Funding Proposal

FP 060: Water Sector Resilience Nexus for Sustainability in Barbados (WSRN S-Barbados)

Barbados | Caribbean Community Climate Change Centre (CCCCC) | Decision B.19/12

16 March 2018

GREEN CLIMATE FUND

GREEN CLIMATE FUND

Funding Proposal

Version 1.1

The Green Climate Fund (GCF) is seeking high-quality funding proposals.

Accredited entities are expected to develop their funding proposals, in close consultation with the relevant national designated authority, with due consideration of the GCF's Investment Framework and Results Management Framework. The funding proposals should demonstrate how the proposed projects or programmes will perform against the investment criteria and achieve part or all of the strategic impact results.

Project/Programme Title:	Water Sector Resilience Nexus for Sustainability in Barbados (WSRN S-Barbados)
Country/Region:	Barbados/Caribbean
Accredited Entity:	Caribbean Community Climate Change Centre
Date of Submission:	_____

GREEN CLIMATE FUND

Contents

Note to accredited entities on the use of the funding proposal template

- Sections **A, B, D, E** and **H** of the funding proposal require detailed inputs from the accredited entity. For all other sections, including the Appraisal Summary in section F, accredited entities have discretion in how they wish to present the information. Accredited entities can either directly incorporate information into this proposal, or provide summary information in the proposal with cross-reference to other project documents such as project appraisal document.
- The total number of pages for the funding proposal (excluding annexes) is expected not to exceed 50.

Please submit the completed form to:

fundingproposal@gcfund.org

Please use the following name convention for the file name:
"[FP]-[Agency Short Name]-[Date]-[Serial Number]"

A.1. Brief Project / Programme Information			
A.1.1. Project / programme title		Water Sector Resilience Nexus for Sustainability in Barbados (WSRN S-Barbados)	
A.1.2. Project or programme		Project	
A.1.3. Country (ies) / region		Barbados/Caribbean	
A.1.4. National designated authority (ies)		Ministry of Finance and Economic Affairs	
A.1.5. Accredited entity		Caribbean Community Climate Change Centre	
A.1.5.a. Access modality		X Direct ☐ International	
A.1.6. Executing entity / beneficiary		Executing Entities: Caribbean Community Climate Change Centre and The Barbados Water Authority (BWA) Beneficiary: The Population of Barbados and The Barbados Water Authority (BWA)	
A.1.7. Project size category (Total investment, million USD)		☐ Micro (≤10) ☐ Medium (50<x≤250)	X Small (10<x≤50) ☐ Large (>250)
A.1.8. Mitigation / adaptation focus		☐ Mitigation ☐ Adaptation X Cross-cutting	
A.1.9. Date of submission		September 1, 2017	
A.1.10. Project contact details	Contact person, position	Dr. Kenrick Leslie	
	Organization	Caribbean Community Climate Change Centre	
	Email address	k.leslie@sbcglobal.net	
	Telephone number	(501)-822-1094 / (501)-822-1104	
	Mailing address	2nd Floor, Lawrence Nicholas Building, Ring Road, P.O. Box 563, Belmopan, Belize, Central America.	

A.1.11. Results areas *(mark all that apply)*

Reduced emissions from:

X Energy access and power generation (E.g. on-grid, micro-grid or off-grid solar, wind, geothermal, etc.)

Low emission transport (E.g. high-speed rail, rapid bus system, etc.)

Buildings, cities and industries and appliances (E.g. new and retrofitted energy-efficient buildings, energy-efficient equipment for companies and supply chain management, etc.)

Forestry and land use (E.g. forest conservation and management, agroforestry, agricultural irrigation, water treatment and management, etc.)

Increased resilience of:

X Most vulnerable people and communities (E.g. mitigation of operational risk associated with Climate Change – diversification of supply sources and supply chain management, relocation of manufacturing facilities and warehouses, etc.)

X Health and well-being, and food and water security (E.g. climate-resilient crops, efficient irrigation systems, etc.)

Infrastructure and built environment (E.g. sea walls, resilient road networks, etc.)

Ecosystem and ecosystem services (E.g. ecosystem conservation and management, ecotourism, etc.)

A.2. Project / Programme Executive Summary (max 300 words)

Please provide a brief description of the proposed project/programme, including the objectives and primary measurable benefits (see investment criteria in section E). The detailed description can be elaborated in section C.

The "Water Sector Resilience Nexus for Sustainability in Barbados (WSRN S-Barbados)" project will result in a paradigm shift that makes the Barbados society aware of the water cycle and climate change impacts threatening the island's drinking water supply, create resilience to severe weather impacts, reduce greenhouse gas emission, reduce consumption, promote appropriate uses of diverse water sources and legislations to support climate smart development and water sector resilience. This will be achieved by employing renewable energy technology, creating a Revolving Adaptation Funding Facility (RAFF), decentralising water storage, increasing rainwater harvesting, building technical capacity, helping to shape policies and legislations related to climate change, raising greater awareness about climate variability and change and providing a platform of knowledge and resources to support further climate change adaptation in the Caribbean. The main objectives of the projects are to:

1. build greater resilience to extreme storm events and drought conditions by utilizing cleaner energy sources, decentralising water storage, promote rainwater harvesting at the household and community level, and improve the efficiency with which rainwater runoff replenish aquifers in Barbados.
2. further advance adaptation and mitigation initiatives in the water sector of Barbados by redirecting and mobilising local funds through a revolving adaptation fund.
3. reduce the greenhouse gas emissions intensity of water provision by integrating renewable energy with back-up natural gas turbines and sustainable Water Loss Reduction (WLR) initiatives.
4. contribute to capacity building via knowledge sharing and lessons learnt platforms within communities, educational organizations, private sector, civil society, BWA and the Government of Barbados to manage and monitor water resources.
5. support the review and development of a legislative framework to supports climate smart development and water sector resilience.
6. collate and disseminate lessons learnt for use in developing further adaptation and mitigation initiatives and raising public awareness about climate change, water conservation, recycle and reuse, the revolving adaptation fund, Green Climate Fund and in general this project.

