



Project Manual:

Climate Change Mitigation Pilot Project

***Energy efficient lighting improvements in select public buildings
in Tobago, Trinidad and Tobago***

Updated AUGUST 2018 (FINAL)



RG-T2543 - Caribbean Climate Smart Islands Program

IDB Reference Number # IDB511-04/15

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Acronyms

CBA	Cost-Benefit Analysis
CEA	Cost-Effectiveness Analysis
CCSIP	Caribbean Climate Smart Islands Program
GEF	Grid Emission Factor
GHG	Greenhouse gas
GWP	Global Warming Potential
HEE	High Energy Efficient
IDB	Interamerican Development Bank
LED	Light Emitting Diodes
kWh	Kilo-Watt-hour
MCA	Multi-Criteria Analysis
MW	Mega-Watt
MRV	Monitoring, Reporting and Verification
NDC	Nationally Determined Contributions to climate change mitigation
NEP	National Energy Policy
THA	Tobago House of Assembly
T&TEC	Trinidad and Tobago Electricity Commission

1. General Information

1.1	Name of Project	Energy efficient lighting improvements in select public buildings in Tobago, Trinidad and Tobago
1.2	Beneficiary country	Tobago (Trinidad & Tobago)
1.3	Project duration	20 Months (July 2017 – February 2019)
1.4	Starting date	July 06, 2017
1.5	Project value (US\$)	\$37,941 (Includes both financial and in-kind contributions)
	CCSIP/IDB (US\$)	\$27,941 (Includes financial contribution)
	Co-share (US\$)	\$10,000 by the THA (in-kind)
1.6	Main Focal Points at the Tobago House of Assembly (THA)	<p>Name: Kelvin Charles, Chief Secretary Telephone: TBD Email: TBD URL: http://www.tha.gov.tt/divisions/office-of-the-chief-secretary/</p> <p>Name: Amoi Romeo, Technical Advisor to the Chief Secretary Telephone: +1-868-704-1602 Email: amoi.romeo@tha.gov.tt URL: http://www.tha.gov.tt/divisions/office-of-the-chief-secretary/</p>
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1.9 Partner Entity:
**Department of
Environment of the
THA Division of
Infrastructure,
Quarries and
Environment**

Partner Entity Name: THA Division of Infrastructure, Quarries and Environment
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(THTA)**

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Partner Entity:
**Trinidad and
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2. Project Description

2.1 CCSIP Program Background

Caribbean Island challenges

Caribbean nations are highly vulnerable to the impacts of climate change. This is due to their limited size and availability of natural resources, relative isolation, high population densities, and having small economies almost completely dependent on tourism which is very sensitive to external shocks. These characteristics sum up to a very limited carrying and resiliency capacity to deal with external factors (e.g. more frequent and intensive hurricanes, extended periods of droughts, etc.) triggered by climate change.

In Caribbean nations, typically most of the population and critical infrastructure are located in narrow low-lying coastal zones and are subject to floods and other weather-related impacts. This reality makes investment in climate change adaptation measures mandatory, while at the same time be attentive to opportunities to pursue low carbon pathways in the lights of showcasing the international community that environmentally responsible development with a reduced “carbon footprint” is possible, even under challenging conditions as in small island communities.

Mitigating climate change in small island communities does not only have a strong demonstrative value but helps addressing other pressing matters as increasing energy security, incentivizing the creation of new productive activities in new and innovative sectors, and generate cross-cutting environmental and socio-economic benefits.

Through the Caribbean Climate Smart Islands Project (hereafter CCSIP); the IDB supports the implementation of one Greenhouse Gas (GHG) emission reduction measure in Tobago, Trinidad and Tobago.

Pilot Project Selection

The pilot project is selected through an extensive selection process that included the performance of a Cost-Benefit Analysis (CBA), a Cost-Effectiveness Analysis (CEA), and a Multi-Criteria Analysis (MCA) with inputs and feedback from key stakeholders in Trinidad & Tobago, and more specifically from Tobago.

On July 6, a multi-stakeholder meeting was held at the HIQ Boutique Hotel and Conference in Crown Point in Tobago, to review, validate and select the pilot project for Tobago. The consultation meeting was attended by critical stakeholders including the Water and Sewage Authority, the Tobago Hotel and Tourism Association, the Ministry of Energy, the Ministry of Tourism and Civil Aviation, the Tobago House of Assembly, and the Environmental Management Authority.

This process resulted in the selection of the climate change mitigation intervention related to the installation of energy efficient lighting

Technology in public buildings in Tobago (EN-01 Energy efficient lighting improvements) to reduce electricity consumption and thereby reduce GHG emissions.

2.2 Background and Justification of the pilot project

Tobago's Energy Production and Consumption

In 2014 Trinidad and Tobago had an installed capacity of 2,428.7MW generated by four electricity producers. Between all electricity producers, there are eight operating plants, two in Tobago and six in Trinidad. From the two energy plants located in Tobago, T&TEC operates a 64MW gas turbine at its Cove power plant, which opened in 2009 and was converted to natural gas in 2011. The Scarborough power plant consists of a 11MW medium-speed diesel generator, also owned by T&TEC, and provides backup capacity in case of power outages from the 25MW inter-island link or the Cove power plant. By 2012, electricity sales of T&TEC were 8,708 GWh, an increment of 7.2% compared to the previous year. Electricity sales had an overall increment of 54% from 2002 to 2012, representing a 4.5% increment per year. This increment level can be attributed to higher per capita electricity consumption, as the population of Trinidad and Tobago increased by 4.6% during the same timeframe. Trinidad and Tobago presented its Intended Nationally Determined Contribution to climate change mitigation (iNDC) to the United Nations Framework Convention on Climate Change (UNFCCC), where renewable energy projects and energy efficiency measures are mentioned briefly as part of possible mitigation actions.

