reduce their cost. It is anticipated that the lessons learnt in this project will have a significant effect on the housing market and the residential sector in general.

As concerns the labeling for EE appliances, regional standards are currently developed and once completed these standards should be adopted as mandatory standards and the relevant conformity assessment activities need to be developed to support the enforcement and application of these standards.

Summarizing, the complete list of the actions implemented and funded by the GoRTT are presented in Table 3.2.

Table 3.2: Existing EE actions implemented and funded by GoRTT

Description of the action	Year	Sector	Cost & Benefit
150% Tax Allowance: Companies engaging certified ESCOs to elaborate and implement EE projects should receive 150% tax allowance on the relevant investment. Prerequisite is the achievement of energy savings at least 15% as a result of the implemented EE measures	2010	Commercial	The programme has not yet operationalized, and no tax revenue or sector-wide benefit has been estimated
150% ESCO Depreciation Allowance: ESCOs acquiring plants and instrumentation for the carrying out energy efficiency audits they are allowed: • 75% accelerated depreciation in the acquired assets in the first year • 25% wear and tear allowance on the acquired assets in the following year	2010	Commercial	No tax revenue or sector-wide benefit has been estimated
Hotels engaging certified ESCOs to elaborate and implement EE projects should receive 150% tax allowance on the relevant investment. Prerequisite is the achievement of energy savings at least 15% as a result of the implemented EE measures	2010	Hotels sector	The programme has not yet operationalized, and no tax revenue or sector-wide benefit has been estimated
Companies engaging certified ESCOs to elaborate and implement EE projects should receive 150% tax allowance on the relevant investment. Prerequisite is the achievement	2010	Light Manufacturing Sector	The programme has not been quantified

Description of the action	Year	Sector	Cost & Benefit
of energy savings at least 15% as a result of the implemented EE measures			
Decrease or removal of import duties on products having high EE		General public	The programme has not been yet quantified

***Source**: Ministry of Finance, 2017*

Nonetheless, despite the adoption of the aforementioned measures the promotion of EE is extremely low for a series of reasons**.**

3.2 The potential of specific EE technologies

In this section some promising EE technologies aiming to achieve energy savings in the following sectors of the country are presented (see comprehensive presentation in Table 3.3):

1. Residential sector
2. Hotels sector
3. Commercial and industrial sector
4. Energy Efficiency upgrade of Power Plants

Residential Sector

As concerns the residential sector, electricity has a 100% penetration and 29% of this kind of energy produced in the Country is consumed in household activities. The average residential consumption is the highest among the countries of the CARICOM region and according to the analysis presented in the paragraph 3.1 there are significant opportunities for the successful introduction of EE in order to reduce the carbon emissions of the country. The measures proposed for the achievement of energy savings in the Country's residential sector are the following:

- Stimulating the use of energy-efficient appliances and lighting;
- Reducing the use of energy consumption in social houses (in lighting and HVAC systems when existed);
- Engaging and motivating the end users to have steadily behaviours concerning energy savings in their premises.

The energy savings occurred from the recommended EE measures implemented in the residential sector are estimated for the first five years at the level of 930 GWh of electricity. The relevant cost savings are equal to 46,5 million USD having as a result the avoidance of 651 kt CO2 emissions.

Hotels

One of the successful business sectors in T&T is tourism and more than 6,300 hotel rooms are available in the country with total annual electricity consumption around 76 GWh. Thus it is acknowledgeable that there is a high potential for energy savings in this sector and is highly recommended to include the EE strategy and the relevant investments as a part of the holistic sustainability approach of the sector. In that framework the Consultant proposes the following EE interventions in order to increase the energy savings in the sector:

- Improve the efficiency of HVAC systems;
- Introduce more efficient lighting systems and relevant controls;
- Launch and use of equipment and appliances having high efficiency;
- Encourage green hotel certification.

According to our assessment the aforementioned measures could "produce" around of 10.3 GWh of electricity savings over a five-year period.

Commercial – Industrial Sector

The total annual energy consumption in this sector during 2011 was estimated to be around 5,600 GWh, which accounted for the 2/3 of country's energy consumption during this year. Taking into consideration the limited availability of reliable end-use energy consumption data for the industrial sector we can assume that the major end-use consumptions are:

- Electric motors;
- Boilers and hot water or steam networks that serve industrial processes;
- HVAC and chilling-freezing systems;
- Lighting.

According to the above points we are proposing the following EE measures to be implemented in the sector in order to increase the energy savings and reduce the carbon emissions:

- Installation of Variable Speed Drives (VSD) in the motors of the industrial plants[10];
- Retrofitting of industrial boilers and their distribution networks;
- Installation of high efficiency HVAC systems as well as industrial chilling and freezing systems
- Installation of lighting control systems and replacement of incandescent bulbs.

It is approximated that during the first five years of the implementation of the above mentioned measures about 230 industrial and commercial clients will engage an ESCO in order to implement EE interventions and take advantage of the 150% ESCO Tax Allowance Programme. The electricity savings occurring from the implementation of these measures are estimated to be around 33GWh, according to IDB estimates. EE Technologies and their estimated uptake is presented in Table 3.3.

Table 3.3: EE Technologies and their estimated uptake (source: IDB and author's adaptations)

EE intervention	Description	Sector	Energy Savings potential	Estimated uptake	Launch status
CFL lamps	Replacement of incandescent bulbs with small fluorescent lamps with electronic ballast reducing the energy consumption by 1/5 to 1/8 and with expected lifetime 8 times longer	Residential commercial	High High	Low/ Medium low	Already being launched
T8 fluorescent lamps with electronic ballast	1'' diameter tubes using electronic as well as traditional magnetic ballast	Residential Commercial Small Industrial Public Sector	Med-High Med-High Med-High Med-High	Low Low-Medium Low- Medium Low	Already being launched
T5 fluorescent lamps (electronic ballast)	5/8'' diameter tubes operating with electronic ballast. More efficient but with higher CAPEX than T8 Tubes	Commercial Small Industrial Public Sector	High High High	Low Low Low	Already being launched
LED Lamps	High efficient lighting systems based on light emitting diode (LED)	Residential Commercial Small Industrial Public Sector	High High High High	None None None None	Already being launched
VSD	Electronic controller for AC motors aiming at the regulation of motors' RPM	Commercial Small Industrial	Med-high Med-high High	Low Low Low-medium	Already being launched
High efficient air conditioning split units	Split units with EER>5 EER is the ratio of cooling capacity to consumed power	Residential Commercial	High High	Low Low	Already being launched
Amelioration of HVAC systems	• Replacement of existing chillers with new ones with high efficiency • EC fans at condensers	Commercial Hotel Industrial	High High High	Low Low	To be launched

[10] VSD (Variable Speed Drive) is an electronic control device used in electric AC motors to control the motor's RPM by varying the voltage and input frequency.

EE intervention	Description	Sector	Energy Savings potential	Estimated uptake	Launch status
	• Installation of BEMS				
Improvement of Chilling and freezing systems	• Replacement of chillers and compressors with new ones with high efficiency	Industrial	High High	Low Low	To be launched

Source: *Own elaboration following discussion with stakeholders in T&T and based on IDB proposals*

As concerns the CFL disposal after their use in residential, tertiary and industrial sector it must be noted the following:

- Mercury is an essential element in the operation of fluorescent lighting and is included in the CFL lamps having an average of 4mg in each bulb as referenced by the ENERGY STAR, the governmental organization in US for EE11.
- Mercury is also included in the Petroleum and Natural Gas[12] and during their combustion in Power Plants is emitted to the atmosphere and diffuses in the vicinity around the Power Plants. It is emitted to the atmosphere during their production and processing as well.
- CFL bulbs consume around 75% less energy than incandescent bulbs. This reduction of electrical energy means less GHG emissions including less mercury from Power Plants.
- No mercury is released when the bulbs are intact

Taking into account the aforementioned points as well the common practice in developed countries the Consultant is of the opinion that even though CFLs contain a small amount of mercury that could ultimately end up in the environment, that amount is significantly less than the amount of mercury avoided as a result of the energy savings. However it is suggested to include the disposal and recycling of CFL bulbs into the National Solid Waste Management (SWM) Plan in order to increase the Country's resource efficiency and to avail from the use and the trade of recycled materials.

3.3 Selected actions for promoting Energy Efficiency

Development of the Regulatory Environment – adoption of an EE Act (Code: EE.LR.2)

The introduction of a dedicated Energy Efficiency Act will foster a stable legal and financial environment catalyzing the involvement of the private sector in the EE investments in the country. Having in mind that the majority of the EE have Simple Payback Periods (SPB) exceeding 3 years it is well understood that this long term target is of crucial importance. The EE Act could regulate the following issues:

- Legally adopt an energy Savings target for 2030 and potentially intermediate targets;
- Development of energy savings indicators (e.g. energy savings compared against a baseline, energy intensity, etc.);
- Definition and emphasis on the exemplary role of public buildings;
- Establishment of long term strategy for the mobilization of investments for the renovation of the existing public building stock;
- Set-up energy efficiency obligation schemes and provision of incentives to Utility companies in order to include Demand Side Management activities (DSM) in their least cost planning models and consequently to provide additional energy services;
- Incentivize the adoption of Energy Management Systems (e.g. ISO 50001) from SME and Large Enterprises
- Development of provisions for the certification to Energy Management Systems
- Provision of financial and tax incentives for EE investments in all sectors including: Residential, commercial, industrial, transport;
- Establishment of an Energy Efficiency Fund for the funding of EE projects;
- Establishment of an Energy Efficiency Information Center promoting EE and advising customers on feasible EE interventions;

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[11] https://www.energystar.gov/products/lighting_fans/light_bulbs/learn_about_clfs/cfls_and_mercury
[12] US EPA, Mercury in Petroleum and Natural Gas: Estimation of emissions from production processing and combustion, 2001

- Development of the secondary regulatory framework concerning energy audits (Methodology for audits, requirements and registry for the auditors);
- Development of the secondary regulatory framework with respect to ESCOs;
- Development of new Building Code aiming to regulate the Minimum Energy Performance Requirements (MEPR) for new buildings[13]. This code can be based on international methodologies and will include:
    - MPER for elements of buildings' envelope (walls, doors and window frames);
    - MEPR for the cooling equipment (split units, heat pumps as well large HVAC systems);
    - Standards for Domestic Hot Water (DHW) production through solar collectors;
    - Standards for ventilation and passive cooling of the buildings (shading devices, solar chimneys, double-skin facades, underground heat exchangers etc.).
- Technical standards for lighting;
- Provisions for the phasing-out of inefficient technologies such as incandescent lighting;
- Provisions concerning energy metering and billing of end-users;
- Provisions on standards and labelling of consumers' appliances;
- In case that public funds are used for the implementation of EE projects, the publication of the energy savings results in web site will be required.

The enactment of the Energy Efficiency Law will ensure that EE will be from now on one of the main pillars of the Country's Energy Policy and will assure for the private stakeholders a stable legal-regulatory environment for the deployment of EE investments.

Labeling for EE appliances and lighting (Code: EE:LR.5)
As concerns the labeling for EE appliances, regional standards are currently developed and once completed these standards should be adopted as mandatory and the relevant conformity assessment activities need to be developed to support the enforcement and application of these standards.

Energy Efficiency upgrade of Power Plants (Code: EE.RA.1 and EE.T. 5)

Currently, the largest part of T&T's generating capacity consists of outdated and inefficient single cycle technology (OCGTs). The upgrade of OCGT's to CCGTs would entail high upfront costs for IPPs who given the current structure of the electricity sector have no incentive to realize them, as well as no means to recollect their investments. It should be also kept in mind that IPPs do not purchase gas, but receive payments based on their ability to make power available when called upon (availability contract). Moreover, contractually are not entitled to energy byproducts (heat, steam etc).

An ongoing discussion for the utilization of the 150% tax allowance scheme to allow for financing of such investments. Nonetheless, this is not feasible for the time being as there is no process to certify ESCOs. According to Energy Chamber's estimate[14] the foregone revenues from taxes until 2025 would be around 140 US million, while the discounted benefit would reach 430 US million if the necessary upgrades are made. While some discussion can be made on the exact assumptions made about the conclusion on the aforementioned figure, in general lie towards the right direction and illustrate the large potential for EE savings in the power generation sector. It is therefore advised to:

- Conduct a detailed feasibility study for the upgrade of OCGTs to CCGTs under various setups
- Proceed with the completion of the certification system for energy service companies (ESCO) to finance the EE upgrades unless no other alternative is proposed[15].