The project will produce four main outcomes: (1) improved/increased resilience to storm events and BWA's carbon footprint reduced; (2) adaptation and mitigation initiatives expanded through a revolving fund; (3) improved resilience to climate change and disruptions in water supply; and, (4) increased capacity building, public-private-partnerships (PPP) and innovation for climate resilience in the water sector of Barbados.

The resulting impacts of this project are:

1. reduced greenhouse gas emissions and the intensity of greenhouse gas emissions in the provision of water.
2. increased adaptation and mitigation actions by households and communities.
3. swift and immediate adaptation and mitigation actions by mobilising localised funds for climate action.
4. more reliable availability of potable water to the public (improved water and food security).
5. increased use of lessons learnt and climate information by communities, educational organizations, private sector, civil society, BWA and the Government of Barbados for sustainable solutions to climate change.
6. improved legislative environment that supports climate smart development and water sector resilience.
7. greater awareness about the effects of climate variability and change by the population of Barbados and the wider Caribbean.
8. scalable and replicable in other Caribbean Countries.

The major beneficiaries are the population of Barbados, which in 2016 was estimated by World bank at 284,215.

A.3. Project/Programme Milestone

Expected approval from accredited entity's Board (if applicable)	31/01/2018
Expected financial close (if applicable)	dd/mm/yyyy
Estimated implementation start and end date	Start: 01/09/2018 End: 31/12/2023
Project/programme lifespan	5 years 3 months.

B.1. Description of Financial Elements of the Project / Programme

Please provide:

- *an integrated financial model in Section I (Annexes) that includes a projection covering the period from financial closing through final maturity of the proposed GCF financing with detailed assumptions and rationale; and a sensitivity analysis of critical elements of the project/programme*

The financial model will be represented in Section 1(Annex) in excel. The financial analysis uses BWA current financial position, operating revenue and cost, as the baseline. Several parameters are considered including: population growth in Barbados, discount rate, inflation rate, water tariff, per capita water demand and energy cost. Of these major parameter, the financial analysis is sensitive to: (1) the inflation rate (high), which could balloon BWA expenses; (2) the per capita demand (high), which if decreases could significantly impact the revenue stream of BWA; (3) increase energy cost (moderate) that would increase operational expenses of BWA but with the project increase the saving to BWA and the amount of money that flow in Revolving Adaptation Fund Facility (RAFF); (4) increase in water tariff (moderate), which has the potential to increase revenue to the BWA; however, this has the spill-off effect of triggering inflation in the economy. See major assumptions below.

Table: Financial Model Assumptions and Notes

Variable	Assumptions and Notes
Project useful Life	30 years
Inflation	Inflation seems to increase during troubling economic times/crisis. Inflationary risk must be considered. For the period 2006-2015 average rate of inflation was 4.55%; whereas, for the period 1980-2014 the average inflation rate was 2.66%. We assume a 2% inflation rate.
Wages, Salaries and Allowances	Adjusted for inflation every five years
Other operation and Maintenance costs	Adjusted for inflation every year
Year 1 operation and maintenance costs	Estimated as the average of 2016 and 2017 and compared with BWA's own projections for 2018. Consideration is also given to indicative obligations that will come on stream during the implementation of this project.
Barbados Population	Assumed growth rate of 0.37% which is average over the decade 2005-2014; population size in 2014: 283,380 (WorldBank, 2016).
Rate of Return	Discount Rate benchmarked at between 1.94%-5.2% (CCCCC,2012). A discount rate of 10% was used and sensitive analysis done using 1% and 5%. The decision to use 10%, is aligned with consideration for market rates (prime lending rate of 8.05% in 2016) and the immediacy of climate action needed in the water sector.
Water Demand and Water Demand Per Capita	These variables are presented based on four different scenarios: No change in water demand, 0.5% change per year, 1% change per year and 2% change per year. These scenarios are aligned with those presented in Halcrow (2011). It is also assumed that there is a one to one relationship between changes in demand and increases in revenue to the BWA.
Scenarios of Water Tariff	Cases of an immediate 0%, 1% ,2.5%, 5%, 10% and 20% increases in the tariff rate for water over present rates.
Reduction in NRW	It is assumed that the replacement of 16KM of main will reduce NRW by 0.03 MGD per KM. This is value at valued at BWA current rate for normal needs (US$1.55/BB$3.1 per cubic meter). Halcrow (2011) estimated that the replacing 49km of main led to a 10% reduction in NRW, which is approximately 0.03MGD per KM of main replaced. The same ratio is assumed.
CO2 emission reduction	UNFCCC Version 6 of the "Table to calculate the emission factor for an electricity system"
Social Cost of Carbon	US$36 per tCO2 (US-EPA, 2016)
Improved resilience against climate change and extreme climate events	Assume that a conservative 10% of the population is more resilience to climate change and extreme climate events. It is estimated that 10% of the population will have water available to meet per capita demand for at least 3 days priced at current water tariff rate.

