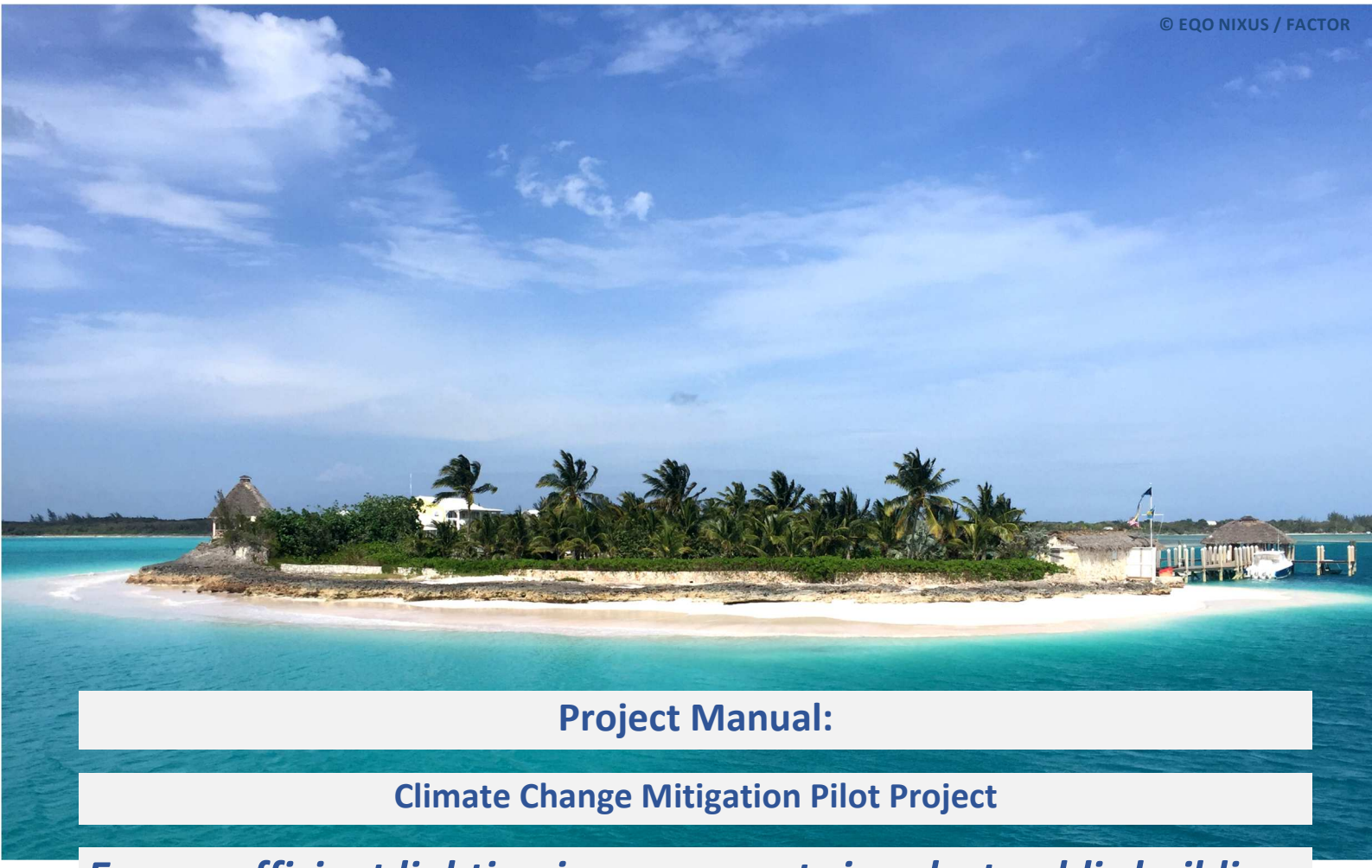

Project Manual:

Climate Change Mitigation Pilot Project

Energy efficient lighting improvements in select public buildings in Harbour Island, Bahamas