The effectiveness of the aforementioned measures will increase with the adoption of Energy Management Systems (EMS) such as the ISO 50001.

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[13] The Regional Energy Efficiency Building Code is currently developed by the Regional Project Team (RPT) for the CARICOM region and will be ready for transposition in the T&T national secondary legislation around September 2018. It must be noted that TTTBS is currently involved in the elaboration of REEBC.

[14] Basic assumption of the model developed by the Energy Chamber:
New power plant assumed necessary post 2025
Capital cost of upgrading to combined cycle - USD $200m (Powergen)
Capital cost of adding a steam turbine and HRSG - USD $100m (Trinity)
Capital cost of upgrading an existing steam turbine - USD $20m (Powergen Penal)
Model does not account for the benefit to GORTT from the NGC dividend
Model assumes NGC receives payment from T&TEC gas purchases

[15] The GoRTT in 2010 passed the Finance Act 2010 which provides legislation on specific EE incentives and subsequently set up an ESCO Certification Committee (ECC) under the chairmanship of the MoEEI

Business opportunities on EE - Elaboration and implementation of incentives: (Code:EE.LR.1)

In this context the GoRTT has already implement several actions. However several issues should be addressed in the near future in order to accelarate the launch of EE Technology in the Country. The Consultant is of the opinion these incentives should be design in detail and be part of the official EE Country;s policy that will be expressed through the Energy Efficiency Act. In this context is proposed the design and implementation of tax and financial incentives for the launch and acquisition of EE appliances. The Programme can include incentives to retailers in order to stimulate the introduction of the appliances as well.

Government Role on increasing awareness

The launch of EE technologies in the country should be supported by the provision of relevant information combined with financial incentives as well as with regulations elaborated and implemented by the GoRTT. It is to be noted that the Government has already implement raising awareness programmes and provided incentives in the field of EE. In that context it is recommended to continue and enhance the concerted actions in the following four areas:

1. Delivery of information and organisation of dissemination actions: It is of great importance the delivery of information to the citizens regarding the benefits of Energy Efficiency on national as well as on individual framework. Thus the GoRTT should elaborate and materialize a national information programme covering the following issues; (Code: EE.AR.3)
    a. Benefits from the introduction of EE in national level as well as in individual context
    b. National Strategic Planning to 2030 for EE
    c. EE technologies and business opportunities for the building and the industrial sector
2. Elaboration and implementation of specific exemplary projects (e.g. Energy Audits and EE interventions in well-known governmental buildings) as well as introducing behavioural changes in energy use in the governmental buildings: The Government of T&T should lead by example in this field in order to inform and motivate the citizens of the country to change their behavior with respect to energy consumption in their dwellings and to be favorably disposed concerning energy efficiency interventions. (Code: EE.AR.6)

Behavioral aspects of EE – Energy Conservation

Although the launch of EE Technology in the country is very important, the behavior of the Citizens is a crucial issue as concerns the achievement of end-use energy savings in residential and professional spaces. The behavior ensures the effective and successful use of EE equipment and appliances so that the maximum energy savings as per specific technology are achieved. In that framework the Consultant suggests the following actions:

1. Elaboration of a study on consumers' attitude concerning on energy consumption in order to identify the public perception and consumption patterns (Code: EE.T.6)
2. Based on the results of the previous study the GoRTT is suggested to design and deliver information and dissemination actions for the promotion of EE in everyday life especially for children and students in universities as:
    a. A programme that will promote among secondary school students and teachers a more efficient way of using energy in everyday life using toolkits comprising handbooks, multimedia animations and experiment toolkits. The programme shall cover all the aspects of end-use EE namely: buildings, industry and transport (Code: EE.AR.4)
    b. A programme for the promotion of energy savings among university students that will provide quality engagement with them enabling, empowering and motivate them to save energy in their home. According to Consultant's view university students is a suitable target group since many of whom are living away from their home the first time. The engagement of the students will be achieved among others through completions and events that will motivate them to perform energy savings actions in their homes (Code: EE.AR.5)

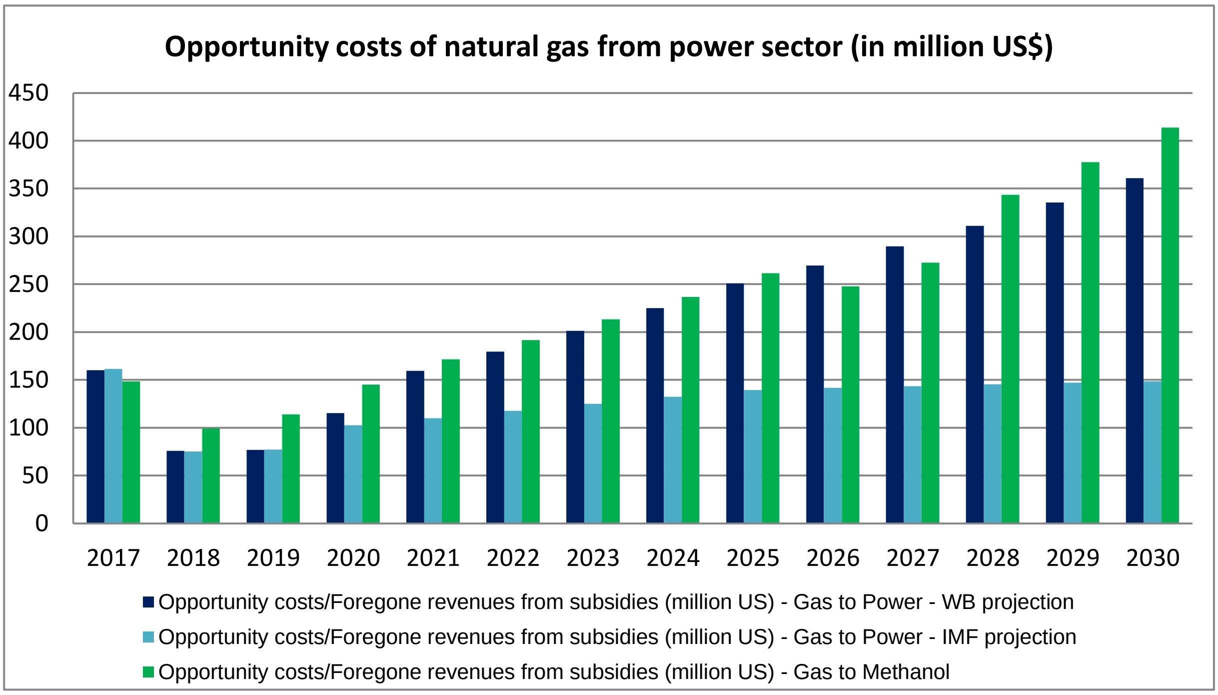
Figure 3.1: Educational programmes on EE for kids

Source: *EC Europe, Kids4Future consortium.*

Concept design of an EE Fund/ESCO scheme

Given the existing institutional arrangements in the energy sector and more importantly the extremely low electricity prices it is unlikely that any commercial ESCO scheme could be sustainable in the longer run in T&T. The lack of efficiency in both the demand and supply sides in combination with the low energy tariffs have as result the consumption of large amounts of NG for electricity generation, while this amount of natural gas could be channelled internally for methanol production or to the international market at higher prices. The opportunity costs as a result of this mode of utilization are ranging from 1.7 to 3.2 US billion up to 2030 as illustrated in Figure 3.2. Any amount of energy saved in the demand side could lead to considerable NG savings and subsequently to large savings of foregone revenues from natural gas sales in the international market and would gradually alleviate T&TEC from the financial burden of the large energy subsidies could serve as the founding principle of an EE mechanism. Exactly this principle could be used as the driving force for the establishment of an EE fund that could be financially sustainable in the longer run through the additional revenues from NG sales.

Figure 3.2: Opportunity Costs of Natural Gas in Trinidad and Tobago



***Source*:** Prepared by the author of the present report, June 2017

The basic objectives that such an EE Fund could fulfil include the following:

- Enabling massive savings of gas and therefore, subsidies and budget funds,
- Enabling conditions for the formation of an EE market of a new efficient and transparent and institution as a tool of governmental policy,
- Creation of financial instruments for households, the commercial and industrial sector to invest in EE and therefore decrease electricity bills,
- Attraction of large scale external financing and expertise in the country,
- Provision of expertise and advice regarding EE to households, construction companies and other players regarding EE measures.

The key characteristics of such an EE Fund should include:

- **Management competence and professionalism.** Given the complexity of Fund goals, as well as the amounts that it could disburse or revolve it should be managed by reputable professionals, preferably from the private sector.
- **Flexibility in decision making.** In the course of the Fund's operations, many changes should be made, such as the revision of EE measures, re-design of financial products, etc. Those changes can only be implemented efficiently if a flexible decision-making process is in place.
- **Effective coordination mechanism between major stakeholders is in place.** As previously stated, the scale of financing needed in the field would hardly be possible without attracting external financing in the form of grants and loans. Most international organizations and donors that may provide financing would like to participate in the Fund's decision-making process. Therefore, creation of an effective coordination mechanism between government and external counterparts is one of the preconditions of a successful governance model.
- **Sustainability of the model.** The Energy Efficiency Fund should be a long-term project. Thus, the governance model should have certain flexibility and could be easily reapplied to different projects.
- **Limited political influence.** The Fund should be as independent as possible from political influence. It should fulfil its own key performance indicators (KPIs), regardless of the political situation.
- **Transparency of governance and processes.** One of the important building blocks of the Fund's success is the development of trust between the institution, businesses and population. This is only possible by enabling full transparency of the Fund. Moreover, transparency is one of the important preconditions for attracting external financing (donor's contributions and IFI loans) to the Fund.

Despite the fact that an idea of an EE Fund could appear as pre-mature in T&T, nonetheless, with appropriate analysis and careful design such a mechanism could be sustainable in the longer run. Some preliminary analysis and discussions with local stakeholders indicate that there is in principle interest for such a mechanism. Various setups can be proposed for establishing such a Fund based on vast international experience. In this Implementation two feasible implementation options are presented. Under the first one the EE fund could employ directly through an in-house technical office (Option A), while under the second one the technical function could be realized through a single ESCO scheme/EE utility (Option B). Both concepts are presented below.

Option A: EE Fund with an in-house Technical Office

Overview of the Fund concept

The basic setup of this Option is presented in Figure 3.3. It generally comprises 3 building blocks.

- **Block 1 – Governance, organizational model and financing.** This block describes how the Fund is financed by government and donors, and utilities (primarily NGC who would largely benefit from EE savings). The Fund could be financed from
  a. International Donors
  b. Disbursements from the Green Fund
  c. Public Utilities (primarily NGC and potentially T&TEC)
  d. Potentially State budget (not illustrated in the Figure)

- **Block 2 - Execution organizational model.** This block shows the Fund's organizational model on a more operational level – functions of Technical Office departments, operating costs and high-level organizational structure.
- **Block 3 - Energy efficiency projects, Fund products and their delivery mechanisms.** This block shows what EE measures will be supported, what financial products will be used by the Fund. and provides an overview of the Fund's operational scheme (delivery mechanism). Specifically, how EE projects are developed, submitted and approved, how and when financing is provided and who is responsible at each step of the process.

Financial Flows

The financial flows are illustrated in Figure 3.4.

- On the "government" side, money is transferred to the Fund via annual allocations from all involved parties. These allocations (by Green Fund, State Budget, NGC) should be foreseen in the relevant legislation or regulations. They should be directly linked to a decrease in subsidies and/or decrease in gas. Preliminary analysis indicates that such a Fund could lead to considerable NG savings sufficient to finance large part of EE measures.
- From the donor's side, grants are deposited to an International Financial Institution (IFI), which will act as a manager of donor funds. IFI then would transfer these funds to the Fund (State Legal Entity) or directly to the project account in commercial bank. These funds are allocated based on an aligned investment plan and its implementation progress (e.g. after completion of certain projects and/or fulfilment of certain KPIs). Money are allocated to the Fund's accounts and later disbursed to individual projects in the form of grants and at a later stage possibly as liquidity to banks (to provide low interest loans to business and/or households). In any case, financing is provided only upon review and approval of the respective project by the Fund.