Cost of Electricity

The electricity production sector in Trinidad and Tobago counts with high energy subsidies resulting in low electricity prices compared to the rates in the Caribbean region. These low costs on energy production pose a great challenge for the implementation of wind and solar energy systems. Low energy prices in the country have led to an overconsumption trend, with low implementation of energy efficiency and energy conservation actions. The estimated commercial cost per kWh of electricity in 2017 was \$0.06 USD according to the rates established by TTEC¹. The removal of fuel subsidies has been a topic under discussion in recent years, an action that would have an impact on the electricity costs for the subsidy acts not on the electricity directly, but rather on the natural gas that is sold to power generation by The National Gas Company of Trinidad and Tobago Ltd. (NGC)². This action will most probably have an impact on the implementation on the pilot project.

¹ Summary of Electricity Rates. TTEC. <https://ttec.co.tt/default/tariffs-2#commercial>.

² Electricity subsidy cost T&T over TT\$800 million in 2016. The Energy Chamber. <http://energynow.tt/blog/electricity-subsidy-cost-tt-over-tt800-million-in-2016?rq=subsidy>.

Renewable Energy Development

Previous experience with renewables in Trinidad and Tobago has been limited to small scale pilot projects. Two 2-kilowatt (kW) off-grid photovoltaic (PV) Systems have been installed at the University of Trinidad and Tobago and T&TEC’s Mt. Hope compound. Additionally, twenty-one 1-kW PV systems have now been installed at schools around the country. The first renewable energy project connected to the grid was a 2.5-kW PV and wind facility at the Islamic Children’s Home in South Trinidad which started operating in August 2012. Trinidad and Tobago does not have utility scale renewable energy generation capacity currently installed and non-fossil fuel generation is limited to small-scale wind and solar photovoltaic installations. Previous experience in Tobago with renewable energy systems comes from domestic installations and pilot projects on Government facilities (MEEA, 2016).

Tobago’s Energy Outlook

The sector with the larger electricity consumption in 2011 was the industrial sector with 60% of the sales translating into 4,825GWh. In second place was the residential sector with 29% of the sales, accounting for 2,412GWh. The commercial sector consumed a total of 773GWh, representing 10% of electricity sales. The final 1%, 109GWh, was consumed by other smaller electricity consuming activities such as street lightning (Inter-American Development Bank, 2016). Compared to electricity sales in 2001, the industrial sector decreased from consuming the 65.8% of the electricity produced, and the residential sector presented an increment from 24% to 29% over the same timeframe.

The country’s electricity system has a total percentage of losses of 7.4% by 2015, increasing from a 6.9% in 2014. The system’s performance was also improved by the decrease of values in indicators such as the System Average Interruption Frequency Index and the System Average Interruption Duration Index. In 2015, there were 35,265 pole-mounted transformers in service, and the number of transformers inspected exceeded the annual target of 20% from 2014 to 2015. In 2015, T&TEC had 461,700 customers, which represented a 2.4% growth from 2014. In 2015, the domestic class accounted for 88.4% of T&TEC’s customers, while the commercial, industrial and street lighting classes collectively accounted for 11.6%. (Regulated Industries Comission, 2017)

2.3 Goal or general development objective of the pilot project

General goal

The principle goal is to increase the awareness and use of high energy efficiency technologies in Tobago in line with the Intended Nationally Determined Contributions to climate change mitigation (INDC) of Trinidad and Tobago. By promoting the use of energy efficient lighting equipment in selected public buildings in Tobago, it will serve as demonstration to assist Tobago in transforming into a low carbon destination and it may bolster the nation’s tourism sector by serving to educate the traveler on how Trinidad and Tobago is playing its part to reduce its dependence on fossil fuels and contribute to mitigating climate change.

Project Objective

In line with topics mentioned in the country's INDC, the objective is to promote and demonstrate the energy and costs savings, and GHG emission reductions to be obtained by replacing old lightbulbs and other appliances with energy efficient appliances in select public buildings in Tobago, and highlight the secondary or indirect benefits as mitigation of climate change and other socio-economic and environmental benefits of utilizing LED lightbulbs and other energy efficient appliances in buildings.

Tobago as Pilot Project

The planned pilot project will be implemented in Tobago to showcase the potential for reducing the level of emissions currently associated with lighting in building spaces running on power originating from diesel generators on the island. Introduction and use of LED lightbulbs and other energy-efficient appliances will lead to measurable reductions in energy consumption and to improve the current levels of GHG emissions assessed under the climate diagnostic phase of the CCSIP program.

As an additional benefit of implementing the pilot project in Tobago is that it is an important touristic destination in Trinidad and Tobago, and through this pilot project the Tobago House of Assembly (THA) will be able to feature with collaboration of energy providers through a visual monitoring system, the performance of the new LED lightbulbs and other energy efficient appliances to visitors and island tours highlighting how the Government of Trinidad and Tobago is committed to promoting and demonstrating how energy efficient technologies can be deployed in a practical manner. Public schools, churches, social clubs, trade organizations as well as touristic hotspots in Tobago will be targeted as demonstration buildings.

Trinidad and Tobago's Tourism Industry

Tobago is a popular tourist spot in Trinidad and Tobago. The addition of energy efficiency or renewable energy technologies at popular tourist destinations in the country would help to further enhance the tourist experience especially eco-tourists by creating an additional topic of discussion for the tour guides and potential further engagement for additional investment and technical assistance.

- 2.4 Purpose or specific measurable objectives of the pilot project
- According to preliminary estimates focused on LED lighting only, the project envisions the selection, procurement, installation, and maintenance of an estimate of 2,725 energy efficient LED lightbulbs. These will be installed at selected public buildings on Tobago to measure and compare the current electricity consumption rates (kWh/month) and post installation of the high energy efficient appliances (kWh/month). The net electricity consumption reduction is converted into the amount of annual tons of CO₂-equivalent reduction using the Grid Emission Factor (GEF) calculated for Tobago.

2.5 Critical elements for achieving the measurable objectives of the pilot project

Energy Audits

Energy Audits will need to be performed in selected public buildings which includes preparing an inventory of existing/installed electric appliances (incl. description, power, category), measuring the electricity consumption, determining the number of impact areas, etc. This all is needed to have the baseline conditions described to allow for future comparative analyses.

Logistics

The available barges, their capacities, routes, and frequency of shipping. Delivery periods and deadlines for purchased LED lightbulbs and other energy efficient appliances.