Given the current macroeconomic, social and political environment in Barbados coupled with BWA's own reality of needing to upgrade its aging infrastructure the proposed mixed of grant funding from the GCF and BWA is ideal to implement this project. Barbados is already suffering the impact of climate change; therefore, inaction is not option. Innovative adaptation and mitigation actions are needed in the near-term to combat the impacts associated with climate change and variability. Actions are needed to address the increased risks associated with flooding, drought, more severe tropical cyclones and saline intrusion. These must consider building capacity both human and institutional to bolster effort to climate proof existing infrastructure as well as incorporate climate change risk into the decision making process. To introduce these actions and effect a paradigm shift, the involvement all shareholders is also critical. The stakeholders must be empowered with the requisite knowledge, technology and financing need for appropriate action. In this case, BWA is championing the cause of effecting change within the water sector of Barbados to build greater climate resilience in the sector and the economic, social and environmental systems of the society. The proposed project is designed with consideration for these caveats, which will result in a comprehensive approach to climate change adaptation and mitigation. As demonstration of it commitment, BWA is committed to spending US$17.6 million over five years and is requesting GCF grant funds of US$27.6 million. A co-financing ratio of 3:2. See summary budget below.

Table: Summary Budget for Water Sector Resilience Nexus for Sustainability in Barbados (WSRN S-Barbados)

Component	Sub-Components	Activities	Financing Institution		Total (USD)
			GCF Amount (USD)	BWA (co-financing)	Total (USD)
1. Improving /Increasing Resilience to Storm Events and Reducing BWA's Carbon Footprint.	1.1 Integrating photovoltaic renewable energy with back-up natural gas turbines	1.1.1: Design, Purchase and Installation of 2.0 MW Grid-tied PV Switchgear, Transformer, and a 2.0 MW Microturbine (Natural Gas) at Belle Pumping Station	7,500,000	-	7,500,000
		1.1.2: Design, Purchase and Installation of 0.5 MW Grid-tied PV plant and a 0.8 MW Microturbine (Natural Gas) at Bowmanston Pumping Station.[1]	1,100,000	1,000,000	2,100,000
		1.1.3: Design, Purchase and Installation of 2.0 MW Grid-tied PV, Switchgear and Transformer at Hampton Pumping Station.	4,500,000	-	4,500,000
	Total component 1		**13,100,000**	**1,000,000**	**14,100,000**
2. Expanding Adaptation and Mitigation Initiatives	2.1 Establishing Revolving Adaptation Fund Facility	2.1.1: Establish fund administration.	-	10,000	10,000

[1]CCCCC will be responsible for the Design, Purchase and Installation of 0.5 MW Grid-tied PV plant at Bowmanston Pumping Station (Activity 1.1.2.1); whereas, BWA will be responsible for the 0.8 MW Micro-turbine for the said pumping station (Activity 1.1.2.2). See Section C7 responsibilities of executing entities .

through a Revolving Fund.		2.1.2: Establish MOUs, protocols and guidelines for the fund	-	88,000	88,000
		2.1.3:Open bank account(s)	-	2,000	2,000
	Total Component 2		**0**	**100000**	**100000**
3. Building Resilience to Climate Change and Disruptions in Water Supply	3.1: Climate Change Adaptation Water Master Plan	3.1.1: Development of Climate resilient Water Master Plan	-	300,000	300,000
	3.2: Rehabilitation of distribution networks	3.2.1: Replacing defective mains and installing a climate smart distribution network	-	7,500,000	7,500,000
	3.3: Real time decision making tool	3.3.1: Developing real time decision making tool[2]	300,000	700,000	1,000,000
	3.4: Enhance potable Water Storage Systems	3.4.1: Execution of Needs Assessment and Installation of Potable Water Storage Systems[3]	5,000,000	2,000,000	7,000,000
	3.5 Rainwater Harvesting Programme	3.5.1: Installation of Rainwater Harvesting Systems	2,836,000	-	2,836,000
		3.5.2: Retrofitting of infiltration (suck) wells	880,000	-	880,000
		3.5.3: Develop a groundwater model for Barbados	500,000	-	500,000
	Total Component 3		**9,516,000**	**10,500,000**	**20,016,000**
4. Capacity Building and Public Awareness	4.1: Training and certification	4.1.1 and 4.1.2: Develop educational materials and a mechanism that builds BWA and local capacity for climate resilient decisions and climate proofing; and, trainings related to the installation, operation, maintenance and monitoring of photovoltaic systems, leak detection technology and techniques, water storage systems, and rainwater harvesting.	1,041,500	-	1,041,500

[2] CCCCC will procure and install OPTIRamp (Activity 3.3.1.1); whereas, BWA will be responsible for: (1) Supply, install and commission of insertion meters for DMA's; (2) Supply Leak Detection Equipment (Acoustic Noise Loggers [50], Noise Logger Receiver [1], Pressure Logger [2], Insertion Flow Meter [1], GPS Equipment [1], Advance Noise Correlator [1] etc.); and, Supply Leak Detection Services for approximately 300 miles of main/pipe (Activity 3.3.1.2). See Section C7 responsibilities of executing entities.

[3] CCCCC will be responsible for the Needs Assessment (Consultant), 1500 Personal Tanks for Vulnerable Households; storage at QEH; storage at polyclinics; storage at schools and tankers (Activity 3.3.1.1); whereas, BWA will be responsible for Personal Tanks (Activity 3.4.1.2). See Section C7 responsibilities of executing entities.