Governance structure

Three main bodies governıng the EE Fund as illustrated in Figure 3.5. Moreover, there is a technical and financial function that deals with daily operations of the Fund.

- Strategic Coordination Committee that consists of all major stakeholders (government, utilities, donor and IFI representatives) and meets 1-2 times per year. This committee aligns on strategic issues, i.e. programs, financial products, reforms needed, board members, etc.
- Management Board that consists of independent directors, government representatives (e.g. Ministry of Finance, Ministry of Public Utilities, Ministry of Energy), optionally donor and IFI representatives. The efficient board should be small and flexible and its members should combine capabilities and expertise needed to run the institution, such as market expertise, functional expertise (finance, engineering), industry expertise (banking, construction), etc. The Management Board sets Fund strategy and operational rules, recruits and appoints an executive team, measures and evaluates their performance, as well as advocates on behalf of the Fund (promotes external relations, raises funds and coordinates with key stakeholders). Board Committees also fulfil tasks that cannot be delegated to the executive team, due to potential conflicts of interest.
- Executive team of professional managers hired by the board that runs Fund operations in line with the strategic direction and KPIs set by the board.
- Onwards, there is a technical function which is responsible for the preparation and approval of standard energy efficiency solutions and typical projects, including calculation of potential savings, costs. Technical experts would undertake training for construction companies and energy auditors, regional technical support for construction companies and households and approval (from technical side) of submitted applications, as well as technical audit of construction work
- The Financial function will fulfils the development of financial products and implementation mechanisms in collaboration with banks, the management the Fund's cash flow, the investment of free cash and project approval (from the financial side).

Option A: In-house Technical Office

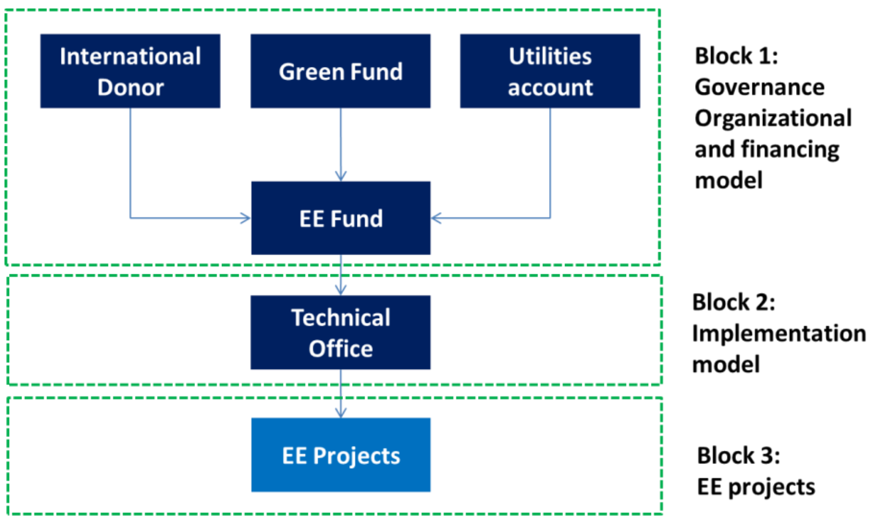


Figure 3.3: Energy Efficiency Fund concept under Option A

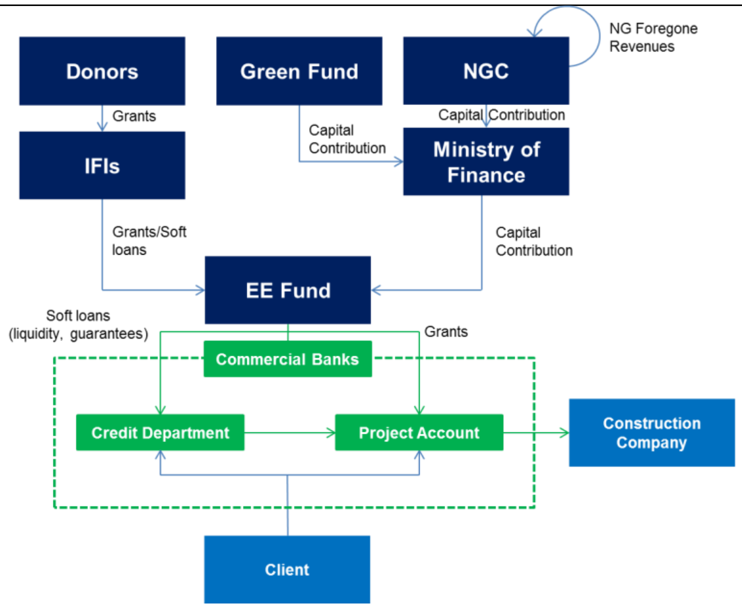


Figure 3.4: Financial Flow scheme under Option A

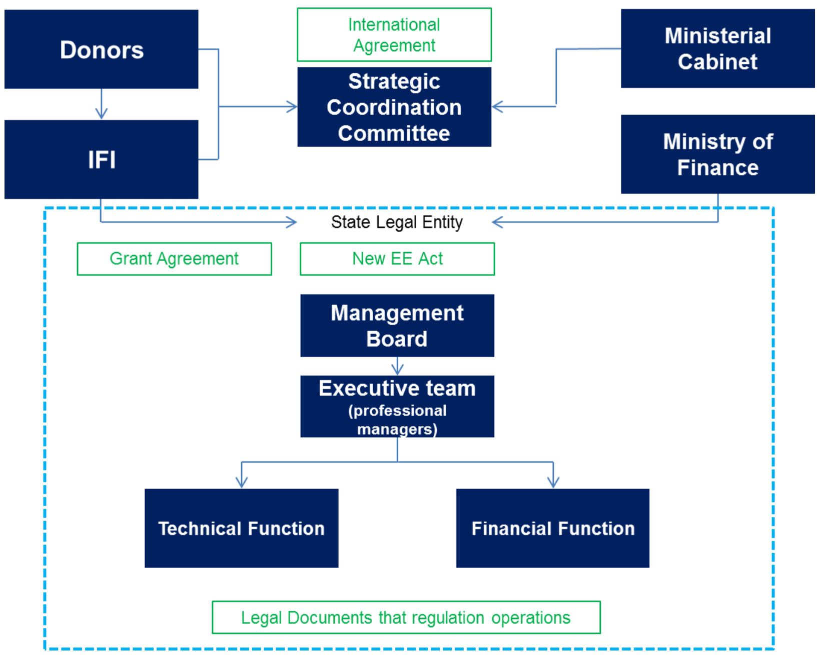


Figure 3.5: Governance structure under Option A

Legal setup of the Fund

The legal requirements for the setting up of an EE Fund could be included in the EE Act (ıf introduced):

- Define legal status of the state legal entity, based on the Fund's required functions (no appropriate legal form exists in current legislation).
- Provide legal grounds for the financial participation of donors and their participation in the management board.

Another important aspect is that the Energy Efficient Fund requires the creation of a new legal entity. A separate legal entity would:

- Allocate funds to business and households
- Provide flexibility in the decision-making process
- Enable independence from the political landscape
- Create a transparent and efficient coordination mechanism between major stakeholders
- Hire professional managers

Customer journey

The customer (industries, business, households, other) journey is a six-step process:

1. **Preparation of project technical documentation.** Customer selects project type and an energy auditor to develop an energy audit via the online platform. After that, the customer selects projects they would like to execute and chooses specific proposition of a construction company.
2. **Fund requests.** Customer (or construction company on his or her behalf) makes a request to the Fund via the online platform. They can see a clear deadline for approval and status of their request on the website. Approval is posted on the website and sent to the customer, construction company and bank (after step 3)
3. **Bank selection.** Customer fills out necessary information (loan sum, monthly payment (% of forecasted bill savings), start date of repayments and financial products of different banks are automatically calculated. Based on that, the customer selects a bank, if loan is needed to co-finance the project.
4. **Construction work.** After project approval, construction company receives first payment and executes the project
5. **Acceptance and submission of final report.** After completion of the construction works, customer signs the construction company's final report. Energy auditor issues new energy certificate and then construction company submits final report. Grant is paid directly to construction company, when project is approved.
6. **Repayments.** Loan repayments start after the grace period, when actual bill savings are achieved. Worth mentioning that monthly payments are less than bill savings, which makes EE measures economically attractive for households.

Option B: EE Fund with an EE utility

The rationale of this option is basically the same like Option A therefore no special description of the specific functions will be made. The major difference compared to Option A is that a third party (an EE utility) could undertake through a **special agreement** the responsibility of technical and financial functions from the EE Fund. This utility could be also **legally obliged to achieve certain annual EE targets** that could be included in an EE Act.

Outsourcing practically the Technical Office (as illustrated Figure 3.6) to a third party could eliminate the need for multiple government interventions, such as tax incentives or ESCo certification. It would also provide a single point of contact for all businesses and industries and homeowners seeking to reduce their energy use. Such an entity could also ensures prioritization of education, awareness, and capacity-building, as needed to meet future targets as it would have financial interest on reducing electricity consumption.

The EE utility could cooperate also with NGC, T&TEC and the government through a special agreement settling all financial and legal issues. In the corporate/shareholder structure of this entity the electricity utility (T&TEC) could also participate to mitigate potential losses from electricity sales. All the financial flows will be made through the EE Utility instead through the Fund as illustrated in Figure 3.7. Also the financial and technical functions would be performed through the EE utility as illustrated in Figure 3.8.