Fiscal context and implications

There is a need to investigate the existing fiscal regime and determine the specific import tax applied to lightbulbs and other energy-efficient appliances entering Trinidad and Tobago.

Equipment Installation

To guarantee a smooth decommissioning of obsolete equipment and installation of the LED lightbulbs and other energy-efficient appliances at selected public buildings, the installation team (CCSIP Expert on Renewable Energy and Energy Efficiency) will ensure that all the tools and any auxiliary equipment is in place in Tobago prior to commencement of installation activities and work closely with identified and licensed technicians from Trinidad and Tobago government. Equipment options, such as the CFL Premium Bulb Eater Lamp Crusher for disposal of removed lightbulbs, have been considered as a possibility for disposal strategy for the complete project.

Training and Capacity Building

In close collaboration with the relevant stakeholder/s, the CCSIP team will prepare and execute training and capacity building in the operation and maintenance of the new energy-efficient appliances. This will contribute to continuous educational development of electricity technicians to increase their knowledge, skill and proficiency.

Outreach and Communications

The reduction in GHG emissions will be determined from the net energy consumption reduction post installation, keeping all other factors at the selected public building equal. With the assistance of T&TEC, monitoring tools, software, and visual tools could be developed to showcase the operational performance of the new appliances and accumulated energy savings / GHG emission reductions over time. These tools are proposed as part of further follow up activities to the pilot project. Sharing data and explaining the outcomes creates increased awareness among the population and visitors to Tobago.

- 2.6 Scope of the Pilot Project
- Scope of Work**
 Due to the available time frame and budget of the pilot project, not all public buildings will be served through this project. Therefore, a selection mechanism presented in **Appendix B**, will be used to objectively determine which buildings are suitable for replacement or installation of energy efficient appliances.
- Tendering Procedure**
 A tendering procedure has been designed where the CCSIP team oversees the planning of the installation and a local contractor in charge of providing the necessary equipment, installation and maintenance of the pilot project infrastructure at least for the 12 months guarantee after the end of the project implementation. See **Appendix C** for details.
- 2.7 Principal beneficiaries
- Direct beneficiaries**
 The THA, as owners and building managers of public buildings in Tobago where cost savings will be achieved and a positive effort to reducing GHG emissions demonstrated.
- Indirect beneficiaries**
 The people of Tobago, showing engagement into low-carbon solutions for tourist destinations and public services and the general population, the electricity utility, and the private sector, due to reduced electricity cost, export savings from the reduction in fuel imports, enhanced environmental conditions from the reduction in carbon emissions, and the availability of electricity for an isolated island such as Tobago. Also, the hotels and other accommodations, tour guides, and general visitors especially those who are interested in Eco/Green Tourism will appreciate these efforts.
- 2.8 Directly involved partners and their roles
- Critical strategic partners that are directly involved for the successful implementation of the pilot project include:
- CCSIP Project Implementation Team:** This team is composed of experts of the Consulting Team, which includes among other, an expert on Renewable Energy and Energy Efficiency.
- T&T Electricity Company (T&TEC):** As the local electricity provider, constant communication and collaboration with T&TEC will be valuable for the assessment of energy production and consumption on the island. T&TEC can also provide valuable insight regarding energy consumption trends for lighting purposes and contribute to the adequate monitoring of the installed equipment.
- Tobago House of Assembly:** Collaboration with representatives will be required as they will be able to provide the perspective of the local authority of the island, as well as a user perspective on the buildings where lightbulbs will be replaced. Working with the THA is key for the success of the pilot project since it is being proposed that lightbulbs are

replaced in buildings owned/occupied by THA and therefore this should be the entity taking over the operation of the pilot project.

Tobago Hotel and Tourism Association: Members of this group have presented great interest in the CCSIP project and including them in the development of the pilot project will provide opportunities for expanding these types of interventions to the private sector.

Environmental Management Authority: As the leading environmental regulatory body, the EMA is able to provide key information for the adequate installation, handling, maintenance and disposal of the equipment required for the pilot project. This institution can also provide information on the environmental effects that the energy industry has on the island, as well as the benefits of energy efficiency measures being implemented.

2.9 Other Partners involved and their respective roles

Other Institutional Partners

Other indirectly involved but also critical for a successful implementation of the pilot project are some key central institutions relevant to the energy sector in Tobago including the Ministry of Energy and Energy Affairs, Ministry of Planning and Development, and the Ministry of Public Utilities, as well as some other commissions and statutory bodies.

Electricity regulations are managed by the central government, and the THA is responsible for the definition of a utility coordination unit to coordinate local electricity supply. It is through this unit that the local authorities manage regulations set by government ministries.

Ministry of Energy and Energy Affairs: this ministry is responsible for national energy policies applicable to all power producers and fuel providers in Trinidad and Tobago. Their contributions can assure that the development of the energy efficiency pilot project follows all guidelines and regulations for the country.

Ministry of Public Utilities: it overlooks the T&T Electricity Commission, as well as the Regulated Industries Commission (RIC). The Ministry of Public Utilities works on the support of a modern and technological electricity sector that suits the demands and requirements of the nation's development.

The Ministry of Planning and Development oversees the National Framework for sustainable development. This Ministry can introduce policies to promote energy efficiency in businesses and households.

Local Inter-American Development Bank Office (IDB): The continuous updating and communications with the local IDB office in Trinidad and Tobago is critical for securing feedback and assistance in financial and administrative needs for the pilot project. Also, based on the implementation success of this pilot project IDB will explore opportunities



for financing the replication or upscale of this pilot project in other sectors and locations in Trinidad and Tobago.

3. Pilot Project Description

The pilot project’s main objective is to demonstrate the performance improvements and power and GHG reduction potential achieved by the replacement of conventional lightbulbs with high energy efficient LED lightbulbs in select public buildings in Tobago, Trinidad and Tobago.

Walkthrough lighting audits were performed, on Thursday 04 and 05 Friday May 2018, at a number of Government Buildings both in the day to determine the quantity and type of LED bulbs required and at night time to determine the use of the lighting after hours.