	4.2: Public awareness campaign	4.2.1 and 4.2.2 : Share lessons learnt to spur greater public and entrepreneurial involvement in climate change adaptation and mitigation; and, promote and encourage the public to utilise RAFF and take action to mitigate, and adapt to climate variability and change.	362,500	-	362,500
	4.3: Policies for water sector resilience and PPPs in Barbados.	4.3.1 and 4.32: Develop policy suggestions for Barbados' water sector resilience and Public Private Partnership (PPP) to combat climate change.	160,000	-	160,000
	Total Component 4		**1,564,000**	**0**	**1,564,000**
	Sub-Total Project Components		**24,180,000**	**11,600,000**	**35,780,000**
Project Support	PS1. BWA's Counterpart for Execution (Equipment, Labour, etc)			3,300,000	3,300,000
	PS2. Survey, Government transactions and protocol, Legal procedures		-	1,500,000	1,500,000
	PS3.1 Project Management Cost/Human Resource		1,500,010	200,000	1,700,010
	PS3.2 Mid-term and Final Evaluations (Project Monitoring and Evaluation)		185,000	-	185,000
	PS3.3 Financial Audits (Project Accounting)		240,000	-	240,000
	Sub-Total Project Support		**1,925,010**	**5,000,000**	**6,925,010**
	Contingency[4]		**1,500,000**	**1,000,000**	**2,500,000**
	Total Project Financing		**27,605,010**	**17,600,000**	**45,205,010**

[4] Contingency is expected to cover unforeseeable expenditure and changes in the budget related to, but not limited to, exchange rate fluctuation, unforeseen adjustment in prices, minor errors and omission in budgeting and other exogenous shocks and unpredictable events during project implementation which do not constitute a Major Change.

B.2. Project Financing Information

	Financial Instrument	Amount	Currency	Tenor	Pricing
(a) Total project financing	**(a) = (b) + (c)**	45.20	million USD ($)		
(b) GCF financing to recipient	(i) Senior Loans (ii) Subordinated Loans (iii) Equity (iv) Guarantees (v) Reimbursable grants * (vi) Grants *	.... 27.60	Options Options Options Options Options million USD ($)	( ) years ( ) years	( ) % ( ) % ( ) % IRR
	** Please provide economic and financial justification in section F.1 for the concessionality that GCF is expected to provide, particularly in the case of grants. Please specify difference in tenor and price between GCF financing and that of accredited entities. Please note that the level of concessionality should correspond to the level of the project/programme's expected performance against the investment criteria indicated in section E.*				
	Total requested (i+ii+iii+iv+v+vi)	27.60	million USD ($)		

	Financial Instrument	Amount	Currency	Name of Institution	Tenor	Pricing	Seniority
(c) Co-financing to recipient	Grant Options Options Options	17.6	million USD ($) Options Options Options	BWA	( ) years ( ) years	( ) % ( ) % ( ) % IRR	Options Options Options Options
	Lead financing institution:						
	** Please provide a confirmation letter or a letter of commitment in section I issued by the co-financing institution.*						

(d) Financial terms between GCF and AE (if applicable)	*In cases where the accredited entity (AE) deploys the GCF financing directly to the recipient, (i.e. the GCF financing passes directly from the GCF to the recipient through the AE) or if the AE is the recipient itself, in the proposed financial instrument and terms as described in part (b), this subsection can be skipped.* *If there is a financial arrangement between the GCF and the AE, which entails a financial instrument and/or financial terms separate from the ones described in part (b), please fill out the table below to specify the proposed instrument and terms between the GCF and the AE.*

Financial instrument	Amount	Currency	Tenor	Pricing
Choose an item.	……	Options	( ) years	( ) %

Please provide a justification for the difference in the financial instrument and/or terms between what is provided by the AE to the recipient and what is requested from the GCF to the AE.

B.3. Financial Markets Overview (if applicable)

How market price or expected commercial rate return was (non-concessional) determined? Please provide an overview of the size of total banking assets, debt capital markets and equity capital markets which could be tapped to finance the proposed project/programme. Please provide an overview of market rates (i.e. 1-year T-Bill, 5-year government bond, 5-year corporate bond (specify credit rating) and 5-year syndicate loan. Provide examples or information on comparable transactions.

The Global Financial Crisis (2007-2012) resulted in a downturn in the Economy. In 2015, growth strengthened and in 2016, investments in tourism sector also helped to bolster the economy. It is estimated that the Barbados economy expanded by 1.6 percent in 2016, with an associated decline in unemployment to 10 percent for four quarters ending in September, 2016 as well as the retail price index fell by 0.8 percent as at June, 2016[5]. Tourism is one of the driving forces behind the Barbados economy. During 2016, long-stay arrivals increased by 6% when compared to the 587,800 long-stay arrivals in 2015. Despite growth in tourism arrival, assets of international banks offering global services declined by 9% to 69 billion. Similarly, the number of international business companies declined by 5 percent, as at October 2016.

The Central Bank's stock of international reserves at the end of December, 2016 stood at $681 million which is equivalent to 10.3 weeks of imports. In 2016, capital expenditure was $36 million lower than for the same period in 2015, and the fiscal deficit was estimated at $665 million. Domestic financing needs were $818 million, consisting of the deficit of $665 million and $153 million of foreign debt. At the end of December 2016, the total debt owed by Government and all public entities, net of assets, was $4.9 billion, or 53 percent of GDP, compared to 68.6 percent as at the end of 2015. The gross government debt, including borrowings from Central Bank was 108 percent of GDP. The proportion of foreign currency debt was 31 percent of GDP, and the cost of servicing that debt was $391 million or 8 percent of earnings from goods and services. For 2016, the average interest on deposit was 0.35-2.90%; whereas, the average prime lending rates ranged from 7.6-8.05%. In 2016, the comparative treasury bill rates and banks rates in Barbados averaged 3.32%, which is high when compared to 1.08% in Trinidad and Tobago, 0.50% in Canada, 0.33% in the United States of America and 0.32% in United Kingdom.