Option B: EE Fund with an EE Utility

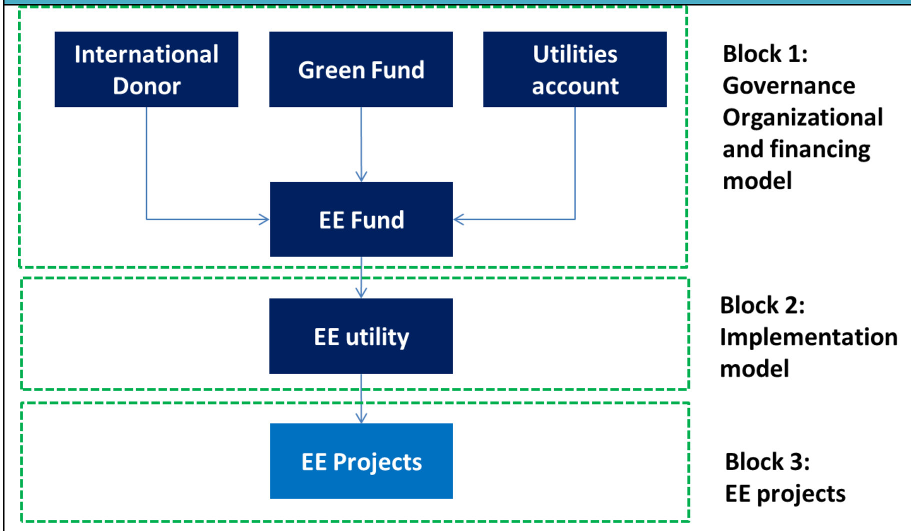


Figure 3.6: Energy Efficiency Fund concept under Option B

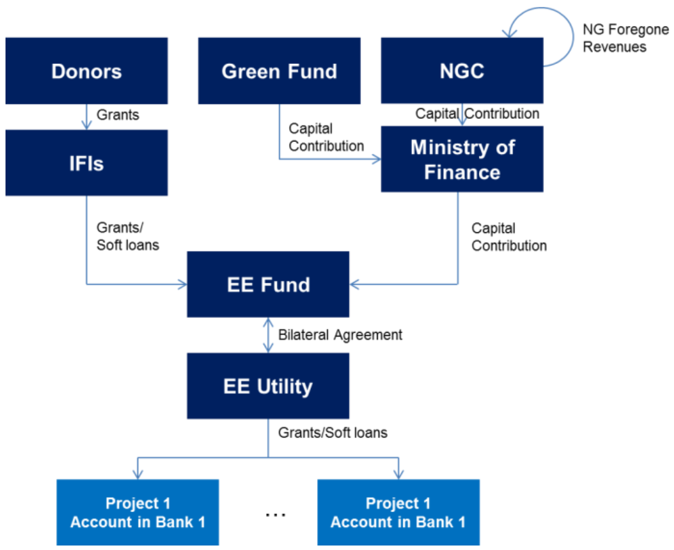


Figure 3.7: Financial Flow scheme under Option B

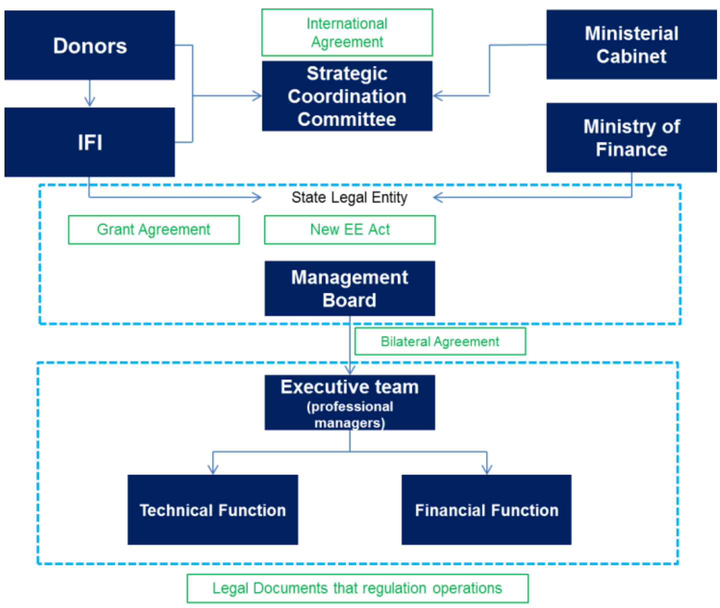


Figure 3.8: Governance structure under Option B

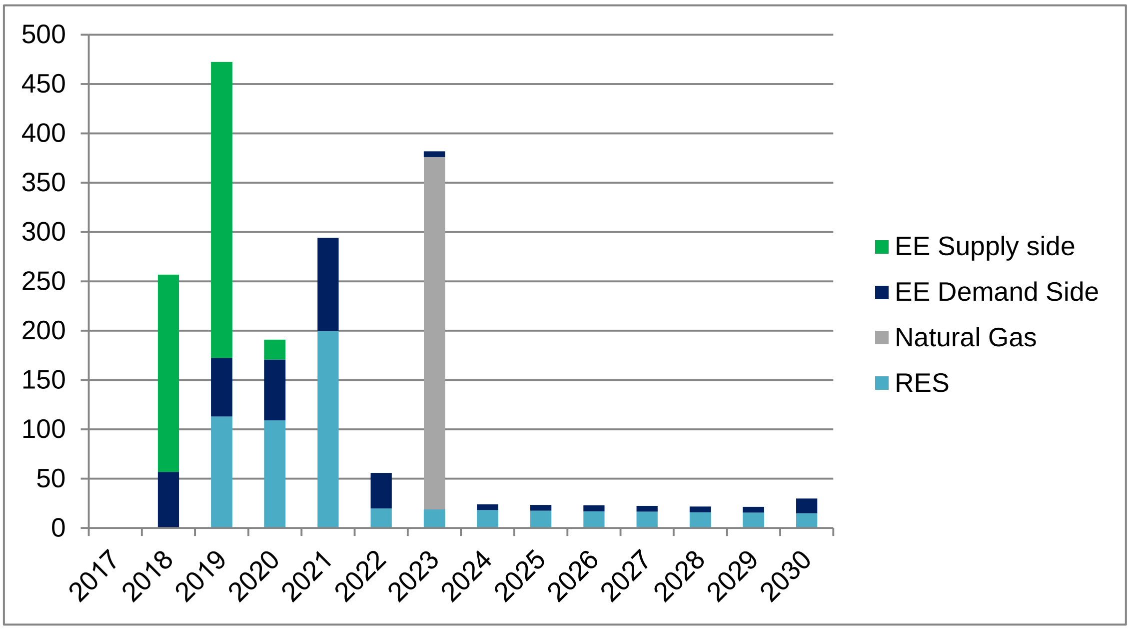
4. Financing Sustainable Energy

4.1 CAPEX requirements

The large uptake of RES and EE will require bold financial support particularly at the early stages of deployment. Figure 4.1 illustrates a rough estimation of the CAPEX requirements in order to realize the investments included in the optimum energy mix regarding both conventional technologies and RES and EE. It can be obtained that the largest CAPEX requirements are required for the improvements of EE in the generation side i.e. the upgrades of OCGTs to CCGTs. The cumulative CAPEX required until 2030 is as following:

- All types of Renewables - 576 US million
- Construction of a Natural Gas plant (350 MW) - 357 US million
- EE improvements in the Demand Side - 366 US million
- EE improvements in the Supply Side - 520 US million

Figure 4.1: Annual CAPEX requirements for major energy investments required in TT's energy sector (in US million)

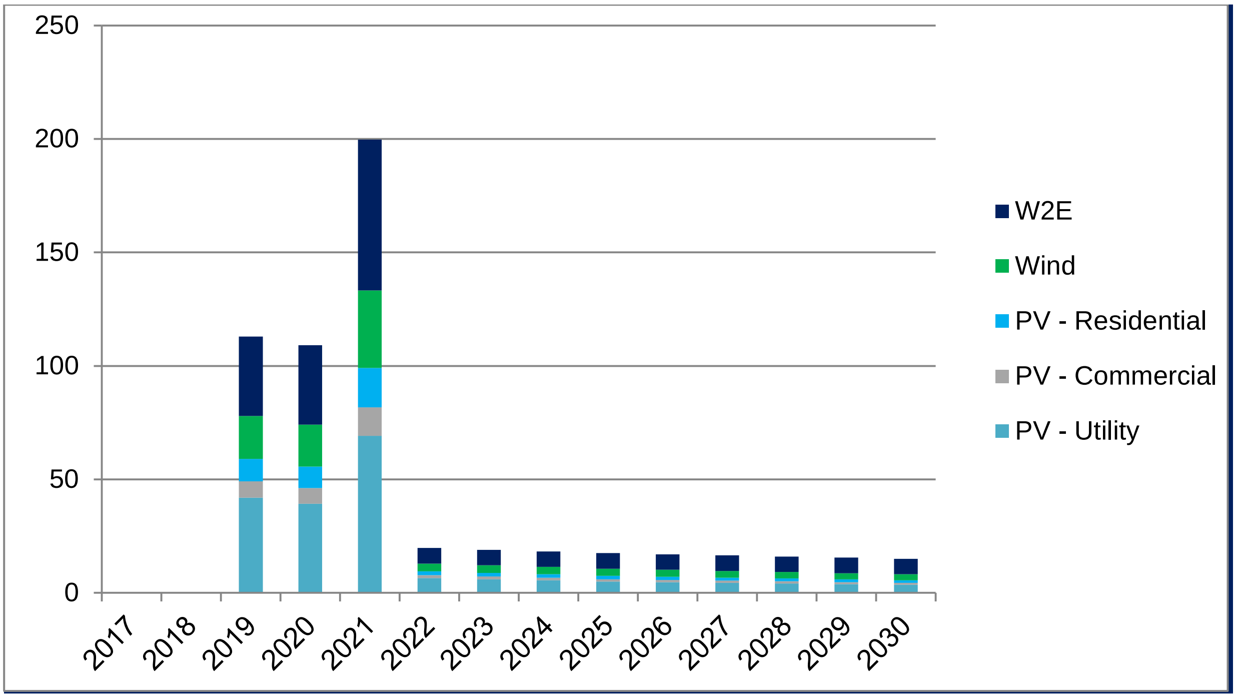


Source: *Author's elaboration*

The total CAPEX requirements for Renewables per technology type are illustrated in Figure 4.2 and can be summarized as following:

- Utility scale PV - 194 US million
- Commercial scale PV - 36 US million
- Residential scale PV - 49 US million
- Wind - 99 US million
- Waste to Energy - 198 US million

Figure 4.2: Annual CAPEX requirements for major energy investments required in TT's energy sector (in US million)



Source: *Author's elaboration*

4.2 Financing options for RES and EE

As presented above the CAPEX for realizing the actions included in the Roadmap and installing the required RES capacity is above 500 US million, while the proposed EE measures are close to 400 US million. On CAPEX the cost of the required soft actions (capacity building, studies, awareness programmes, etc.) - which of course are of a much smaller scale – has to be added. Whether the support policy instrument is net billing/net metering or auctions as additional cost will be incurred compared to the existing generation costs from conventional modes of generation. The exact level of annual financial support that will be required is a matter of more detailed analysis. Potential financial options for realizing these investments:

- **RES surcharge be included in the electricity bills.** The introduction of a RES surcharge could finance the additional cost incurred by a tendering process and a FiT/net metering scheme. The RES surcharge in general does not have to be uniform for all tariff categories thus the burden could be different for the 3 tiers. The common international practice is that the RES surcharge is collected by the electricity utility and deposited to a special account. Onwards, the utility reimburses the RES producers according to the PPA they have. The relevant legal provisions can be included in the T&TEC Act. RIC should be in principle responsible for monitoring this process through an amendment of the RIC Act, where it has to be included in its mandate and its supervisory role of the energy sector. While as a mechanism is quite easy to be introduced from a legal/regulatory perspective, defining the exact level of the surcharge is a matter of careful analysis so that no deficits are created in the longer run and RES disbursements are not delayed. It would also offer the advantage that T&TEC while being responsible for paying the RES disbursements in practice and if the system is well designed it would be insulated to a large extent against any liabilities.
- **Green Levy/Green Fund.** Currently, the Green Levy is defined in the legislation as 0.3% on gross income which is applicable to companies and partnerships doing business in Trinidad and Tobago. Despite the difficulties related to the disbursements of funds either part of this amount could be used to finance RES and EE or a small increase of this tax could be sufficient for financing sustainable energy. Moreover, it would offer the advantage through special provisions in the legislation that a separate for RES and EE could introduced in the Fund's activities. The negative aspect of this option is that does not create any (dis)incentive among the wider public to conserve and save energy unlike the RES surcharge.
- **Tax incentives (150% tax allowance scheme).** Currently, in T&T according to the pertinent legislation companies engaging certified ESCOs to elaborate and implement EE projects should

receive 150% tax allowance on the relevant investment. Prerequisite is the achievement of energy savings at least 15% as a result of the implemented EE measures. Under this mechanism which in principle offers quite a robust incentive for EE upgrades the state budget is initially burdened with the tax allowance costs. Currently, as the ESCO certification is pending measure is essentially inactive.

- **ESCOs/NG saving mechanism**. An interesting idea for financing of both RES and EE would be the establishment of an EE Fund which would finance the EE upgrades under a similar tax allowance scheme/capital grants or loans while investments would repay the capital expenditure. This mechanism has been thoroughly explained in Section 3.3.
- **State budget for investments made by T&TEC.** Direct state budget allocations could be used for TTEC projects particularly for RES projects or for financing the cost of a tendering/FiT scheme.
- **Development banks and IFIs**. Development banks and IFIs would be willing to finance both RES and EE projects in the form of grants and mostly loans or loan guarantees provided that there is sufficient political commitment.
- **Loans from commercial banks.** The commercial sector should be eventually included in the financing of EE and RES investments. Nonetheless, there is indication that local banks have currently the technical capacity to support EE investments or small scale RES through dedicated financial products.

Financing Option	Applicability		Difficult to design/deploy	Source of funding	Pros and Cons
	RES	EE			
RES surcharge	✓		Low	All electricity consumers	+ Separate account for financing RES + Steady source of funding thus predictable + Partial insulation of T&TEC - Should be constantly matched against needs
Green Levy/ Green Fund		✓	Low	All businesses in T&T through 0.3% on gross income	+ Amounts of the Fund more than sufficient for financing RES/EE projects and actions - No (dis)incentive to consumers to consume less
ESCOs/ NG saving mechanism	✓	✓	High	IFIs, State Budget NGC, (T&TEC)	+ Once designed properly it would create a massive uptake of EE + Flexible mechanism to accommodate RES - Complex mechanism to be set up
150% tax allowance scheme	✓	✓	Medium	State budget	+ Could be in principle highly effective - Practical issues during implementation - Issues for application in the industrial sector
State budget	✓	✓	Low	State budget (all citizens)	+ Easy to implement and fully targeted - State budget limitations
Development banks and IFIs	✓	✓	Low	International Donors	+ support from foreign funds
Commercial banks	✓	✓	High	Commercial Banks	+ Gradual involvement of the banking sector is absolutely essential - FOREX considerations - Lack of technical capacities

Source: *Author's elaboration*

Approximation of RES surcharge height

Assuming a simplistic approach under which the three selected technologies would have to be financed through a FiT, for small and medium scale PV (through net billing) while auctions would be implemented for utility scale PV, wind and waste to energy the results for additional cost incurred are shown in Table 4.1. It can be obtained that when the maximum RES capacity is deployed the annual additional cost is below 40 million. If this cost is to be covered through a RES surcharge to be paid through electricity bills this would lead to an increase 0,3 cents/kWh. Of course, this is only a rough estimate but it indicates that financing RES through this mechanism does create a large burden for consumers.