The implementation of this project will demonstrate the following:

- (1) The energy savings and GHG reductions achieved by replacing conventional lightbulbs with high energy efficient LED lightbulbs.
- (2) The energy savings and GHG reductions achieved by introducing behavioral change and increased awareness of light use patterns.
- (3) To showcase how this and similar projects can properly dispose of the old bulbs.

4. General Plan of Action

4.1 Expected Results

Result 1	Obtain a pre-cleared implementation plan for the pilot project
Result 2	Selection of buildings for the pilot implementation among pre-identified public buildings in Tobago
Result 3	Confirm the pilot project scope
Result 4	Secure buy-in and partnerships
Result 5	Pilot Project implementation
Result 6	Build capacity in the adequate use of the newly installed high energy efficient lighting
Result 7	Equipment performance and maintenance report (3-months post installation) and final hand-over.

4.2 Project Activities

Result 1	Obtain a pre-cleared plan of action for the pilot project
Activity 1.1	Prepare a first draft Project Manual for the implementation of the pilot project to present to stakeholders.
Activity 1.2	Set up a multi-stakeholder meeting together with the Tobago House of Assembly (THA) to elaborate about the pilot project's objectives and scope.
Activity 1.3	Determine the timing and requirements for effective site visits to Tobago during the implementation phase of the pilot project.
Activity 1.4	Address any pre-identified data or information gaps, technical or equipment needs to facilitate the site visit and address any other project management needs.
Activity 1.5	Share the updated Project Manual with the IDB and THA for clearance of the implementation plan.
Result 2	Selection of buildings for the pilot implementation among pre-identified public buildings in Tobago
Activity 2.1	Determine from literature and interviews with the THA and other local stakeholders the amount, type and locations of public buildings in Tobago.
Activity 2.2	Organize a multi-stakeholder meeting to gather all key stakeholders to present the draft Project Manual and plan of action to secure the buy-in as official implementation partner and pre-identify candidate public buildings to host the pilot project.
Activity 2.3	Pre-identify the building managers and establish formal contact through the THA to make appointments for site visits and schedule meetings for the Consulting Team.
Activity 2.4	Prepare any data request sheets and data gathering tools and instruments, e.g. excel sheets and forms to be filled out prior or during the site visits by the building managers.
Activity 2.5	Perform a site visit at pre-identified public buildings in Tobago to gather first hand data and information about the general conditions, light bulbs used and lighting needs.

- Activity 2.6 Perform a data analysis and prepare an inventory of the number and type of light bulbs currently being used, the general building conditions, and the current performance of the installed and operated light bulbs.
- Activity 2.7 Process all the gathered data and info and prepare a detailed mission report that includes information, data, and observations to determine the suitability of the pre-identified public buildings to be selected for the implementation of the pilot project.

Result 3 Confirm the pilot project scope

- Activity 3.1 Exchange findings among THA, the IDB, and the Consulting Team to assess findings, conclusions and recommendations from the site visit (mission report).
- Activity 3.2 Request quotations and prepare detailed implementation plan and budget.
- Activity 3.3 Prepare, review and confirm the Plan of Action for the pilot project implementation.
- Activity 3.4 Update the Pilot Project Manual.
- Activity 3.5 Identify, secure feedback, and determine the suitable partnerships to support and obtain the established objectives for the pilot project.
- Activity 3.6 Address any pre-identified data, technical, or equipment needs to facilitate the project implementation.

Result 4 Secure buy-in and partnerships

- Activity 4.1 Actively reach out to the identified partners and present the updated Project Manual of the pilot project to request the formal buy-in and collaboration (expressed in Letters of Participation) and indication of their potential in-kind contribution to the pilot project.
- Activity 4.2 Secure the formal documentation for the formal hand-over/donation of the purchased and installed equipment with the principal beneficiary (THA) for maintenance post implementation phase.

Result 5 Implement the pilot project

- Activity 5.1 Carry out additional research and prepare a detailed implementation plan to be executed by the project team in cooperation with stakeholders in Tobago.
- Activity 5.2 Identify potential equipments providers and request quotations to prepare detailed budget
- Activity 5.3 Purchase, order and ship HEE light bulbs and ancillary equipment to Tobago.
- Activity 5.4 Request tax exemption for HEE light bulbs and ancillary equipment.
- Activity 5.5 Secure monthly utility bills for all selected public buildings to perform baseline performance assessment.
- Activity 5.6 Establish procedure regarding the proper disposal of old light bulbs.
- Activity 5.7 Pilot project implementation - including customs clearing, shipping to Tobago, and physical installation of LED units, and responsible disposal of old light bulbs in Tobago.
- Activity 5.8 Commissioning of the new HEE lighting in Tobago.
- Activity 5.9 Official inauguration of pilot project with THA + Launch of Outreach Program CCSIP

Result 6	Create awareness and build capacity in the adequate use of the newly installed high energy efficient light bulbs
Activity 6.1	Determine Scope and Timing of Training
Activity 6.2	Prepare a capacity building and training program.
Activity 6.3	Implement the capacity building and training program.
Activity 6.4	Capacity building and training program evaluation and capitalization.
Result 7	Equipment performance and maintenance report (3-months post installation) and final hand-over
Activity 7.1	Set up and use of the MRV system for the project
Activity 7.2	Monitor, gather and process data collected (3 months)
Activity 7.3	Draft Performance Report
Activity 7.4	Draft Final Report (CCSIP Component 1)
Activity 7.5	Official hand-over of the pilot project to the Tobago House of Assembly.