***Updated* AUGUST 2018 (FINAL)**

RG-T2543 - Caribbean Climate Smart Islands Program

IDB Reference Number # IDB511-04/15

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Acronyms

BBSQ	Bahamas Bureau of Standards and Quality
BEST	Bahamas Environmental, Science & Technology Commission
BPL	Bahamas Power & Light
CBA	Cost-Benefit Analysis
CEA	Cost-Effectiveness Analysis
CCSIP	Caribbean Climate Smart Islands Program
DEHS	Department of Environmental Health Services
GEF	Grid Emission Factor
GHG	Greenhouse gas
GWP	Global Warming Potential
HEE	High Energy Efficient
HIA	Harbour Island Administration
IDB	Interamerican Development Bank
LED	Light Emiting 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

1. General Information

1.1	Name of Project	Energy efficient lighting improvements in select public buildings in Harbour Island
1.2	Beneficiary country	Harbour Island (Bahamas)
1.3	Project duration	23 Months (April 2017 – February 2019)
1.4	Starting date	April 11, 2017
1.5	Project value (US$)	$38,060 (Includes both financial and in-kind contributions)
	CCSIP/IDB (US$)	$29,476,20(Includes financial contribution)
	Co-share (US$)	$10,000 by the Ministry of Tourism (in-kind)
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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 GHG emission reduction measure in Harbour Island, Bahamas.

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 the Bahamas, and more specifically from Harbour Island.

On April 11, 2017, a multi-stakeholder meeting was held at the Office of the IDB in Nassau, to review, validate and select the pilot project for Harbour Island. The consultation meeting was attended by critical stakeholders including the Ministry of Tourism, the Bahamas National Trust, the Ministry of the Environment, the BEST Commission, the Civil Aviation Department, and the Road Traffic Department. A participant List of the validation workshop can be consulted in **Appendix A**.

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 Harbour Island (**EN-01 Energy efficient lighting improvements**) to reduce electricity consumption and thereby reduce GHG emissions.

Through the application of a cost-benefit analysis, a cost effectiveness analysis, and a multi-criteria analysis, this GHG mitigation option (EN-01) scored the highest when combining all categories. Replacement of old incandescent light bulbs with HEE light bulbs (LEDs) has a very short payback period of 1.02 while resulting in the highest Net Present Value (NPV) among 10 different GHG mitigation options assessed. Other criteria taken into account in the overall multicriteria analysis, included (1) alignment and coherence with domestic Policy Framework, (2) GHG Emission Reduction Potential, (3) technological and financial feasibility, (4) social / political / institutional / regulatory viability, (5) no regret, (6) sustainable development benefits and secondary effects, (7) climate proofing and adaptation co-benefits, (8) synergy with other IDB interventions, (9) maintenance requirements and government willingness to ensure maintenance, and (10) urgency / implementation period.

Additionally, the team explored the possibility to broaden the scope of the pilot project to include not just light bulbs, also motion sensors and other solutions for efficiency improvements. The project scope was also subject to the budget and time limitations.

2.2 Background and Justification of the pilot project

Harbour Island's Energy Production and Consumption

Electricity consumed in Harbour Island is generated on the neighboring island of Eleuthera and is supplied to the island through two different submarine cables. The grid connected islands fall under the responsibility of the Bahamas Power & Light (BPL). Eleuthera's present installed capacity is 20.85 MW with a total of 60 miles distribution system running from Bannerman Town in the south up to the Current in the north, including Harbour Island. In addition, there is about 6MW of installed stand-by diesel generation capacity in Harbour Island under operation by the BPL.

Cost of Electricity

Like many island nations, the Bahamas is almost 100% reliant on imported fossil fuels, leaving it vulnerable to global price fluctuations that directly impact the cost of electricity. In line with the caribbean average, the estimated commercial cost per kWh of electricity in 2015 was $0.32 USD (NREL, 2015).

Renewable Energy Development

In Bahamas, renewable energy technologies such as solar water heaters (SWH) and photovoltaic (PV) systems remain unexplored, but present as a potential opportunity for diversification of the energy matrix. In line with the National Energy Plan 2013 to 2033 and the Electricity Act 2015,

BPL has begun authorizing residential grid-tied solar energy production with net-metering and is actively considering utility scale solar potential.