Table 4.1: Cumulative CAPEX requirements for RES investments required in TT's energy sector (in US million)

Year	Installed capacity (MW)			Annual additional cost (US million)	RES surcharge (US cents/kWh)
	PV	Wind	W2E		
2017	0	0	0	**0**	**0,0**
2018	0	0	0	**0**	**0,0**
2019	35	10	5	**9**	**0,1**
2020	70	39	10	**21**	**0,2**
2021	137	39	20	**33**	**0,3**
2022	143	41	20	**33**	**0,3**
2023	150	43	21	**34**	**0,3**
2024	157	47	23	**35**	**0,3**
2025	164	47	23	**35**	**0,3**
2026	171	49	24	**36**	**0,3**
2027	177	51	25	**36**	**0,3**
2028	184	53	26	**36**	**0,3**
2029	191	55	27	**36**	**0,3**
2030	198	57	28	**36**	**0,3**

Source: *Author's elaboration*

5. Sustainable Energy and value creation

5.1 Contribution of sustainable energy on jobs and growth

Accelerating the deployment of RES and EE will fuel economic growth, create new employment opportunities, enhance human welfare, and contribute to a climate safe future. Advances in RES and EE technologies and growing cost-competitiveness have strengthened the business case of sustainable investments and opened new opportunities for countries to transform their energy systems. The benefits of scaling up sustainable energy surpass cost competitiveness. Increased deployment can meet the growing energy needs, drive development and improve well-being, while reducing greenhouse gas emissions and increasing natural resource productivity.

Macroeconomic impact of Renewables

An overview of country and region-specific studies (see Table 5.1) shows that selected effects of renewable energy deployment at sectoral and national/regional level are predominantly positive. In fact, GDP growth in the target year can be between 0.2% and 4%. The magnitude of the impacts of renewable energy on GDP typically depends on the economic structure of the country, the interrelationship between sectors and sub-sectors, the costs of alternative energy sources and whether the equipment and required services are imported or sourced locally. Indeed, research has shown that investments in RES - and any other technology - can have a more significant positive effect if the technology is produced locally under the right conditions. The existing studies also show that increased RES deployment contributes to job creation. Depending on the exact policy measures introduced in the countries under consideration, employment could increase anywhere from a few thousand to over a million in 2030.

Table 5.1: Previous studies on the projected economic impacts of renewable energy deployment

Country/Region (Source)	Forecast year	Analyzed policy intervention	Impact on GDP	Impact on employment
Chile (NRDC and ACERA, 2013)	2028	20% RES in electricity generation (excl. large hydro)	+0.63% (USD 2.24 billion)	7,800 direct and indirect jobs (+0.09%)
European Union (European Commission, 2014)	2030	-40% GHG emissions by 2030	+ 0.46%	+1.25 million economy-wide jobs (+0.5%)
Germany (Lehr et al., 2012; Blazejczak et al. 2014; Bohringer et al. 2013)	2030	Different targets for renewable energy deployment	Up to + 3%	From negative to + 1% on net employment
Ireland (Pöyry Manage- ment Consulting and Cambridge Econometrics, 2014)	2020	Meeting the target for wind by 2020	+0.2% to + 1.3%	+1,150 to + 7,450 net jobs
Japan (IRENA and CEM, 2014)	2030	Adding 23.3 gigawatts (GW) of solar PV	+0.9% (USD 47.5 billion)	N/A
Mexico (own calculations based on PwC, 2015)	2030	21 GW of additional renewable power capacity	+0.2%	+134,000 in the sector
Saudi Arabia (own calculations based on K.A.CARE, 2012)	2032	54 GW of renewable power capacity	+4% (USD 51 billion)	+137,000 in the sector
United Kingdom (Cambridge Econometrics, 2012)	2030	Larger role of onshore wind instead of natural gas	+0.8%	+70,000 net employment

USA (ICF International, 2015)Synapse Energy Economics et al. (2015))	2030	Decarbonisation driven by renewable energy	+0.6%,	+0.5 to +1 million net

Source: *IRENA (2016), Renewable Energy Benefits: Measuring The Economics*

Macroeconomic impacts of Energy Efficiency

Implementing measures to meet EE targets has a positive impact on both GDP and employment. Typically, as of energy efficiency improvements increase, so do the positive impacts on GDP and employment. Specific data and studies highlighting the positive macroeconomic impacts of EE impact specifically in the Caribbean are not available. Nonetheless, there are several studies and empirical data illustrating the benefits of EE. In a major study assessing the impacts of the achievement of European EE targets16, it was found that in the scenario with a 30% energy efficiency target, GDP increases by 0.4% compared to the (27% target) by 2030 and employment increases by 0.4%. In the most ambitious scenario, there is the potential for GDP to increase by more than 4% and employment by more than 2%.Many of the jobs would be created in sectors directly relevant to energy efficiency (e.g. construction, engineering) but there would also be increases in employment in the wider economy. Unemployment in the EU could be reduced by up to 3 million people by 2030. Findings are shown in Table 5.2.

Table 5.2: Summary of EE measures impact on GDP and employment impacts

Degree of crowding out		EE saving targets compared to baseline			
Efficiency target		30%	33%	35%	40%
GDP	**No crowding out**	0.4%	1.5%	2.1%	4.1%
	Partial crowding out	0.4%	1.3%	1.6%	2.2%
Employment	**No crowding out**	0.2%	0.7%	1.0%	2.1%
	Partial crowding out	0.2%	0.6%	0.9%	1.4%

Source(s): *E3ME, Cambridge Econometrics*

The degree of crowding out is clearly important in determining the macroeconomic outcomes. If European industry is able to increase production to the levels required to manufacture and install the energy efficient equipment, then the full benefits could be realized. If investment in energy efficiency displaces other production, however, around half of the benefits could be lost. While the actual degree of crowding out is uncertain, policy makers could reduce it by signaling the ambition clearly to companies in advance; they would then be able to take a view on the prospective increases in demand. Ensuring an adequately skilled labor force could also mitigate potential crowding out.

There are also other economic benefits. Investment could increase substantially and household consumption could also increase due to the incomes earned by the additional people in employment. Reducing imports of fossil fuels would boost Europe's trade balance, and also improve the energy security of Member States that are exposed to a highly concentrated source of supply for gas.

The sectors that benefit the most in the scenarios are those that produce and install energy efficient equipment. These are principally the construction and engineering sectors, where by 2030 output could increase by 2.5% compared to the reference case in the 30% energy efficiency increase scenario and by more than 10% in the more ambitious cases. A necessary condition for realising these increases is that companies in these sectors have the capacity to increase production.

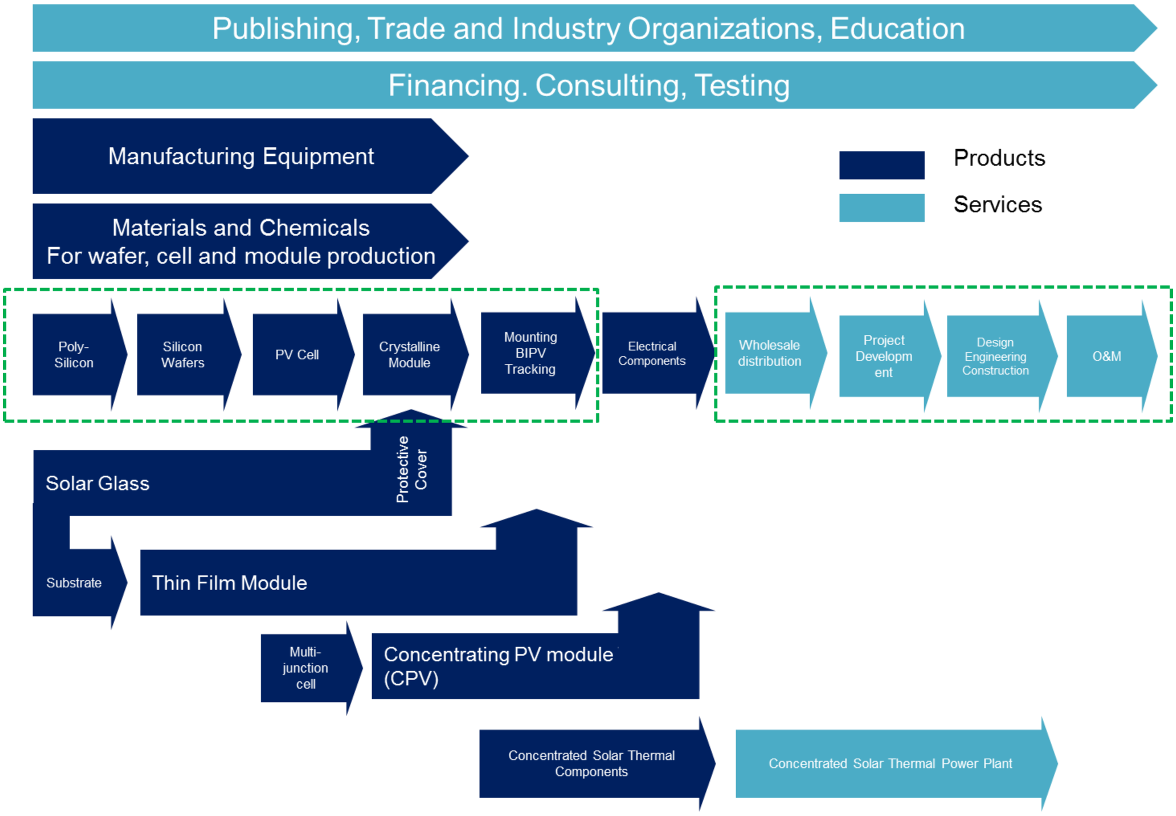
5.2 Solar value chain and local manufacturing

The socio-economic impacts of renewable energy can be evaluated along the different segments of the value chain, including project planning, manufacturing, installation, grid connection, O&M and decommissioning. Further opportunities exist in supporting processes such as policy-making, financial services, education, R&D and consulting. The extent to which domestic value is created along these different segments will depend on the overall level of development of a country's renewable energy sector. Countries embarking on this path have a potential for domestic value creation in activities such as O&M or grid connection. Where the country produces technology locally, many more opportunities for domestic value

[16] Study for a comprehensive assessment of the macro-level and sectoral impacts of Energy Efficiency policies, Cambridge Econometrics, Ernst & Young and SQ Consult, 2017.

creation arise with the development of a local industry. The segments of the value chain that can be localized depend on a number of factors. These include the current state and competitiveness of local complementary industries as well as the projected demand for goods and services. A typical solar supply chain is presented in Figure 5.1.