5. General Project Chronology

Starting date: 06 July, 2017

	Months (2017)						Months (2018)												(2019)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
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6. Pilot Project Output, Replication, Added Value and Sustainability

- 6.1 Main expected Project Outputs/Deliverables
1. About **+600** High Energy Efficient LED lightbulbs installed at selected public buildings in Tobago by **September 2018**;
 2. At least **20** people trained through a practical experience when installing the LED lightbulbs by **October 2018**; and
 3. A final installation and performance report of the LED lightbulbs installed at selected public buildings in Tobago (based on a 3-month maintenance and monitoring cycle), including a complete technical description of the lightbulb units by **January 2019**.
- 6.2 Other programs and projects linked to this project and the level of cooperation
- According to the IDB project data base, there have been programs directed towards sustainable development of the energy sector in the country. None of the projects are uniquely directed towards the topic of energy efficiency in lighting. However, energy efficiency is one of the topics considered in some projects:
- TT-L1027: Support to the preparation of the Sustainable Energy Program.
 - TT-L1023: Sustainable Energy for Trinidad and Tobago. Caribbean Hotel Energy Efficiency Action Programme (CHENACT)
- 6.3 Applicable monitoring and evaluation method
- It is expected that the Project will be monitored under the supervision of the THA. Evaluation shall consist of in-country visits, discussions and interviews with relevant government and private sector officials, various partners and stakeholders, beneficiaries of the project, and building managers where the LED lightbulbs and other energy efficient appliances are installed.
- A Monitoring, Reporting and Verification (MRV) System has been designed for the adequate analysis of the development and performance of the pilot project in terms of GHG emission reductions. This information is detailed in **Appendix D**.
- In addition, online/off-site monitoring capabilities may be incorporated in design. In partnership with the government, online monitoring of instant system performance will facilitate the monitoring and evaluation of the lightbulbs' performance and better determine results of the pilot project.
- 6.4 The general social, economic and environmental implications of the pilot project
- Socio-Economic and Environmental advancements**
- This project is at the outset considered economically sustainable. Support for this assertion can be found in an examination of CBA and CEA analyses performed under the climate diagnostic phase of the CCSIP program.
- This pilot project will have a positive effect on Trinidad and Tobago by promoting the improvement of environment and the economic advancement by reducing fossil fuel consumption. Promoting and

facilitating access to sustainable and energy efficient technology, increase energy security, capacity enhancement, and income generation through job creation.

Handling and Disposal of old appliances

An environmental management guideline or action sheet will be sourced in coordination with the EMA to determine how the obsolete appliances are best handled and disposed of. Data must be recorded of each lightbulb regarding the type and power requirements. Disposal of old lightbulbs will be considered among the project activities to avoid further fugitive emissions.

6.5 The potential for ownership, replication and upscaling

Ownership and Replicability

Given that appliances are modular more energy efficient appliances can be deployed upon need making this pilot project replicable in most grid-connected and off-grid locations in Tobago and other Caribbean countries, where the cost of electricity is unusually high, and where the effects of peak oil and climate change will be felt more strongly in the future, resulting in greater social and economic impacts.

The maintenance requirements for this pilot project include the monitoring of operation on a periodic basis, but not needing to be frequently. Another activity would be revision for broken appliances requiring replacement.

A clear straightforward manual or instructions will be prepared to enforce a habit of use of the newly installed appliances. This includes instructions regarding the turn on/off moments, use duration, other improvements necessary in the buildings (isolation) to increase the performance in the building.

With the institutional commitment from the THA and other public agencies to support such initiatives, the sustainability of this pilot project can be guaranteed once the formal commitments of each is secured to own and carry forward the operations and maintenance of the installed equipment.

Upscale potential

The upscale potential of this project is high, as the replacement of electric appliances does not require highly specialized or trained personnel to perform the installation. Also, it is considered as a low hanging fruit opportunity for many building owners in Tobago beyond the public sector buildings. The threshold for building owners to invest in high efficiency lighting is considered low compared to other assessed climate change mitigation options.

During the Climate Diagnostic phase of the CCSIP Program the upscale potential of this pilot project is assessed for the time frame 2017 – 2030 which can result in the following outputs:

- 100% lighting in Tobago replaced by LED lightbulbs
- Total benefit: 4,574,732.81 USD
- Total cost: 1,047,799.67 USD
- Payback period: 2.42 years
- GHG savings in 2030: 271,64.82 t CO₂
- Cost-effectiveness by 2030: -129.83 USD / t CO₂

Training and Capacity Building

Next to the purchase and installation of the LED lightbulbs as well as the other energy efficient appliances, capacity building workshops are planned to train stakeholders to understand why the shift is beneficial to the environment and cost of electricity. This element of the pilot project will be performed in close collaboration with the THA. Where training and capacity building in the operation and maintenance of the new energy efficient LED lightbulbs will be provided.

- 6.6 Any other information deemed relevant for this pilot project
- Critical factors impacting the potential for scale up of this pilot project are linked to the existing regulatory framework, as the fiscal regime. To have a wide scale adoption of high efficiency equipment and appliances incentive and reward mechanisms should be explored and applied to energy efficient lightning technology and other commonly used appliances in buildings, to incentivize and enable building owners to make the step of purchasing and shipping high efficiency appliances to be installed on Tobago. Intervening in the existing regulatory framework falls outside the scope of this pilot project.

7. Implementation Plan

In order to maximize the energy savings to be obtained from this pilot project, the following activities will be performed:

- (a) Retrofit all existing incandescent and florescent lights to Light Emitting Diode (LED), please see **Appendix D** for the technical specifications.
- (b) Retrofit some existing HPS 175W floodlights to Light Emitting Diode (LED) bulbs. Refer to **Appendix D** for the technical specifications.

Another important aspect of this project is the disposal of the old bulbs. As such a bulb crushing equipment is sourced for the island administration and together with the DEHS propose a system for the future disposal of old bulbs.

All selected public buildings on Tobago will have some of their bulbs changed to LEDs – see **Appendix E** for results of the Lighting audit.

7.1 Interventions at Selected Public Building

- | | | |
|-----|--|---|
| 1.1 | Tobago Emergency Management Agency | I. Supply and install one hundred (100) LED 18W tubes (4 feet each).
II. Replace three (3) HPS 175W lamps. |
| 1.2 | Customs Building | I. Supply and install forty-four (44) LED 36W tubes (8 feet each).
II. Supply and install eighteen (18) LED 18W tubes (4 feet each). |
| 1.3 | Division of Health Wellness and Family Development-Public Health Services Department | I. Supply and install sixteen (16) LED 36W Tubes (8 feet each)
II. Supply and install one hundred and twenty (120) LED 18W tubes (4 feet each)
III. Supply and install three (3) 100W LED Floodlights |
| 1.4 | THA Chief Secretary Administration Complex | I. Supply and Install three hundred (300) LED 18W tubes (4 feet each). |
| 1.5 | Supply of Spare lamps | I. Supply a total of ten (10) 18W LED Tubes (4 Feet) |

A summarized Scope of Works will include the following:

- (a) Supply and installation of 548 LED 18W tubes (4ft each)
- (b) Supply and installation of 60 LED 36W tubes (8 feet each)
- (c) Replacement of 6 HPS 175W lamps to LED bulbs
- (d) Purchase of bulb crushing and disposal machine to dispose of used bulbs

7.2 Project Implementation

The pilot project will be executed as follows:

- (i) Project team purchases the lamps and accessories directly from reputable suppliers, all in accordance with specifications.