The Bahamas's NDC sets an economy-wide GHG reduction target of 30% when compared to its Business as Usual scenario by 2030. To meet that target, and given the nation's dependence on fossil fuels, the NDC refers to the National Energy Policy, which in turn sets a target to achieve a minimum 30% renewables in the energy mix by 2030, including a 10% Residential Self Generation Programme. More precisely, the Bahamas' NDC refers to the transition from a high dependence on petroleum to an increased presence of indigenous renewable energy from solar, ocean and wind resources (Ministry of Works & Urban Development, 2013) (The Government of The Bahamas, 2016). This renewable energy target is aligned with the Second National Communication to the UNFCCC, where the Bahamas indicated the vision of the development and implementation of sustainable energy opportunities, by aggressively re-engineering its legislative, regulatory, and institutional frameworks (The Commonwealth of The Bahamas, 2014). On March 1, 2017, BPL announced the recommencement of the country's Small Scale Renewable Generation (SSRG) program. The Renewable Energy Self-Generation Program was established in May 2015 but suspended in November 2015 due to changes from the energy sector reform process.

Harbour Island's Energy Outlook

According to the data collected in the initial GHG inventory for Harbour Island, the main electricity consumption source were the hotels. There are incentives regarding the import of energy efficient appliances and products. There is a listing of eligible energy efficient appliances as HEE lightbulbs and other types of appliances that are import duty exempt. It is believed by many stakeholders that there are plenty of opportunities to reduce power consumption by simply making behavioral changes and make lifestyle changes. In general, the Bahamas' Electricity Actestablished in January of 2016 the Utilities Regulation and Competition Authority (URCA) as country's power sector regulator, assuming responsibility for all activities related to generation, transmission, distribution and electricity supply. The Bahamas is enacting energy efficiency support mechanisms such as appliance labeling standards, tax credits and national energy efficiency standards suggested in the C-SERMS, 2015.

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 Harbour Island in line with the Nationally Determined Contributions to climate change mitigation (NDC) of the Bahamas. By promoting the use of energy efficiency lighting equipment in selected public buildings in Harbour Island, it will serve as demonstration to assist the Bahamas' transform in an eco-tourism destination. It may also bolster the nation's tourism sector by serving to educate the traveler on how the Bahamas is playing its part to reduce its dependence on fossil fuels and contribution to mitigating climate change.

Project Objective

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

Harbour Island as Pilot Project

The pilot project is implemented in Harbour Island to showcase the potential for reducing the level of emissions currently associated with lighting in building spaces running on power from fossil fuels. Introduction and use of LED lightbulbs will lead to measurable reductions in energy consumption and 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 Harbour Island is that it is an important touristic destination in the Bahamas, and through this pilot project the local administration will be able to feature with collaboration of energy providers through a visual monitoring system, the performance of the new LED lightbulbs to visitors and island tours how the Government of the Bahamas is committed to promoting and demonstrating how energy efficiency technologies can be deployed in a practical manner. Public buildings in Harbour Island will be targeted as demonstration buildings.

Harbour Island's Tourism Industry

In Harbour Island there has been a trend of turning old residential properties into boutique hotels. There is a hotel licensing board at the Ministry of Tourism. But before a property is recognized as a hotel accommodation, there is an environmental and health inspection, the fire department will check the property, controlled by the Ministry of Works, then a business license must be requested, where land revenue taxes can be collected. Records on accommodation services in Harbour Island since 2007 show a slight decrease of businesses.

2.4 Purpose or specific measurable objectives of the pilot project

The project envisions the replacement of +800 incandescent lightbulbs with energy efficient LED lightbulbs. These are installed at selected public buildings on Harbour Island to measure and compare the current electricity consumption rates (kWh/month) and post installation of the high energy efficient lightbulbs (kWh/month). The net electricity consumption reduction is converted into the amount of cost savings and annual tons of CO2-equivalent reduction using the Grid Emission Factor (GEF) calculated for Harbour Island. The potential impact of the proposed pilot project if upscaled to cover the complete island, estimates a reduction of 451 tCO2e per year, with potential overall cost saving up to $1,972,465 USD in case of a 100% transition to LEDs in Harbour Island by

2030. It is estimated that this would require about +15,000 lightbulb replacements.

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 lightbulbs (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.