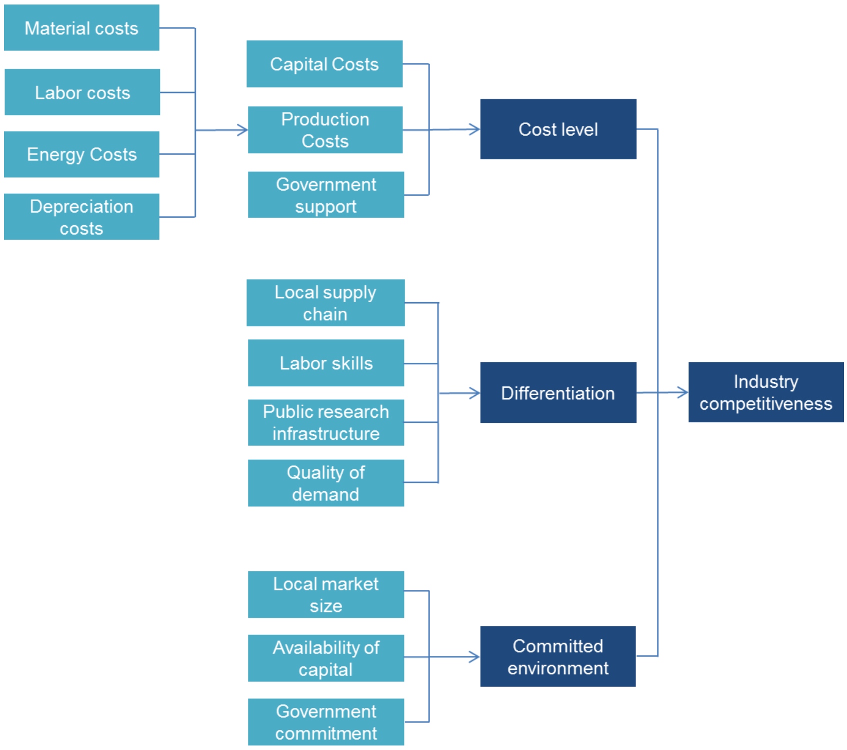
Figure 5.1: Overview of the solar supply chain



Source: *GreenRhinoEnergy, 2017*

Various factors determine the competitiveness and attractiveness of an industry against its competitors. The cost level is, for instance, impacted by the costs for production inputs such as labour, energy and materials. Furthermore, the depreciation of equipment and cost of capital for financing the investments are relevant. Finally, government support measures such as subsidies or cheap loans may lead to different cost levels across geographies. When it comes to the ability to differentiate, other framework conditions are relevant, such as the availability of skilled labor and leading research institutions. Also the presence of strong supply chain partners could be beneficial for a manufacturer's ability to differentiate, as well as a customer base that values differentiated products (quality of demand). Finally, some framework conditions exist that do not directly impact a manufacturer's cost level or ability to differentiate but can still play a large role in enabling investments in the industry. A large and growing local market is one of those, as well as the availability of the appropriate forms of capital. Furthermore, a government that expresses a clear commitment to the development of the industry is considered of relevance for investment decisions. All factors affecting the competiveness of an industry are shown in Figure 5.2.

Figure 5.2: Factors determining the competitiveness and attractiveness of an industry against its competitors



Source: *Assessment of Photovoltaics (PV),Trinomics, 2017*

In 2014 a feasibility[17] was completed for the establishment of a manufacturing complex for plants in four key areas of solar, silicon and glass manufacturing. These four areas include Metallurgical Silicon (MGSi), Polysilicon (PolySi), Float Glass, and Integrated Photovoltaic Manufacturing (Ingot, Wafer, Cell and Module). The study concluded that Trinidad was cost competitive against any global source of glass currently imported into Latin America, the Caribbean and the United States. The study has also shown Trinidad and Tobago to be in the top quartile for low cost silicon processing. The cost savings from these plants, combined with the availability of high quality of engineering talent, could aid in allowing the country to produce low cost and high quality PV panels for the Americas, as well as generating substantial returns for investors.

Each of the proposed plants can operate independently with substantial returns for investors. However, due to significant synergies and cost advantages in co-locating the plants, a 250 acre site in Point Lisas has been proposed for the location of these facilities. The site is in close proximity to Trinidad's robust petrochemical and LNG industries and next to the Port of Point Lisas. The location offers easy access to the United States, Europe, Latin America and the Caribbean. Additional advantages of this site are its industrial infrastructure, industrial gas and chemicals, favorable geotechnical conditions and good electrical grid connection and utilities.

It was also concluded that at least 4,500 permanent jobs, mostly skilled could be created (management, administrative, engineers, production Operators, maintenance trades, operations support, at least 3,000 construction jobs and 1000's jobs throughout the solar supply chain.

Similar is the case for the manufacturing of SWH in T&T. Assessing the success of the Barbados case it appears that there is a huge potential for solar water heating in T&T, especially since the insulation conditions are similar. However, the main significant difference is the price of electricity in T&T which is several times lower than in Barbados. Nonetheless, T&T has a significant advantage over Barbados in that with the country's wealth in natural gas resources for electricity generation, manufacturing is a real possibility. Labor costs in T&T are relatively cheaper than in Barbados. In addition, some of the raw materials would also be more easily available than in Barbados. All this amounts to high potential and favorable conditions for manufacturing in T&T.

[17] Feasibility of a Solar, Silicon and Glass Manufacturing Cluster in Trinidad and Tobago. SiTek Ltd, 2014.

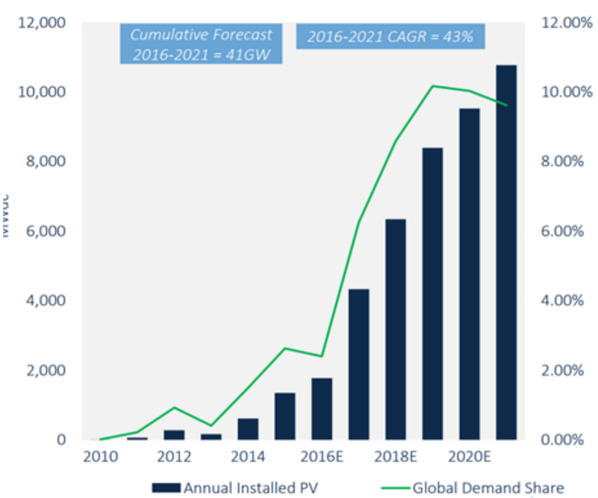
bago could exploit its industrial championship in the wider area and utilize the following competitive advantages in order to develop its domestic solar manufacturing industry:

- **Proximity with promising markets.** Trinidad has close proximity to attractive end-markets with positive outlooks, also suggesting that the country could position itself as a supplier for solar panels in growing markets like Mexico and other South American countries. Utility-scale PV is likely to remain at the forefront in the Latin American energy mix, with Mexico expected to exhibit a diversified growth profile in all market segments, while Caribbean nations are likely to see the most growth in commercial scale projects. In addition to growing demand in some of the world's largest economies, such as USA, China, India, Southern Africa, Europe and Japan, there will be increased regional demand from Caribbean nations as they seek energy independence and to reduce imports of fossil fuels.
- **Low electricity costs.** Trinidad and Tobago offers a competitive cost advantage for the manufacture and supply of solar modules. The country has the extremely low electricity prices and one of the lowest in the Caribbean region.
- **Networks and infrastructures.** The adequate availability of local ports for export of solar PV cells, especially at Pt. Lisas, and its skilled labour force that can be trained for high-tech manufacturing.
- **Availability of skilled labour**. Another comparative/ competitiveness factor is the availability of skilled labour. Trinidad and Tobago has a pool of skilled labour in electronics, engineering, and project management. The existence of a strong industrial base in Trinidad and Tobago has allowed Trinidad and Tobago technical labour force to acquire experience and competencies in technical field. Given the recent integration trust to form the Caricom Single Market Economy (CSME) in 2006, such skilled labour can be accessed from Trinidad and Tobago to support the wider Caribbean.
- **Government incentives**. Trinidad and Tobago wide range of incentives for manufacturing investments through government legislation. The Fiscal Incentives Act which includes exemption on customs duties on the construction of an approved project, exemption from value added tax, and exemption on income tax on dividends or other distribution (other than interest) out of profits or gains derived from the manufacture of the approved product during the tax holiday period. The Free Zones Act allows for exemption from corporation tax, exemption from import duties on capital goods, parts and raw materials for use in the construction and equipping of premises in connection for the approved activity, exemption from value added tax, exemption from withholding taxes, exemption from container examination fee, exemption from work permit fees, and exemption from land and building taxes. The Customs Act allows for duty free treatment for manufacturing enterprises for raw materials, machinery and equipment and, in some cases, packaging material.

Trinidad's PV manufacturing industry could have access to a constantly growing market

Latin America is expected to significantly increase continues to increase its share of PV demand. The region as a whole is expected to take over 6% of global PV demand in 2017 on the basis of strong growth in several major markets such as Mexico and Chile. Several key markets on the rise include Argentina and Colombia, with regional giant, Brazil, capable of becoming a force once again through economic recovery

Figure 5.3: The Latin America PV Demand 2010-2020



Source: *GTM Research Q4 2016 Market Update – Executive Summary*

Small scale renewables – A headache or an opportunity for T&TEC?

While electricity utilities and TSOs are quite familiar with managing large scale infrastructures such as utility scale PV their not familiar with small scale distributed generation or in the worst case they can be treated as a threat to the conventional BAU practices. The contribution of any electricity from small scale RES to the system may be outweighed by the costs of upgrading the grid to accommodate new inputs, which can require better communication and automation, accommodation of bilateral energy flows and reinforcement and strengthening of grid infrastructure. The integration of small scale RES, however, can be a useful tool that resource planners at utilities can incorporate to help meet a region's electricity demand. DERs could enable utilities to avoid adding new transmission/distribution equipment or other upgrades and extending maintenance schedules. In order this strategy to be productive utilities will need a comprehensive understanding of how small scale RES will fit into the system from a technical and regulatory perspective. To unlock this opportunity, some actions to be made by T&TEC include:

- **Measuring the impact of small scale RES.** To build the necessary skills small pilot programs should be implemented. T&TEC is already working towards this direction. These pilot programmes offer a better technical understanding of the technologies, the regulatory requirements, learn how to measure their impact and begin to adapt their own internal processes to accommodate the changes. Moreover will have to gradually incorporate them as a capacity resource in its system planning. This will require the utilization of specific software, grid stability studies, etc.
- **Determine how to compensate the RES owners** for the electricity they contribute to the system. T&TEC will have to work closely with RIC to conclude to the modalities one of the the many options for ownership and remuneration.
- **Update internal processes. T&TEC will have to gradually adapt its internal processes** and operations to maximize the benefits from integration of DERs. It might potentially have to train certain officials if the required skills are not in place, amend internal documents, etc.

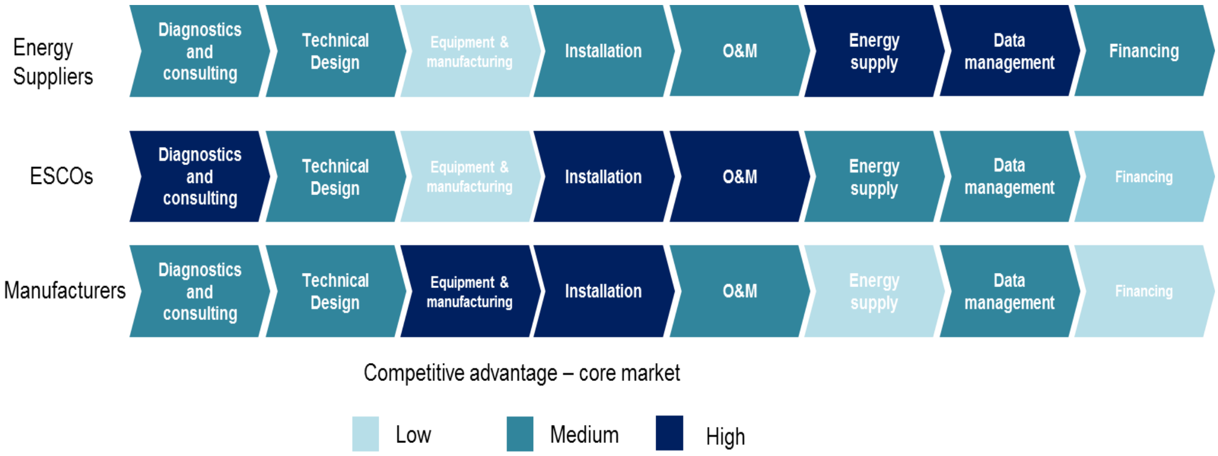
5.3 Engagement and value creation of the private sector in the EE market

Once the regulatory framework for EE is in place (standards, codes, etc) and the financial incentives by the GoRTT have been set up properly then the private sector can engage actively and invest in the EE market. The Government should set the game rules in a way it is clearly transmitted to the private sector. Similarly, companies must gain a solid understanding of the ways that regulators structure policies, regulations and incentives for EE programs. The development of an ESCO market for instance is inherently more complex than the adoption of mandatory provisions prohibiting or imposing certain provisions. Particularly international firms that are willing to enter a market should understand a market in terms of regulations and trends because the alignment with international norms that multinational corporations follow is implemented in a different way from country to country. In the case of T&T it appears that the private sector is eagerly waiting for market signals through appropriate regulatory amendments.