- (ii) Ship lamps and accessories consigned to local administrators.
- (iii) Project Team/IDB will request duties and tax clearance
- (iv) Employ a certified electrician and assistant on Tobago to install lamps.
- (v) Have the CCSIP EE Expert supervise the installation process including the measurement of lighting levels and perform the necessary de-lamping.
- (vi) Develop bulb disposal methodology and instruct local administrators on correct procedure and use of bulb disposal equipment.
- (vii) Monitor energy bills for a few months after retrofit is completed to determine the benefits of the process.

This energy efficient lighting project **is expected to save about 40% of the energy consumed** by lighting at Government Buildings which could be **approximately 10% of the total energy consumed**. The actual amount could not be determined because the utility bills have yet to be received. Once the actual bills for the various buildings are obtained the energy savings will be estimated based on the lighting retrofit.

The project implementation is planned to take approximately four (4) months, as follows:

(a)	Request for quotation for bulbs (Completed)	1 weeks
(b)	Request for bulb crusher quotation (Completed)	3 weeks
(c)	Payment of suppliers for equipment	3 weeks
(d)	Delivery of bulb	5 weeks
(e)	Delivery of bulb crushing machine	5 weeks
(f)	Contract certified electricians	3 weeks
(g)	Installation of LED lamps	3 weeks
(h)	Monitoring of lamps performance and energy consumption	16 weeks

8. Pilot Project Budget

Based on the Plan of Action, a detailed budget is set up. This budget includes all costs related to the purchase, shipping and landing costs of equipment, the installation, and commissioning. See budget as follows (VAT inclusive as no exemptions were made).

Description	Qty.	Unit Cost (US\$)	Cost (US\$)	Import Duty (20%) (US\$)	Brokerage (US\$)	Value Add Tax (12.5%) (US\$)	Landed Cost (US\$)
S&I 748 – 18W LED Tubes (4 feet)	548	14.71	8,059.00			1,007.42	9,066.74
S&I 104 – 36W LED Tubes (8 feet)	60	36.79	2,208.00			275.95	2,483.56
S&I 16 - 100W LED Floodlights	6	196.88	1,181.00			147.66	1,328.91
S&I bulb crushing machining	1	7,724.00	7,724.00	1,544.80	386.20	1,206.88	10,861.88
Employment of certified technician	1		2,000.00				2,000.00
Employment of electrical technician	1		1,200.00				1,200.00
Miscellaneous materials for installation	Sum		1,000.00				1,000.00
TOTAL US\$			23,372.00	1,544.80	386.20	2,637.90	27,941.08

Appendix A: Validation Workshop Participants

Date: July 06, 2017

Participant list:

- Head of the Water and Sewage Authority – Tobago (WASA): Mr. Peter Hackett
- President of the Tobago Hotel and Tourism Association (THTA): Mr. Christopher James
- Tobago House of Assembly (THA) – Environment Division: Mr. Howard Robin
- Tobago House of Assembly (THA) – Environment Division: Mrs. Crystal Lawrence
- Environmental Management Authority (EMA): Mrs. Gillian Stanislaus
- IDB: Gerard Alleng and Priya Ramsumair
- CCSIP Project Team: Kevin de Cuba and Iker Larrea (remotely)

Appendix B: Host Selection Process

Selection Criteria:

As pre-condition, the project's scope is limited to working with public sector entities and related buildings. This reduces the scope among the selected buildings supported by the Tobago House of Assembly. It is not clear whether among the remaining buildings on the island, there are government owned, ran, or subsidized buildings.

To make a final selection of the buildings where interventions will take place the following criteria are established:

1. The building is a publically owned, ran or subsidized building;
2. The lightbulbs used presently at the building are categorized as conventional lighting technology;
3. The lightbulbs used are in line with the purpose or function of the building (e.g. office hours, school hours, or other regularly expected activities);
4. The building ownership or lease duration should have a validity of at least five (5) years;
5. The public entity or government supported organization needs to have the required financial capacity to guarantee the adequate operation of the LED lightbulbs and have no outstanding debts or utility bills payments pending;
6. The host building manager should share all pertinent utility bills and costing information to enable the Consulting Team to prepare a building envelop profile (e.g. assessing the electricity consumption, the CO₂ emissions, etc. per building);
7. The host building manager should be willing and able to allow Consulting Team members to enter the premises for an initial inspection and audit of the energy consumption profile of the building;
8. The host building manager should be willing and able to periodically share data and statistics of the new lightbulbs' performance for monitoring and evaluation purposes;
9. The building owner or manager commits to hand over the old conventional lightbulbs to a pre-identified organization for the collection and responsible handling of the conventional lightbulbs of Tobago.

Method:

Step 1 – Site Visits

A site visit will take place where the Consulting Team accompanied by the principal Focal Point and representatives of the Ministry of Tourism, will visit all the locations or buildings pre-identified as public buildings. The Energy Efficiency Expert (EEE Expert) will perform a site visit and a quick scan analysis of the conditions of the buildings (to take the measures of the dimensions of the areas and spaces to be illuminated); determine the number and type of lightbulbs installed; gather information about the use and performance of the lightbulbs; assess the accessibility to the lightbulbs for dismounting, mounting of the new lightbulbs, and future maintenance needs; and gather any other data and observations to determine the suitability of the building to become a candidate to be included in the pilot project.