Fiscal context and implications
There is a need to investigate the existing fiscal regime and determine the specific import tax applied to lightbulbs entering Harbour Island. Current regulations make mention of home appliances but not specific mention of LED lighting Technology. This shall be consulted with local stakeholders as to analyze the possibility of sourcing the equipment from local suppliers.

Equipment Installation
In order to guarantee a smooth decommissioning of obsolete units and installation of the LED lightbulbs 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 Harbour Island prior to commencement of installation activities and work closely with identified and licensed local technicians.

Disposal
For the removed lightbulbs, a special consideration is taken for appropriate disposal of the lightbulbs to avoid fugitive emissions and other forms of pollution. Based on example by a previous lightning project by the BEST commission in the Bahamas, the sourcing of a “bulb crusher” is included in the pilot for proper collection and adequate disposal of old lightbulbs.

Training and Capacity Building
In close collaboration with the Ministry of Tourism and the Department of Environmental Health Services (DEHS), the CCSIP team will prepare and execute training and capacity building in the use, maintenance, and responsible disposal of the new LED Lightbulbs. This will contribute to continuous educational development of electricity technicians so as to increase their knowledge, skill and proficiency.

Outreach and Communications
It is recommended together with local counterparts to investigate needed investment in equipment to measure and visualize the reduction in GHG

emissions. The cost savings and GHG reduction can be determined from the net energy consumption reduction post installation, keeping all other factors at the selected public building equal. With for instance the assistance of the Bahamas Power & Light, monitoring tools, software, and a visual tool could be used to showcase the operational performance of the LED lightbulbs and accumulated energy savings / GHG emission reduction over time. Sharing data and explaining the outcomes creates increased awareness among the population and visitors to Harbour Island.

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**, is used to objectively determine which buildings are suitable for replacement or installation of energy efficient LED lightbulbs.

2.7 Principal beneficiaries

Direct beneficiaries

The Ministry of Tourism as leading ministry in promoting sustainable solutions in an important economic sector for the nation, the Harbour Island Administration and building managers of public buildings in Harbour Island where cost savings will be achieved and a positive effort to reducing GHG emissions demonstrated.

Indirect beneficiaries

The people of Harbour Island, showing engagement into eco-friendly 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 Harbour Island. Also, the hotels and other accommodations, tour guides, and general visitors especially those who are interested in Eco/Green Tourism will appreciate the efforts by the Bahamas Government.

2.8 Directly involved partners and their roles

Critical strategic partners that are directly involved for the successful implementation of the pilot project include:

Harbour Island Administrators Office: the Harbour Island administration office under the Department of Local Government responsible for administrative affairs in Harbour Island and Eleuthera as principle beneficiary and designated entity to appropriate the pilot project and guarantee its management after pilot project hand-over.

Ministry of Tourism: Collaboration with representatives will be required as they will be able to provide the local perspective of activities on the island, as well as a user perspective on some of the buildings where lightbulbs will be replaced. Working with the Ministry of Tourism is key

for the success of the pilot project as the main liaison with all involved parties, and with an interest in upgrading and promoting Harbour Island as one the principle tourist destination in the nation as an eco-friendlier destination.

Bahamas Power & Light (BPL): As the local electricity provider, constant communication and collaboration with BPL will be very valuable for the assessment of energy production and consumption on the island. BPL can also provide valuable insights regarding energy consumption trends for lighting purposes and contribute to the adequate monitoring of the installed equipment. Upon a successful pilot, PBL may become an important player as investor and beneficiary in transitioning the nation to the universal use of HEE light bulbs. This reduces the pressure to continuously source financing to invest in additional capacity and allow for better planning.

BEST Commission: BEST is a commission under the Office of the Prime Ministry dedicated to the protection, conservation and management of the environment; participating in international conventions, treaties, protocols and agreements relating to the environment. The commission serves as the National Designated Authority under the UNFCCC, and therefore responsible for the National Communications and reporting on compliance with Nationally Determined Contributions (NDCs). It also serves as the National Focal Point for the Green Climate Fund (GCF) and the Global Environmental Facility (GEF). The cooperation and exchange of the results if the pilot project is important to explore new or additional funding sources to replicate and upscale the pilot throughout the Bahamas.