Once the regulatory framework is set and clearly understood by market players, businesses can begin to identify their position and strategy in the industry, relevant market opportunities and prospective customers. Typically SMEs will aim at delivering specific services and products at the first stage of the market development. Other firms who want to influence the market may come in early and aim for a broader role in the landscape offering more disruptive products, services or business models. Depending on their role, strategy and resources energy companies will find different opportunities along the EE value chain as illustrated in Figure 5.4.

Onwards, companies must will start developing competitive business models, as well as the capabilities that will help them deliver on their goals. For businesses entering emerging markets, a key aspect of this process is determining whether their products or services are suitable, or require substantial reinvention. They should also assess what skills are needed and what partnerships might be beneficial. Finally, they must evaluate their geographic capabilities: In one region, they may have the necessary people and assets for success, but find they are unable to replicate it in another. Similarly to RES, T&T firms despite the absence of an internal EE market and relevant experience could largely exploit the fact the country is an industrial champion among other Caribbean countries.

Figure 5.4: The Energy Efficiency value chain ecosystem and the positioning of different type of companies



Source: *Bain & Company, 2017*

5.4 Business Opportunities for T&T from Sustainable Energy

The large scale deployment of RES and EE can create large impact on economic growth and job creation. If the prescribed targets are to be achieved this could lead to investments in RES and EE of 600 US million and 400 US million respectively up to 2030. Such investments could create up to 10.000 of direct and indirect new jobs throughout the total value chain of technologies. The deployment of large scale RES and EE applications could create considerable business opportunities for the private sector.

Even though a detailed value chain analysis is required to identify these opportunities in a comprehensive way international experience from emerging markets and a rough assessment of the structure of market players indicate that significant business opportunities throughout the RES and EE value chain. Several opportunities can arise for EPC firms, RES developers, SMEs and retailers of residential and small scale PV and SWH. Similarly opportunities can arise for EE business and especially Components in the EE supply chain (LED, CFL, pumps, etc.), Companies doing energy audits and design Construction companies, doing facility management companies and building operators Energy intensive industries (e.g. distilleries, breweries, etc.), hotels, etc. This assessment is shown in Table 5.3.

Table 5.3: Rough assessment of business opportunities in the field of Sustainable Energy

Sector	Player category	Market player	Horizon		
			Short (2017-2021)	Medium (2022-2025)	Long (2026-2030)
Renewables	**Manufacturers**	PV and SWH manufacturing cluster	✓	✓✓	✓✓✓
	Technology Providers	Engineering firms	✓✓	✓✓✓	✓✓✓
		EPC contractors	✓	✓✓	✓✓
	Solution Providers	SMEs and retailers of residential and small scale PV and SWH	✓	✓	✓
	Investors	RES developers	✓✓	✓✓✓	✓✓✓
		O&G companies willing to invest in RES	✓	✓✓	✓✓
Energy Efficiency	**Technology Providers**	Instrumentation and automation	✓	✓✓	✓✓
	Others	Components in the EE supply chain (LED, CFL, pumps, etc.)	✓✓✓	✓✓✓	✓✓✓
	Solution Providers	ESCOs	✓✓✓	✓✓✓	✓✓✓
		Companies doing energy audits and design	✓✓✓	✓✓✓	✓✓✓

		Construction companies	✓✓	✓✓	✓✓
	Consumers	Companies doing facility management and building operators	✓✓	✓✓	✓✓
		Hotels and their associations	✓✓	✓✓	✓✓
		Energy intensive industries (e.g. distilleries, breweries, etc.)	✓✓	✓✓✓	✓✓✓
		Large consumers and conglomerates	✓	✓✓	✓✓
	Finance	Banks and accounting firms	✓	✓✓✓	✓✓✓
✓: Low potential, ✓✓: medium potential, ✓✓✓: high potential					

Source: *Author's elaboration*

6. Overview of proposed actions and timing

6.1 Introduction

In the following Tables an overview of all proposed actions – including both RES and EE and are presented, alongside the period of implementation.

The proposed country can be systematized in the following categories:

- Resource Assessment actions (RA)
- Policy Actions (P)
- Institutional actions (I)
- Legal/Regulatory actions (LR)
- Capacity Building activities (CB)
- Awareness Raising actions (AR)

All the proposed actions are presented in Table 6.1 for RES and Table 6.2 for EE. For each proposed action apart from the category, code and description the following aspects have been assessed:

- Category
- Description
- Objective
- Priority
- Sufficiency of in-house capacities
- Sector/ Technology specific
- Implementing Parties
- Completion degree
- Period of implementation
- Associated Cost (refers to the cost of external Consultants)

6.2 Overview of proposed actions for RES

In the present section an overview of the proposed measures for the promotion of RES and EE is presented in the following Tables.

Table 6.1: Overview of proposed actions for the promotion of RES

Category	Code	Description	Objective	Priority	Sufficiency of in-house capacities	Sector/ Technology specific	Implementing Parties *	Completion degree	Period of implementation	Associated Cost (US$)
Resource Assessment (RA)	**RES.RA.1.**	**Assessment of solar resources** Development and provision of country-wide solar radiation data by the Meteorological Service of T&T to reflect local conditions on both islands	• Assess resources	Medium	Medium	RES/ Solar PV, SWH	• Meteorological Service of T&T (L)	-	2019	50,000
Resource Assessment (RA)	**RES.RA.2.**	**Assessment of wind resources** Perform detailed wind measurements at potential concrete sites, based on the national wind resource assessment	• Assess resources	High	Low	RES/ Wind Onshore	• MoEEI (L)	Low	2017-2018	500,000
Resource Assessment (RA)	**RES.RA.3**	**Assessment of waste resources** Establish a long-term strategy and program on waste treatment	• Assess resources	High	Low	RES/ Waste to Energy	• MoEEI (L) • SWMCOL	Low	2017-2018	300,000
Policy (P)	**RES.P.1**	**Elaboration of tariff study** Study for the assessment of the rationalization of electricity tariffs focusing on the introduction of 4^{th} Tier	• Creating a conductive environment	High	Medium	All	• RIC (L) • T&TEC	-	2018	50,000
Institutional (I)	**RES.I.1**	**Establishment of an Energy Agency** Study for the internal organization of an Energy Agency and setting up of the Agency. Introduction of regulatory amendments for the establishment of the Agency and budget allocation	• Enhance capacities	High	Low	All	• MoEEI (L) • MFIN	-	2017-2018	50,000
Institutional (I)	**RES.I.2**	**Establishment of a RES/EE Association** that will promote interests of RES/EE companies and constitute their formal lobbying associations with the Government	• Active engagement of private sector	Medium	High	RES	• IPPs, • Energy Chamber, • RES/EE firms	-	2017-2018	10,000
Legal/ Regulatory (LR)	**RES.LR.1**	**Amendment of the Trinidad and Tobago Electricity Commission Act and the RIC Act**	• Create a robust regulatory framework for RES	High	Medium	RES	• MoEEI (L), • MPU (L), • RIC, • T&TEC	-	2017-2018	60,000
Legal/ Regulatory (LR)	**RES.LR.1.a**	**Introduction of RPS as mandatory obligations (TTEC Act)**	• Create a robust regulatory framework for RES	High	Medium	RES	• MoEEI (L), • MPU (L), • RIC, • T&TEC	-	2017-2018	10,000
Legal/ Regulatory (LR)	**RES.LR.1.b**	**Establishment of a tendering scheme (TTEC Act)**	• Create a robust regulatory framework	High	Medium	RES	• MoEEI (L), • MPU (L), • RIC, • T&TEC	-	2017-2018	10,000
Legal/ Regulatory (LR)	**RES.LR.1.c**	**Provisions related to PPAs (TTEC Act)**	• Create a robust regulatory framework	High	Medium	RES	• MoEEI (L), MPU (L), • RIC, • T&TEC	Low	2017-2018	10,000
Legal/ Regulatory (LR)	**RES.LR.1.d**	**Provisions to allow access to the grid for operators of RE generation facilities (TTEC Act)**	• Create a robust regulatory framework	High	High	RES	• MoEEI (L), MPU (L), • RIC, • T&TEC	Medium	2017-2018	10,000
Legal/ Regulatory (LR)	**RES.LR.1.e**	**Establishment of a FiT scheme for small scale RES generation (TTEC Act)**	• Create a robust regulatory framework	High	Medium	RES	• MoEEI (L), • MPU (L), • RIC, • T&TEC	Low	2017-2018	10,000
Legal/ Regulatory (LR)	**RES.LR.1.f**	**Legal provisions regarding the introduction of a 4th tier in electricity tariffs (RIC Act)**	• Create a robust regulatory framework	High	High	Electricity	• MoEEI (L), • MPU (L), • RIC, • T&TEC	-	2017-2018	10,000
Legal/ Regulatory (LR)	**RES.LR.2**	**Development of appropriate standards and regulatory framework for WtE**	• Create a robust regulatory framework	High	Medium	WtE	•	-	2017-2018	200,000

Category	Code	Description	Objective	Priority	Sufficiency of in-house capacities	Sector/ Technology specific	Implementing Parties *	Completion degree	Period of implementation	Associated Cost (US$)
Legal/ Regulatory (LR)	**RES.LR.3**	**Development of an appropriate legal and regulatory framework to kick start SWH.**	• Create a robust regulatory framework	High	High	SWH	• MoEEI (L), • TTBS • HDC	-	2017-2018	200,000
Legal/ Regulatory (LR)	**RES.LR.4**	**Development/update and publication of PPA contracts for RES**	• Create a robust regulatory framework • Engage private sector	High	Medium	RES	•	Medium	2017-2018	10,000
Legal/ Regulatory (LR)	**RES.LR.5**	**Amendment of Building Code** to introduce a mandatory requirement of SWH installation for all those establishments with a high consumption of hot water, such as hotels, restaurants, hospitals etc.; for new constructed buildings effective immediately, for existing buildings after a grace period	• Create a robust regulatory framework	High	Medium/Low	SWH	• MoEEI (L) • HDC • TTBS	-	2017-2018	10,000
Legal/ Regulatory (LR)	**RES.LR.6**	**Amendments in the Green Fund to finance RES and EE projects** Amendments of in the legislation to facilitate financing of RES and EE from the Green Fund	• Secure financing for RES and EE	High	High	All (RES/EE)	• MoF (L) • MoEEI	-	2018	20,000
Capacity Building (CB)	**RES.CB.1**	**Development of Consistent National Energy** Utilization of least cost programming software for the elaboration of a long term energy strategy and update of all energy policy documents. Training of staff from a research institure, Energy Agency and MoEEI on the software	• Enhance energy planning capacities	High	Low	All	• MoEEI (L) • UWI • Energy Agency (provisional)	-	2018	150,000
Capacity Building (CB)	**RES.CB.2**	**Training on Solar PV** Training of electricians and electrical inspectors for Solar PV installations	• Enhance capacities of the private sector	High	Medium	PV/SWH	• MoEEI • UTT	-	2018-2019	200,000 +
Capacity Building (CB)	**RES.CB.3**	**Joint enhancement of capacities of academia and private sector on wind energy** Introduce know-how on wind energy in university and college courses and start training of technicians for construction, operation and maintenance	• Enhance capacities of academia • Enhance capacities of the private sector	High	High	RES	• MoEEI, • UTT, • UWI, • Ministry of Education	Low	2017-2022	50,000
Technical/ Implementation	**RES.T.1**	**RES Grid impact study** Assess impact on grid stability and capacity if relevant levels of wind or solar energy are fed into distribution or transmission lines	• Implementation of RES projects	High	High	RES	• T&TEC(L) • UTT	Low	2017-2018	100,000
Technical/ Implementation	**RES T.2**	**RES tariff setting study** Determination of the exact level of tariffs for small scale RES through a net metering or net billing mechanisms through an appropriate study	• Implementation of RES projects	High	Medium	RES	• MoEEI (L), • MPU (L), • RIC, • T&TEC	-	2017-2018	30,000
Technical/ Implementation	**RES.T.3**	**Technical Assistance for tendering process** Technical assistance (legal and financial) for the launch of tendering process for large scale wind, PV and waste to energy projects	• Implementation of RES projects	High	Medium	RES	• RIC/T&TEC (L)	-	2017-2018	150,000
Technical/ Implementation	**RES.T.4**	**Launch of 100-Roof PV Program** Establishment of an introductory 100-Roof PV Program with capital subsidies of the Government Budget	• Implementation of RES projects	High	High	PV	• MoEEI (L)	-	2017-2021	600,000
Technical/ Implementation	**RES.T.5**	**Waste Characterization Study** Implementation of a comprehensive waste characterization study	• Implementation of RES projects	High	Medium	WtE	• MoEEI	Low	2017-2018	500,000
Technical/ Implementation	**RES.T.6**	Use SWH for retrofitting of social housing in case of new constructions	• Implementation of RES projects	Medium	Medium	SWH	• Ministry of Housing	-	2017-2030	300,000
Technical/ Implementation	**RES.T.7**	**Grid Connection Requirements** Development of Grid Connection requirements for large and small scale RES. Relevant amendment of T&TEC wiring code	• Implementation of RES projects	High	High	RES	• T&TEC(L) • MoEEI, • RIC	Low	2017-2018	100,000