Step 2 – Data Analysis

Upon return to the office, the data gathered per pre-identified public building during the site visits will be processed into a mission report which will contain an inventory of the number and type of lightbulbs currently being used, also preliminary conclusions and recommendations regarding the general building conditions and the current performance of the installed and operated lightbulbs are shared. This will result in a baseline or reference data for future comparative analysis upon replacements of the conventional lightbulbs with the high energy efficient LED lamps.

Step 3 – Screening of buildings based on selection criteria

The buildings and lightbulbs inventory gathered from the site visits will serve as a database for follow up emails and contact with building owners or managers to verify their compliance with the established selection criteria. Based on the process, the number of candidate buildings will be filtered down to the selected ones that comply with the criteria.

Step 4 – Determining the buildings and lightbulbs that require replacement

Based on the selection of the buildings that comply with the established criteria in combination with the pilot project budget, and other factors, clarity is achieved regarding which buildings, and the number of related lightbulbs will require replacement. This serves as needed information to purchase and order the adequate number of high energy efficient LED lightbulbs to achieve cost-effectiveness.

Appendix C: Specific guidelines for GHG emission reduction calculation and MRV

This document is an Annex to the Project Manual to implement the afore described project in Tobago, Trinidad and Tobago. Its objective is to provide guidelines to estimate the GHG emissions reduced by the pilot project during the implementation phase, and to establish procedures related to the Monitoring, Reporting and Verification (MRV) of the GHG emission reductions achieved.

The GHG emission reductions will be calculated, monitored and reported in line with the general guidelines for GHG emission reduction calculation and MRV under the CCSIP.

Applicable Carbon Methodology

The selected methodology corresponds to AMS-II.E.: Energy efficiency and fuel switching measures for buildings - Version 10.0.

Scope of the GHG emission reduction calculation

Geographical scope: Project Boundary

The geographical boundary is represented by the geographical limits of Tobago as an Island. The physical boundaries of the project are represented by the physical space of the building where the energy efficient LED lightbulbs will be installed.

Material scope: GHG covered

The project will cover GHG emission reductions from all gases, sectors and source categories listed in Annex A to the Kyoto Protocol. The project will therefore express GHG emission reductions in tonne CO₂ equivalent (t CO₂e).

Temporal scope: Crediting Period

The project will consider a crediting period of 8 years, which is the expected lifetime of the new equipment installed.

GHG Carbon Emission Reduction Calculation Procedure

The baseline scenario will consist of the energy use of the existing equipment that is replaced in the case of retrofit measures and of the facility that would otherwise be built in the case of a new facility. Each energy form in the emission baseline is multiplied by an emission coefficient.

An excel calculation tool will serve as supporting documentation for the baseline and projected GHG emission reductions of the project. Baseline and Project emissions will be calculated through statistical analysis based on the energy requirements for the substituted equipment and the new installed equipment. The following list presents the required information to be collected:

- Equipment energy requirements (kW) – technical specification of the technology for optimal performance of the equipment.
- Active daily time (hours) – number of hours per day that the equipment is used.
- Active days a year (days) – days per year that the equipment is used in the physical space of the project activity.

Calculations for the total energy consumption of the equipment will be performed with the following formula:

$$\text{Activity Data} = \text{ED} * \text{AH} * \text{AD}$$

Where:

- Activity Data: energy consumption.
- ED: energy demand of the technology.
- AH: active daily hour use.
- AD: active day use per year.

Monitoring, Reporting and Verification (MRV)

The GHG emission reductions achieved through the project activity will be determined based on the electrical energy reduction from the energy efficiency measures taken in the building.

The parameters to be considered during the monitoring and reporting phase are the following.

Data / Parameter	EBA
Unit	MWh/year
Description	Electricity consumed by the LED lamps in the project building in the baseline scenario.
Measurement methods and procedures	An energy simulation will be done for the lightbulbs of the baseline building. The specifications of the lightbulbs for the baseline building have been provided previously.
Monitoring frequency	Monthly with the inclusion of the implementation period of the pilot project
Purpose of data	Computation of Baseline emissions

Data / Parameter	EPA
Unit	MWh/year
Description	Electricity that would have been consumed by the lightbulbs in the project building in the project activity scenario.
Measurement methods and procedures	Data type: Measured Archiving policy: Paper and electronic Responsibility: Maintenance Engineer Calibration frequency: Annually
Monitoring frequency	Monitoring frequency: Daily and aggregated monthly Monthly
Purpose of data	Computation of projected emissions

Reporting will cover the GHG emissions and GHG emission reductions of a given calendar year and will be carried out in a reporting format to be prepared by the consultant.

Following CDM standards on sampling, 245 lightbulbs in the project will be monitored. This will require filling a questionnaire for each installation. The information gathered will be cross-checked with the initial GHG emission reduction calculation.

Guidelines for GHG emission reduction calculation and MRV

Approved Carbon Methodologies The calculation of the GHG emission reductions will be based on an approved methodology for project activities under the Clean Development Mechanism (CDM) of the United Nations Framework

Convention on Climate Change (UNFCCC). A complete list of the approved methodologies (together with general reference, tools as well as outreach materials such as the CDM booklet) is available at <http://cdm.unfccc.int/methodologies/index.html>.

Small Scale Methodologies

As a general rule, the GHG emission reduction calculations will benefit from existing small-scale methodologies (SSC CDM methodologies). According to paragraph 6(c) of decision 17/CP.7 [year 2001], as amended by 1/CMP.2, paragraph 28 [year 2007], the updated small-scale project types are as follows: type (i): renewable energy project activities with a maximum output capacity equivalent to up to 15 megawatts (or an appropriate equivalent); Type (ii): energy efficiency improvement project activities which reduce energy consumption, on the supply and/or demand side, by up to the equivalent of 60 gigawatt hours per year; and type (iii): other project activities that both reduce anthropogenic emissions by sources and directly emit less than 60 kilotonnes of carbon dioxide equivalent annually (17/CP.7, paragraph 6(c) as amended by 1/CMP.2, paragraph 28)³.

Scope of the GHG emission reduction calculation

Geographical scope: Project Boundary

The boundary shall be limited to the physical project activity. Project activities that displace energy supplied by external sources may claim GHG emission reductions associated with the reduced supply of energy by those external sources.