Department of Environmental Health Services (DEHS): the DEHS is tasked with investigating problems and instituting preventative and remedial measures in areas that cause environmental pollution. This includes the proper management of solid waste in the Bahamas and provide ways and means for the training of persons involved in environmental services, among other. Working together with DEHS on establishing a proper protocol for the responsible disposal of old lightbulbs is of added value for the future potential upscale and replication of the project nation-wide.

2.9 Other Partners involved and their respective roles

Other Institutional Partners

Other indirectly involved, but as critical for successful implementation of the pilot project, are some key central institutions relevant to the energy sector in Harbour Island. These include the Ministry of Works and Urban Development, and the Ministry of the Environment and Housing, as well as some other commissions and statutory bodies.

Ministry of Works and Urban Development: A government agency dedicated to plan and produce quality services that will protect, improve, provide for and maintain the physical infrastructure and natural

environment of the Bahamas for its residents and visitors by serving its client agencies.

Local Inter-american Development Bank Office (IDB): The continuous updating and communications with the local IDB office in the Bahamas is critical for securing feedback and assistance in financial and administrative needs for the pilot project during implementation and beyond.

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 Harbour Island, the Bahamas.

A walkthrough lighting audit was performed on 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 in the after-hours. In the following sections the scope of works, the proposed method of execution, and related budget cost, are described relating to this EE lighting retrofit pilot project.

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 Harbour Island
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 Harbour Island Administration (HAI) through the Ministry of Tourism's CCSIP Focal Point to elaborate about the pilot project's objectives and scope.
Activity 1.3	Determine the timing and requirements for effective site visits to Harbour Island 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, the Ministry of Tourism and HIA for clearance of the implementation plan.
Result 2	**Selection of buildings for the pilot implementation among pre-identified public buildings in Harbour Island**
Activity 2.1	Determine from literature and interviews with the HIA and other local stakeholders the amount, type and locations of public buildings in Harbour Island.
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 HIA 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 Harbour Island 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 HIA, Ministry of Tourism, 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	Activily 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 (HIA) for maintenaince 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 Harbour Island.
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 anciliary equipment to Bahamas.
Activity 5.4	Request tax exemption for HEE light bulbs and anciliary 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 Harbour Island, and physical installation of LED units, and responsible disposal of old lightbulbs in Harbour Island.
Activity 5.8	Commissioning of the new HEE lighting in Harbour Island.
Activity 5.9	Official inauguration of pilot project with Harbour Island Administration + 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 Harbour Island Administration.

5. General Project Chronology

Starting date: 11 April, 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	22	23	24
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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 Harbour Island 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 Harbour Island (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	The proposed activity may build upon the energy audits financed by the IDB under the CHENACT programme, a 3-year project which studied the energy saving potential from hotels in several Caribbean countries, including at least 5 hotels in Harbour Island.
6.3	Applicable monitoring and evaluation method	It is expected that the Project will be monitored under the supervision of the Harbour Island Administration in collaboration with the Building Managers of the selected public buildings. Evaluation shall consist of interviews with relevant government officials, various partners and stakeholders, beneficiaries of the project, and building managers where the LED lightbulbs 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 and to assess the GHG emission reduction the project will bring about. This information is detailed in **Appendix C**.
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 a Cost-Benefit Analysis (CBA) and a Cost Effectiveness Analysis (CEA) performed under the climate diagnostic phase of the CCSIP program. This pilot project will have a positive effect on the Bahamas 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 in case this pilot is upscaled and replicated throughout the nation. **Handling and Disposal of old lightbulbs** In close cooperation with DEHS, an environmental management guideline or protocol will be sourced to determine how the obsolete lightbulbs are best handled and disposed of in the case of Harbour Island. Data must be recorded of each lightbulb regarding the type and power requirements. For the disposal of the replaces lightbulbs, special consideration will be taken to avoid fugitive emissions and other forms of pollution.

6.5 The potential for ownership, replication and upscaling

Ownership and Replicability

Given that LED lightbulbs are modular more lightbulbs can be deployed upon need making this pilot project replicable in most grid-connected locations in Harbour Island 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 lightbulbs requiring replacement.