In March 2017, Moody's Investors Service, ("Moody's") downgraded Barbados' government bond and issuer ratings to Caa3 and maintained a stable outlook[6]. The reasons for the downgrade were:

1. The continued increase in government debt and very limited prospects of fiscal reform

"Although macroeconomic conditions in Barbados have stabilized with a pick-up in growth, driven by rebound in tourism and investment in the sector, the fiscal deficit remains high. Despite the government's efforts to contain the fiscal deficit and alleviate pressures on foreign exchange reserves, the fiscal deficit remains large and credit risks have increased in Barbados. The debt burden has risen in recent years and will continue to do so for the next few. Domestic and external liquidity pressures on the sovereign have increased. We assess the likelihood of a credit event in the near-term as very high, given lack of fiscal adjustment and increasingly limited financing options. Given the scale of the fiscal and structural reforms needed to correct the rising imbalance, the likelihood of a credit event is now very high"

[5] Central of Barbados (2016). Review of Barbados' Economic Performance for 2016. Press Release December, 2016. Retrieved on August 17, 2017 from: http://www.centralbank.org.bb/Portals/0/Files/December%202016%20Press%20Release%20F.pdf

[6] Moody's Investors Service (2017). Retrieved on August 17, 2017 from: https://www.moodys.com/research/Moodys-downgraded-Barbados-government-bond-and-issuer-ratings-to-Caa3--PR_362922

2. In consequence, rising domestic and external financing pressures that are very likely to impair the government's ability to service its debt

"*With commercial banks having reduced their exposure to the sovereign, the government has become increasingly reliant on short-term debt issuance, financed by the Central Bank of Barbados, to meet the rising refinancing and interest costs. The rapid increase in short-term debt since 2013, allied with the large financing gap, imply mounting concerns about rollover risk. In 2016, the central bank was the only source of new financing for the government. As of end-2016, the central bank's holdings amounted to 34% of outstanding short-term T-bills, equivalent to 13.2% of GDP. The central bank's unwillingness to increase its exposure to the government would trigger a credit event. External financing pressures are also high and rising. A number of factors, in particular maintaining the peg to the US Dollar, caused the stock of international reserves to drop significantly last year coming to USD 340.5 million in December from USD 463.5 twelve months earlier. This is the lowest level of reserves recorded since 2009, and only half the average level observed between 2009 and 2012, equivalent to under 11 weeks of imports at end-2016, compared to 13.6 weeks and 14.7 weeks in 2014 and 2015, respectively. The persistent decline in reserves continues to pressure the exchange rate peg.*"

International Monetary Fund (IMF) in its 2016 Article IV Consultation[7] reports that the high country-specific risks are:

- Fiscal financing pressures. Fiscal financing pressures, high borrowing costs, and possible monetization of the deficit raise the risk of a liquidity crisis and/or imperil the currency peg.
- Fiscal slippages. These would reinforce market concerns about fiscal sustainability and default and undermine private sector confidence necessary for investment.
- Brexit. Adverse impact on tourism and investment from uncertainties and economic spillovers associated with Brexit.

Barbados has already begun to take steps to 'green' its economy by incorporating renewable energy into its energy mix. The recognition and production of renewable energy is growing. In 2016, a 10 megawatt solar photovoltaic farm was introduced by the Barbados Light and Power Co. Ltd.

Going forward the engines of growth will be tourism services and construction related to tourism, infrastructure, energy and housing. Critical to realizing its growth potential is a water sector, which is resilient to climate change, that can meet the demand associated with these development agenda.

Barbados is ranked the 16th most densely populated country in the world, with a population density averaging 662.8 persons/km^2 and a population growth rate of 0.3 %, at 2016[8]. Barbados' freshwater supply is primarily a function of its climatic and physical conditions as the main source of potable water on island is groundwater. In considering the state of the island's water resources, it must be borne in mind that Barbados is ranked among the world's 15th most water scarce countries. Rainfall is predominately seasonal: The Wet Season (June to November/December), which coincide with the Hurricane Season; and, the Dry Season (December/January to May). Given the impending and increasing impacts of climate change, it is pertinent that the BWA reduces its Non-Revenue Water (NRW) and promote conservation, recycling and the collection and use of rainwater.

The BWA obtains its water supply from twenty-four (24) groundwater wells, two (2) spring water sources and one (1) privately owned reverse osmosis desalination plant, augmented by a smaller containerized desalination plant. This water is distributed through a network consisting of approximately 2,500 km of water mains, ranging in size from 1 inch to 21 inches. The water infrastructure is aged with some pipes dating back to the 1850's. Approximately 85% of the mains are either ductile iron or cast iron with small amounts of polyvinyl chloride and high density polyethylene. Approximately 72% of all the pipes in the network range from 3 inches to 6 inches in diameter. The system experiences a high rate of ruptures, in the range of 29 to 59 per 100 km annually, with 80% of these bursts incidents occurring on 4 inches and

[7] IMF: https://www.imf.org/external/pubs/ft/scr/2016/cr16279.pdf
[8] World Bank: http://databank.worldbank.org/data/Views/Reports/ReportWidgetCustom.aspx?Report_Name=CountryProfile&Id=b450fd57&tbar=y&dd=y&inf=n&zm=n&country=BRB

smaller diameter pipes. In the last quarter of 2015 and into 2016, some District Metered Areas (DMAs) in elevated areas of the island experienced prolonged outages; some for more than 4 months.