6.3 Overview of proposed actions for EE

Table 6.2: Proposed actions for the uptake of EE technologies

Category	Code	Measure	Objective	Priority	Sufficiency of in-house capacities	Sector/ technology specific	Implementing Parties	Completion degree	Period of implementation	Associated cost (USD)
Resource Assessment (RA)	**EE.RA.1.**	Conduction of energy audits	• Identification of energy savings measures	High	Medium	Residential Commercial Industrial	• HDC (L)	-	2018 - 2030	1,500,000
	EE.RA.2.	Conduct a detailed feasibility study from an independent and reputable advisor for the upgrade of OCGTs to CCGTs under various setups and financing mechanisms	• Implementation of EE measures	High	Low	Power Generation	• MoEEI (L) • Energy Chamber • TTEC	-	2018	100,000
Policy (P)	**EE. P.1.**	Setting of energy savings targets with horizon to 2030 in the primary legislation	• Setting an appropriate policy framework for EE	High	Low	All	• MoEEI (L)	-	2018 - 2030	-
Legal/ Regulatory (LR)	**EE.LR.1**	Design and implementation of tax and financial incentives for the launch and acquisition of EE appliances. The Programme can include incentives to retailers in order to stimulate the introduction of the appliances as well.	• Establishing the appropriate legal and regulatory framework for EE	Medium	Medium	All	• MoEEI (L)	-	2030	1,500,000 (including appliance subsidies)
	EE.LR.2	Development and Enactment of an EE Act	• Establishing the appropriate legal and regulatory framework for EE	High	Low	All	• MoEEI (L)	-	2020	200,000
	EE. LR.3	Development and implementation of secondary regulation required for the effective implementation of EE act	• Establishing the appropriate legal and regulatory framework for EE	High	Low	All	• MoEEI (L)	-	2023	3,500,000
	EE.LR.4	Implement a monthly billing instead of bi-monthly for residential and commercial customers	• Increase the clients' perception on electricity consumption	Low	Medium	Residential	• T&TEC (L)	-	2020	300,000 (annually)
	EE.LR. 5	Adoption of standards for EE labeling and development of relevant conformity assessment activities for the enforcement and implementation of these standards	• Promotion of EE appliances	Low	Low	Residential Commercial	• GoRTT • TTBS	-	2030	3,000,000
Technical/ Implementation	**EE.T.1**	Incentivize the replacement of old air-conditioning systems with new of high efficiency by reducing the import duties to 10% on new systems and progressively increasing import duties on low efficiency systems from 20% to 50%.	• Increase the energy savings in residential sector	Medium	Medium/high	Residential	• MoEEI (L) • MOF	-	2030	1,500,000
	EE.T.2	Incentivize the replacement of incandescent light bulbs by increasing import duty form 20% to 30% and by announcement of the government intention to phase out in 5 years. In parallel the Government will design and implement a CFL disposal programme	• Increase the energy savings in residential sector	High	Medium/high	Residential	• MoEEI (L) • MOF	-	2030	500,000
	EE.T.3	Design and implement a programme for replacement of incandescent bulbs with CFL lights to new HDC social housing units	• Increase the energy savings in residential sector	High	Medium/high	Residential	• HDC	-	2022	850,000
	EE.T.4	Elaboration and implementation of 150% tax allowance programme	• Incentivize EE in various sectors	High	Medium/high	Hotel, Commercial	• MoEEI (L)	-	2030	8,000,000
	EE.T.5	Completion of the certification system for energy service companies (ESCO)	• Incentivize EE in various sectors	High	Low	All	• MoEEI	-	2018	20,000
	EE.T.6	Elaboration of a study on consumers attitude concerning energy savings	• Identification of the public perception and consumption patterns	High	Medium	Residential	• GoRTT	--	2019	70,000
Awareness Raising (AR)	**EE.AR.1**	Elaboration and implementation of an awareness and information programme in order to raise awareness on energy issues and especially on energy efficiency	• Awareness raising on EE issues	High	Low	Residential	• GoRTT	-	2018-2030	2,500,000
	EE.AR.2	Elaboration and implementation of an awareness and information programme target at owners, operators and stakeholders in the hotel & tourism sector.	• Awareness raising on EE issues	Medium	Low	Hotels	• GoRTT, • TDC, • THRTA	-	2022	1,500,000
	EE.AR.3	Elaboration and implementation of an national awareness and information programme targeting to general public, municipal and institutional stakeholders	• Awareness raising on EE issues	High	Low	Residential Public sector (municipal, ministerial)	• GoRTT	-	2018-2030	1,000,000
	EE.AR.4	Elaboration and implementation of a programme that will promote energy savings behavior among secondary school students	• Awareness raising on EE issues	Medium/High	Low	Secondary school students	• GoRTT	-	2018-2030	300,000

Category	Code	Measure	Objective	Priority	Sufficiency of in-house capacities	Sector/ technology specific	Implementing Parties	Completion degree	Period of im-plementation	Associated cost (USD)
	EE.AR.5	Elaboration and implementation of a programme that will promote energy savings behavior among university students	• Awareness raising on EE issues	Medium/High	Low	University students	• GoRTT	-	2018-2030	300,000
	EE.AR.6	Elaboration and implementation of exemplary projects in public buildings. Introduction of behavioral changes with respect to energy savings in public buildings	• Awareness raising on EE issues	Medium	Low	Public buildings	• GoRTT	-	2018 -2030	1,000,000

Source: Author's proposal

7. Monitoring

An Implementation Monitoring System should support the review and assessment of progress of the Sustainable Energy Roadmap towards its implementation in accordance to the objectives and targets set in the Implementation Plan. The first step for the development of such a system is the clear definition of monitoring responsibilities i.e. which entity/unit within the Government is responsible for monitoring the Implementation of the Plan.

The monitoring of the Implementation Plan should be done at two levels:

- a high policy level – Energy Strategy and
- at the level of individual actions/measures – Implementation Programme

The most reasonable option is that the monitoring of the Implementation Plan is done at technical level by the Sustainable Energy Unit within MoEEI and at high policy level by the Renewable Energy Committee.

High policy level – Energy Strategy

The following assessment criteria should be used for the assessment:

- Relevance which describes how well the actions address the problem of sustainable energy transition and how well it matches the strategic objectives.
- Efficiency which stands for how well the inputs are transformed into outputs and outcomes.
- Effectiveness which measures the degree to which the Plan's outputs have provided benefits and contributed to the programme's purpose.
- Impact which describes how and to which degree the Plan has contributed to the solution of the problem and to the achievement of the overall objective.
- Sustainability which introduces a time dimension into the monitoring. It measures to the likelihood of a continuation in the stream of benefits produced by the programme after the period of external support has ended.

Individual actions/measures – Implementation Plan:

At the level of the concrete actions/measures the progress and compliance level should be assessed against the following aspects:

- The entity responsible or appropriate for implementation;
- The necessary institutional infrastructure, or support for the implementation;
- The relevant organisational arrangements needed for the implementation;
- The financial information and corresponding planning for implementation;
- An assessment of the required human resources for implementation;
- The availability of studies, or other supporting material necessary for implementation;
- The overall timetable;
- Potential risks and mitigation measures;
- Monitoring and evaluation indicators, where possible, regarding the effectiveness and efficiency of the implementation.

Bi-annual Monitoring Report
The monitoring process should be ideally recorded in a Bi-Annual Report to be prepared by the Sustainable Energy Unit, focusing on the following:

- the results accomplished in the last 2 year against the objectives;
- the estimated effects of the achieved results and their impact
- proposed measures for a more efficient implementation, and
- estimated need for adjusting Plan to the actual needs.

Key aspects of this report could include:

- **Achieved results:** how the overall results achieved in the previous year have contributed towards the achievement of overarching targets in the implementation strategy.
- **Estimated effect and impact:** the estimated effects of the results that have been achieved until the preparation of the Bi-Annual Report will be assessed. Moreover, interdependencies among measures will be evaluated and more specifically it will be highlighted whether the improper or delayed implementation of a measure will cause delays in the implementation of the measures of the forthcoming years.

- **Proposed measures for more efficient implementation.** Organizational, institutional, legal, technical, capacity and various other key issues related to the implementation of the Plan will be identified and measures for rectifications and improvements will proposed.

The first Monitoring Report could be prepared for the period 2018-2019.

Monitoring tool and indicators

Apart from the Report a monitoring tool in a simple and user-friendly format registering and visualizing all the items and actions of the Implementation Plan could be developed. The development of appropriate performance benchmarks and indicators in order to keep track of the set targets is strongly advised. A list of typical indicators related to Renewables includes:

- Primary production of energy from renewable sources
- Electricity generation from renewable sources
- Installed capacity for renewable electricity generation
- Production of liquid biofuels (not applicable in T&T)
- Imports and exports of renewables (not applicable currently in T&T)
- Gross inland consumption of renewables
- Renewable energy available for final consumption
- Share of energy from renewable sources in gross final consumption of energy
- Share of energy from renewable sources: electricity
- Share of energy from renewable sources: heating and cooling
- Share of energy from renewable sources: transport

Indicatively, a series of typical EE indicators commonly used for various sectors is presented in Table 7.1

Table 7.1: Typical EE indicators

Sector	Indicator	Unit	Short description
Macro	Overall energy efficiency gain	%	Energy efficiency gains are calculated from unit consumption trends by sub –sector (or end-use or mode of transport) by aggregation of unit consumption indices by sub-sector in one index for the sector on the basis of the current weight of each sub-sector in the sector's energy consumption.
	Final energy intensity	kWh/unit of GDP	The final energy intensity is the ratio final energy consumption (climate corrected) over GDP. The purpose of these climatic corrections is to leave out the influence of cold winter
	CO_2 emissions per capita	Tonnes CO_2/ capita	CO_2 emissions per capita corresponds to CO_2 emissions divided by the population.
Residential sector	Annual Electricity consumption of households	kWh per dwelling	Annual electricity consumption of households in kWh per permanently occupied dwellings, calculated at normal climate. The purpose of these climatic corrections is to leave out the influence of cold winter.
	Energy consumption of households for space heating	kWh/m^2	Energy consumption of households for space heating in toe per floor area in m^2 adjusted for climatic conditions
Industrial sector	Energy consumption of industrial sub-sectors (e.g. chemicals) per unit of production	kWh/unit of production	The unit consumption of a subsector of industry is calculated as the ratio between the final energy consumption of the sub-sector over the output measured in absolute units
	Energy consumption of industrial sub-sectors (e.g cement) per value added	MWh/unit of GDP	Energy intensity of industry is defined as the ratio between the final energy consumption and the value added at constant price in a specific year, using purchasing power parities instead of exchange rates
Agricultural sector	Energy intensity	MWh/unit of GDP	The energy intensity of agriculture is defined as the ratio between the final energy consumption of the sector and the value added measured in constant purchasing power parities.
	CO_2 intensity	tCO_2/ unit of GDP	The CO_2 intensity of agriculture indicator is calculated as the ratio between CO_2 emissions of agriculture over value added.
Transport Sector	Energy consumption of road vehicles	Toe/ car equivalent	Annual energy consumption measured per equivalent car

	Energy consumption of cars	Goe/ passenger-km	Energy consumption of cars in grams of oil equivalent per passenger-distance