A clear straightforward manual or instructions is prepared to enforce a habit of use of the newly installed LED lightbulbs. This includes instructions regarding the turn on/off moments, use duration, other improvements necessary in the buildings to increase the performance in the building.

With the institutional commitment from the Ministry of Tourism and other public agencies to support such initiatives, the sustainability of this pilot project can be guaranteed once the formal commitments (through letters of intent) of each is secured to own and carry forward the operations and maintenance of the installed equipment, also assist in building the case for pilot replication and upscale in Bahamas.

Upscale potential

The upscale potential of this project is high, as the replacement of lightbulbs does not require highly specialized or trained personnel to perform the installation of new LED lightbulbs. Also, it is considered as a low hanging fruit opportunity for many building owners in Harbour Island 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 replaced by LED lightbulbs
- Total benefit: 1,379,199.35 USD
- Total cost: 141,530.38 USD
- Payback period: 1 year
- GHG savings in 2030: 25,596 t CO2
- Cost-effectiveness by 2030: -48.35 USD / t CO2

Training and Capacity Building

Next to the purchase and installation of the LED lightbulbs, a capacity building workshop is held to train public buildings manager and

		technicians why the shift in use of particular lightbulbs is beneficial to the environment and cost of electricity. This element of the pilot project will be performed in close collaboration with the Ministry of Tourism and the DEHS. 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 for instance the fiscal regime. To have a wide scale adoption of high efficiency lightbulbs and other HEE equipment and appliances, VAT-exemption, fiscal 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 LED lightbulbs to install on Harbour Island and across the nation. Intervening in the existing regulatory framework falls outside the scope of this pilot project but is highly recommended as an important area of intervention and chance for success.

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) Providing solar outdoor lighting on a few selected buildings
(c) Use occupancy sensors to switch lights off in unoccupied offices and rooms
(d) Using ambient light and motion sensors as necessary
(e) Providing smart bulbs with light or movement sensor in selected areas which add another feature to efficiency, which is behavioral change or change in consumption patterns
(f) Use lighting controls

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 Harbour Island will have their bulbs changed to LEDs – see **Appendix E** for results of the Lighting audit. In addition to this, specific buildings will have some of the additional items listed on (b) to (f) above.

7.1 Interventions at Selected Public Building

1.1	Government Clinic	I.	Supply and install one hundred and fifty (150) LED 18W tubes (4 feet each).
		II.	Supply and install twenty-five (25) LED 10W lamps.
		III.	Supply and install four (5) wall mounted occupancy sensors
		IV.	Supply and install two (1) Solar powered outdoor lighting systems
1.2	Library	I.	Supply and install twenty (20) LED 18W tubes (4 feet each).
		II.	Supply and install eighteen (18) LED 10W lamps.
		III.	Supply and install one (1) Solar powered outdoor lighting system.
1.3	Primary School	I.	Supply and install two hundred and thirty (230) LED 18W tubes (4 feet each).
		II.	Supply and install thirty-six (36) LED 10W lamps.
1.4	BTC	I.	Supply and install fifty-five (55) LED 18W tubes (4 feet each).
		II.	Supply and install four (4) LED 10W lamps.
		III.	Supply and install two (2) wall mounted occupancy sensors
		IV.	Supply and install one (1) Solar powered outdoor lighting system.
1.5	Water and Sewage	I.	Supply and install five (5) LED 10W lamps.
1.6	Admin Complex	I.	Supply and install fifteen (15) LED 18W tubes (4 feet each).

		II.	Supply and install three (3) LED 10W lamps.
1.7	Post Office	I.	Supply and install six (6) LED 18W tubes (4 feet each).
1.8	Police Station	I.	Supply and install ten (10) LED 18W tubes (4 feet each).
		II.	Supply and install five (5) LED 10W lamps.
		III.	Supply and install three (3) wall mounted occupancy sensors
1.9	Magistrate Court	I.	Supply and install six (6) LED 18W tubes (4 feet each).
1.10	Ministry of Tourism	I.	Supply and install six (1) LED 18W tubes (4 feet each).
1.11	Costums	I.	Supply and install fourteen (14) LED 18W tubes (4 feet each).
		II.	Supply and install two (2) LED 10W lamps
		III.	Supply and install eight (8) 50W LED Spot lights

A summarized Scope of Works will include the following:

(a) Supply and installation of 500 LED 18W tubes (4ft each)
(b) Supply and installation of 100 LED 10W lamp
(c) Supply and installation of 3 Solar powered outdoor lighting systems
(d) Supply and installation of eight (8) 50W LED Spot lights
(e) Supply and installation 10 Wall mounted occupancy sensors
(f) 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 Harbour Island 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 lading csosts of equipment, the installation, and commissioning. See budget as follows.