Material scope: GHG covered

The project will cover GHG emission reductions from all gases, sectors and source categories listed in Annex A to the Kyoto Protocol. The project will therefore express GHG emission reductions in tonne CO₂ equivalent (t CO₂e).

Temporal scope: Crediting Period

The project will calculate the GHG emission reductions of each for a set crediting period. The total GHG emission reductions achieved by the mitigation measure will consider a crediting period in line with the lifetime of the new equipment installed.

GHG Carbon Emission Reduction Calculation Procedure

Subject to the specific provisions established by the selected CDM methodology, the GHG emission reduction will be calculated applying the following formula:

$$ER_y = BE_y - PE_y$$

³ The definition of “maximum output capacity equivalent of up to 15 MW (or an appropriate equivalent)” and other additional guidance is provided by the general guidelines to SSC CDM methodologies. http://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid06.pdf

Where:

ER_y: Emission Reduction in year y in (t CO₂e)

BE_y: Baseline Emissions for the year y (t CO₂e)

PE_y: Project Emissions for the year y (t CO₂e)

BE or the baseline is a hypothetical reference case representing the volume of GHG that would have been emitted if the project were not implemented. PE or project emissions represent the actual volume of GHG emission inside the project boundary. The calculations of the baseline and the project emissions may keep decimals, but GHG emission reductions will be rounded down and will be given in integer figures.

The GHG emissions of the baseline scenario and the project scenario (project emissions and leakage) will be calculated applying the following formula:

$$t \text{ CO}_2\text{e} = t \text{ CO}_2 + t \text{ CH}_4 + t \text{ N}_2\text{O}$$

Where:

t CO₂ is the amount of carbon dioxide measured in metric tonnes

t CH₄ is the amount of methane measured in metric tonne of carbon dioxide equivalent (t CO₂e)

t N₂O is the amount of nitrous oxide measured in metric tonne of carbon dioxide equivalent (t CO₂e)

GHG emissions related to fuel combustion will be calculated applying the following formula:

$$t \text{ GHG} = \text{Activity data (TJ)} * \text{EF (t GHGI/TJ)} * \text{GWP}$$

Where:

Activity data is the amount of energy measured in Tera joules (TJ). This value will be product of the amount of fuel combusted (physical units) multiplied times the Net Calorific Value.

EF or emission factor is the average emission rate of a given GHG per unit of energy.

GWP are the Global Warming Potentials are the conversion factors for non-CO₂ GHG to CO₂ equivalent, as published by Climate Change 2007: Working Group I: The Physical Science Basis (1 for carbon dioxide or CO₂, 25 for methane or CH₄, and 298 for nitrous oxide or N₂O).

GHG emissions related to electricity will be calculated applying the following formula:

$$t \text{ CO}_2 = \text{Activity data (MWh)} * \text{GEF (t CO}_2\text{/MWh)}$$

Where:

- Activity data is the amount of electricity measured in megawatt hours (MWh).
- GEF will be the Grid Emission Factor calculated during the development of each GHG Inventory: 0.878 t CO₂e per MWh for projects located in Caye Caulker (simple operating margin of Caye Caulker's isolated grid, based on 2013-2015 data), 0.7704 t CO₂e per MWh for projects located in Harbour Island (grid emission factor of Eleuthera), and 0.684 t CO₂e per MWh for Tobago (simple operating margin of Trinidad and Tobago's national grid emission factor, based on 2010-2013 data).

Monitoring, Reporting and Verification (MRV)

Monitoring and Reporting

Final beneficiaries (i.e. the public institution which will be entrusted with the long-term maintenance and operation of the project) will be requested to report GHG emissions and GHG emission reductions to IDB for three years after project completion. Reporting will cover the GHG emissions and GHG emission reductions of a given calendar year and will be carried out in a reporting format to be prepared by the consultant.

The UNFCCC Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities will determine the sample size. According to Simple Random Sampling methodology, for a total of 2,530 lightbulbs installed, the size of the sample for the MRV system corresponds to 245 lightbulbs⁴.

Verification

No third-party verification is envisaged under the CCSIP.

⁴ https://cdm.unfccc.int/Reference/Guidclarif/meth/meth_guid48.pdf

Appendix D: Equipment Specification

3	18W Clear	288	17.8	1670 (220V)	0.085A	0.94	5750K	93.8
			17.8	1714 (250V)	0.077A	0.92	5756K	96.3
4	18W Frosted	288	18	1623 (250V)	0.078A	0.91	5745K	90.11
Test Temperature		25C						
Test Humidity		65%						
PCB working voltage		DC38.4V						
Light source		SMD3528						
Power supply		Isolated						
Type of PCB		AL						
Size		Ø 26mm *1200mm						
LED's Qty 288 PCS		12 series 24 connections						
LED's Qty 240 PCS		12 series 12 connections						
Input Vol / Operating Frequency		AC100-290V / 50-60Hz						
Working current		16W CC:400MA±5% 18W CC:450MA±5%						

Lighting type_ Led reflector

- Exterior projector LED MICROLED
- Powerful and maximum energy efficiency.
- Aluminum housing
- Suitable for exterior use
- 50.000 hours of life
- Luminous flux: 9000lm
- Frequency: 50 / 60Hz
- Degree of protection: IP65. Weatherproof, dust, rain and wind.
- CRI70



Technical information

Mounting	Dimensions	Watts	Tonality	Voltage	driver
• Exterior	• L-365mm x 285mm A- x 100mm	• 100W LED	• 6500K	• 90V-305V	• Light Source

Appendix E: Lightbulbs Inventory (May 2018)

Results of the lightbulbs counting during the building walk-throughs on Thursday and Friday, May 03 and 04, 2018 in Tobago, Trinidad and Tobago.

Buildings	10W	4 FT Tube	8 FT Tube	175W	2 FT	125W
TEMA	0	100	0	3	0	0
Customs	0	18	44	0	2	0
Public Health	0	120	16	3	0	0
THA Admin	167	300	0	0	0	0
TOTAL	248	538	60	6	2	0