As a public utility, BWA has no control over water tariffs. BWA rate structure is made up of four rising blocks and the charges are determined over a 30-day period. The blocks are as detailed in the following table.

Table: Tariff Structure for the BWA

Domestic Rates Water	Price per m^3
Basic Needs (0 to $8m^3$)	US$1.24
Normal Needs (9 to $20m^3$)	US$1.55
Discretionary Use (21 to $40m^3$)	US$2.33
Excessive Use (Over $40m^3$)	US$3.89
Commercial Rate	
Fixed Rate per m^3	US$2.33
Sewerage Rates	
Domestic	1/3 of water charge
Commercial	2/3 of water charge

The rate structure was intended to make it affordable to meet the basic needs (first block) and thereafter to induce water conservation. In 2009, a similar block tariff structure was proposed for commercial customers; however, cabinet, who at the time had oversight for BWA tariffs, approved a flat rate of US$2.33 per cubic meter for commercial customers. Subsequently, Fair Trading Commission (FTC) assumed oversight responsibility for BWA tariffs. The tariffs put before Cabinet in 2009 were intended to cover the operating costs of BWA but the approved rates are 40% lower than those proposed.

Government of Barbados through its Welfare Department pays some of the water bills for those households that cannot afford to pay their bills, on a case by case/needs basis but offers no direct subsidies to commercial entities. Additionally, the Government does not provide a direct subsidy to the BWA but has provided some emergency funding when needed.

The FTC rate regulation has two aspects: a) control of the level of earnings to be derived from the rates, referred to as "rate level" and b) control of the tariffs in the rate structure. The Commission, in establishing the principles for setting rates under the Utilities Regulation Act adopted four generally accepted objectives:

- Prevention of excessive profits
- Assurance of adequate earnings to enable the utility to develop and expand
- Provision of service to a maximum number of customers
- Promotion of cost efficiencies within the operation of the regulated utility

It is not clear if consideration is given to climate change in determining the rate level and structure.

Please fill out applicable sub-sections and provide additional information if necessary, as these requirements may vary depending on the nature of the project / programme.

C.1. Strategic Context

Please describe relevant national, sub-national, regional, global, political, and/or economic factors that help to contextualize the proposal, including existing national and sector policies and strategies.

Barbados has a population of approximately 284,215 (WDI, 2016) with land area of 431 km^2. The expected impacts of climate change on Barbados include coastal inundation and sea level rise, an increase in tidal and storm surge levels, coastal erosion, rising temperatures, changes in rainfall patterns, and more frequent and severe weather events including drought and tropical storms (Wellington and Moore, 2001).[9] These adverse impacts will have significant negative implications for Barbados' tourism sector, freshwater supply, coastal infrastructure, coral reefs and fisheries. This project is aimed at kick-starting through demonstration how mitigation actions married to adaptation options can improve the welfare of the population of Barbados. While the primary focus of many developed countries is mitigation, developing countries like Barbados must consider mitigation and adaptation options as complements because the adverse effects of Climate Change (CC) are already upon these small island-developing states and despite current efforts to mitigate greenhouse gas emission, these effects will be exacerbated in the medium- to long-term.

The impacts of climate change have the potential to destabilize the capacity of the water supply in Barbados. The Belle pumping station is a critical facility in Barbados as it provides about one third of the overall water supply to the population. Currently there is no sustainable backup mechanism in place for a power failure from the current electrical grid nor is there any power storage capacity that would be able to sustain operations for an extended period of time, in case of a major electrical outage. In addition, there are no current renewable energy technologies integrated into the operations of this crucial water pumping station, which serves the largest catchment area of Barbados. With regards to weaknesses, to increase the climate change resilience and further identify areas that are vulnerable to climate change impacts; this project can mitigate the risk of disruption in water supply during and after extreme weather events; reduce the loss of water due to leakages and faulty mains caused by shifting of land after severe flooding; reduce the chance of increasing water prices to vulnerable communities; and reduce the impact of climate change on water, sanitation and food security.

With the integration of solar energy use, the BWA would be able to ensure that after hurricanes, (which are normally associated with power outages from the main electricity grid), there is continued access to potable water resources to the public. In this regard, the installation of the PV systems at the critical pumping stations can supply 66.3% of the population, thus increasing its climate resilience. In addition, this would decrease the potential of water borne disease outbreaks directly associated with the aftermath of severe weather events.

The current problem of leakages and faulty mains is a serious cause for concern as Barbados is classified as one of the 15 most water scarce countries in the world; therefore, making every drop of water a precious resource. With this project, the climate change resilience will be enhanced - leakages in the distribution network and the occurrences of faulty mains are intensified as land shifts after severe weather events and pipe material and connections are usually subject to corrosion due to saline intrusion. In order to avert the likelihood of increasing the price of this critical basic necessity, this project will seek to minimize this weakness by the retrofitting of the mains network in order to alleviate water losses.

The scarcity of water is also heavily impacting the agricultural sector as there is less water penetrating the soils to the underground aquifers as a result of the flash flooding that results in a majority of the water running off into the sea. Water balance models for Barbados were previously generated using the relationship between precipitation, surface runoff, evaporation and the change in soil water storage. These models have taken into account additional hydrological information of Barbados and the generated Palmer Drought Severity Index (PDSI) value and the Crop Moisture Index (CMI) value all emphasize the current water situation in Barbados as mentioned above.[10] In addition, it was also deduced that the recharge to the aquifer is about 15-20% of the average annual rainfall.[11] This then reduces the volume of water

[9] Wellington, C. and Moore, R. (2001). Barbados' First National Communications under the United Nations Framework Convention on Climate Change (UNFCCC), Ministry of Physical Development and Environment, Barbados, West Indies.