Description	Qty.	Unit Cost (US$)	Cost (US$)	Import Duty (45%)	Brokerage	VAT	Landed Cost
18W LED T8 Tubes	500	13.00	6,500.00		325.00	819.00	7,644.00
10W LED Lamps	100	7.00	700.00		35.00	88.20	823.20
Solar powered outdoor lighting systems	3	571.52	1,714.56		85.73	216.03	2,016.32
50W LED Spot lights for Customs	8	73.00	584.00		29.20	73.58	686.78
Wall mounted occupancy sensors	10	75.00	750.00		37.50	94.50	882.00
BULB CRUSHER	1	7391.48	7,391.48	3,326.17	375.12	1,331.13	12,423.90
Employment of certified technician	1	2000.00	2,000.00				2,000.00
Employment of electrical technician	1	1500.00	1,500.00				1,500.00
Miscellaneous materials for installation	1	2000.00	1,500.00				1,500.00
TOTAL US$			**24,640.04**	**3,326.17**	**887.55**		**29,476.20**

Appendix A: Validation Workshop Participants

Date: April 11, 2017

Participant list:

- Ministry of Tourism: Mr. Earlston Mcphee
- Ministry of the Environment: Ms. Rihanna Neely
- Bahamas National Trust: Ms. Shelly
- BEST Commission, Ministry of the Environment: Mr Keith Philippe
- Civil Aviation Department: Mr Bradley Strachan
- Road Traffic Department: Mr Michael Hudson
- IDB: Ms. Sara Valero
- CCSIP Project Team: Iker Larrea and Kevin de Cuba (remote)

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 Government of the Bahamas. 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 CO_2 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 Harbour Island.

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 Harbour Island, Bahamas. 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 Harbour Island 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 CO_2 equivalent (t CO_2e).

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:

Activity Data = ED * AH * 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: Daily and aggregated monthly
Monitoring frequency	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)[1].

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:

ERy = BEy - PEy

[1] 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:
ERy: Emission Reduction in year y in (t CO2e)
BEy: Baseline Emissions for the year y (t CO2e)
PEy: 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 CO2e = t CO2 + t CH4 + t N2O

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 GHG = Activity data (TJ) * EF (t GHGI/TJ) * 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 CO2 = Activity data (MWh) * GEF (t CO2/MWh)

Where:

- Activity data is the amount of electricity measured in megawatt hours (MWhe).
- 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 lightbulbs[2].

Verification

No third-party verification is envisaged under the CCSIP.

[2] 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	Φ 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%

Appendix E: Lightbulbs Inventory (March 2018)

Results of the lightbulbs counting during the building walk-throughs on Wednesday, March 22, 2018 in Harbour Island, the Bahamas.

Buildings	T12 4'	Dawn to Dusk	Incandescent	T12 2'	Spot Light	2' U	4' U
Government Clinic	251	2	30		-	-	-
Library	24	-	18	2	-	-	-
Primary School	316	7	46	-	-	-	-
BTC	66	2	4	4	-	8	10
Water & Sewerage	4	-	5	-	-	-	-
Admin Complex	15	-	3	-	-	-	-
Magistrate Court	6	-	-	-	-	-	-
Police Station	16	-	5	-	-	-	-
Post Office	16	-	1	-	-	-	-
District Commissioner Office	8	1	-	-	-	-	-
Ministry of Tourism	25	-	1	-	-	-	-
Customs	14	8	2	-	-	-	-
Basketball Court	-	-	-	-	4	-	-
TOTAL	**761**	**20**	**115**	**6**	**4**	**8**	**10**