[10] Shontelle Stoute 2014, Potential uses of Indices (PDSI, CMI) and other Indicators to estimate drought in Barbados. Caribbean Institute for Hydrology and Meteorology (https://www.mcgill.ca/cariwin/files/cariwin/SAW_09_Stoute.pdf)

[11] Andrew P. Hutchinson 2014, Commercial Scale RWH, Case Studies from the Barbados Experience, Stantec Caribbean,

that can contribute to the internal renewable water resources and this impacts water availability that has direct consequences on food security. This project aims to implement a rainwater harvesting program and retrofit suck wells; therefore, reducing the volume of water that is lost as surface water run-off into the sea.

Beside directly addressing climate change issues, this proposed project is aligned with several of the recently agreed Sustainable Development Goals (SDGs) such as climate action, clean water and sanitation, affordable and clean energy, responsible consumption and production, and decent work and economic growth[12]. Additionally, this project satisfies the three pillars of the Paris 2015 agreement[13] which includes:

- The phasing out of greenhouse gas emission to zero by mid-century by installing renewable energy source.
- Enhancing adaptation and building resilience to climate impacts by reducing leakages and building capacity within the water authority and communities to guarantee greater water security; and,
- Moving financial flows away from dirty fossil fuels toward clean forms of development by using this project to replicate similar projects with the priorities of reducing carbon emissions, building resilience and sustainable development.

Nationally, the scope of this project fits into the Barbados' Growth and Development Strategy broad objectives[14] of: reducing dependence on fossil-fuels, ensuring environmental sustainability and combating Climate Change; building human and social capital; infrastructure upgrade and modernization; and, ensuring more modern and efficient public and private sector institutions. It will also aid BWA to better execute its' responsibility in supplying the island with potable water. The performance of these responsibilities will come under increasing scrutiny from the Fair Trading Commission as it implements the General Standards of Service[15].

BWA, the sole water service authority in Barbados, is critical to guaranteeing the water security of Barbados. However, given the impending impacts of climate change, BWA needs to position itself to continue to guarantee this security. It is expected that its function in the future will not only be limited to the production and distribution of water but also demonstrating, raising awareness, and building capacity within localities about water conservation, storage and treatment. The need for this comes against the background that BWA needs to improve its efficiency and build greater resilience to climate variability and change. Here, efficiency refers to minimizing its operation and maintenance costs and increasing the amount of water available to the public whilst at the same time minimizing its impact on the environment. Implementing the changes necessary to achieve these objectives can be costly; especially if a one-off total overhaul is attempted. BWA recognizes that a one-off total overhaul is not possible and as such it is attempting to incrementally adjust its operations to achieve greater efficiency and resilience to climate variability and change whilst going 'Green'.

At a community level, this project will directly positively impact the communities in which it is being implemented as well as the broader network of customers that BWA supplies water to. The project will engage with households to raise greater awareness and put into practice water conservation techniques as well as promote actions and technologies that will lead to greater efficiency in storage and use. Vulnerable households (differently able and ailing) will benefit directly through efforts to decentralise storage by installing personal tanks. Barbados sole public hospital will also benefit through increase storage for emergency purposes as well as several schools and polyclinics. Several farmers will benefit by increasing rainwater harvesting and incorporating this into their irrigation systems. These actions coupled with efforts to sensitise the public about climate change and variability and its impact on the water sector and other sectors will result in a paradigm shift in the monitoring, distribution, storage and utilisation of water resource. Indirectly, it will benefit the entire population of Barbados by creating an enabling environment that is investor friendly and cleaner.

Barbados is a member of CARICOM, which is a regional body, and has aligned itself with frameworks associated to building climate change resilience in the water sector. At a regional level, this project supports the strategic approach and actions outlined in the Regional Framework for Achieving Development Resilient to Climate Change and

(http://www.caribbeanrainwaterharvestingtoolbox.com/Media/Print/CARPHA%20-%20Commercial%20Scale%20RWH.pdf)

[12] http://www.un.org/pga/wp-content/uploads/sites/3/2015/08/120815_outcome-document-of-Summit-for-adoption-of-the-post-2015-development-agenda.pdf
[13] http://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf
[14] https://barbadosunderground.files.wordpress.com/2013/07/draft-growth-and-development-strategy-document-for-2013-2020.pdf
[15] http://www.ftc.gov.bb/library/sos/2017-05-31_commission_decision_sos_bwa_2018-2020.pdf

Implementation Plan[16], which are designed to deliver significant improvement in the resilience of the CARICOM member States social, economic and environmental systems. The Implementation Plan for a Regional Framework for Achieving Development Resilience to Climate Change was adopted by Barbados as a CARICOM member in March 2012 at the 23rd Inter-Sessional Meeting for the Conference of Heads of Government of the CARICOM.[17] There was a pledge that the program will achieve increased availability of acceptable quantity and quality of water for all beneficial uses, and increased capacity and ability of countries and communities to adapt to climatic variability in the Caribbean region. This project therefore is in direct alignment with the projected outcome of this Regional Framework and therefore can serve as a regional model for other members of CARICOM. In addition, this project also reflects the desired outcomes of the CARICOM Framework for the Comprehensive Disaster Management (CDM) Strategy 2014 – 2024[18]; Outcomes 2.2, 2.3, 3.2. and, 3.3 which focus on increased and sustained knowledge management for CDM and improved effectiveness of CDM at the sectoral level.

C.2. Project / Programme Objective against Baseline

Describe the baseline scenario (i.e. emissions baseline, climate vulnerability baseline, key barriers, challenges and/or policies) and the outcomes and the impact that the project/programme will aim to achieve in improving the baseline scenario.

As set out in section C.1, the climate change vulnerability of Barbados is inclusive coastal inundation and coastal erosion, tidal and storm surges, increased temperatures, reduction in rainfall and altered rainfall patterns, and more frequent and severe weather events including drought, flooding and tropical storms. These factors will impact the Barbados' water resources through increased water demands, significant impacts on the quantity and quality of freshwater resources, reduced groundwater recharge, and the potential impairment of groundwater quality in low lying coastal aquifers. Added to this reality is the threat of tsunami and volcanic activities from "kick-em Jenny" just off the coast of Grenada, for which projected impact will be mostly in the Southern and Eastern Caribbean, which will further test the region's resiliency.

Baseline: Water Sector

The effects of climate change are already evident[19]. In 2015, the Caribbean, more specifically Eastern Caribbean Islands including Barbados, experienced one of the most severe droughts. This drought caused drastic drops in groundwater levels in the West Coast wells of Barbados resulting in approximately 11,356m^3 reduction in production by the BWA. The 2015 drought demonstrates the vulnerability of Barbados' coastal aquifers to the potential impact of Climate Change. The production wells on the West Coast, including extraction at Belle, Hampton and Bowmanston, serve close to more than 54% of the population. The Hampton station is the second largest of the BWA's pumping stations and provides potable water to St. Philip, some areas in Christ Church and St. George, whereas Bowmanston Pumping Station mostly services the rural areas of the parishes of St. John, St Joseph and St. Andrew. These pumping stations and associated aquifers are however vulnerable to saline intrusion during times of low aquifer recharge, as was the experience during the 2015-16 drought period. Such effects will be exacerbated by sea level rise and changes in precipitation patterns.

This situation is compounded by the fact that 43% of the water pumped by the BWA is classified as Non-Revenue Water (NRW). Non-Revenue Water is water that enters the water supply system but does not produce revenue either because it is a real loss from the system – leakage, or an apparent loss because of under reporting by faulty meters. Although, efforts are on the way to curb losses from Non-revenue water, more is need. The BWA is well underway in terms of curtailing these losses through the identification of revenue leakage and by significant mains replacement, the latter which will take several decades to sufficiently arrest.

The water sector is also vulnerable to extreme storm events. Hurricanes are known to cause severe damages to infrastructure in the Caribbean (both above and below ground). Barbados is affected by storms and hurricane every 3.54 years with average sustained winds associated with direct hits of 98mph (Hurricane City, 2016). For the period 1980-2012, tropical cyclones affected Barbados 6 times, killed 1 and affected 10,617 persons. In 2010, Hurricane Tomas caused damages to the light and power infrastructure, road and homes in Barbados. An estimated 1,200 residences sustained damage and overall estimated damages were at US$8.5 million. The BWA operations are dependent on

[16] http://www.caribbeanclimate.bz/ongoing-projects/2009-2021-regional-planning-for-climate-compatible-development-in-the-region.html

[17] Delivering Transformational Change 2011-21: Implementing the CARICOM Regional Framework for Achieving Development Resilient to Climate Change. 2012. Caribbean Community Climate Change, Centre and the Climate and Development Knowledge Network

[18] http://www.cdema.org/CDMStrategy2014-2024.pdf

[19] http://www.fao.org/3/a-i5695e.pdf

energy from the grid. Whenever, a storm or hurricane or other climatic or non-climatic factor disrupt power supply to it pumping stations water supply to the population is disrupted. Based on calculations by the BWA, in face of extended island wide power disruption, the BWA will have just under one day's reservoir storage capacity. Recently, BWA began implementing, on a small scale, grid-tied photovoltaic systems to reduce it energy cost and minimize it carbon footprint; however, these efforts have not mitigated the vulnerability of the water supply system to extreme storm events.

Baseline: Energy sector

Energy is strongly tied to the provision of water in the Caribbean—for instance, approximately 5% of the electricity consumption in Barbados is used for providing water and wastewater services. Energy is needed to lift raw water from its source (deep ground water sources), treat and pump it to end-users. This contributes to greenhouse gas emissions as majority of the energy used to carry out these operations are from fossil fuel combustion. When taken on a per capita basis, the energy intensity water production and distribution for Barbados and other small island developing states are significantly high. Currently, Barbados relies almost entirely (96%) on fuel oil and diesel to generate electricity with the majority of it being imported at a cost of approximately 7% of the islands' GDP (United Nations Environment Programme, 2012; NREL, 2015). The use of energy-intensive water supply systems with these kinds of traditional energy sources places a great strain on the local carbon footprint as well as Net International Reserves, especially under current economic conditions. It also makes the price of water susceptible to international oil prices and constrains the fiscal space needed to pursue welfare improving development projects.

Electricity generation accounted for 56.8% of the island's CO_2 emissions in 2000. This contribution rose to 61.4% in 2005. The total CO_2 emissions from electricity generation that year were 837,000 tonnes. As the largest source of CO_2 emissions, reducing emissions from electricity generation will have a significant impact on the country's emissions profile Based on 2005 data, reducing CO_2 emissions from electricity generation by 10% can reduce the country's CO_2 emissions by 6.14%. CO_2 emissions tracked the electricity consumption from 2000 to 2004; both grew at around 4.5% per year.

To mitigate the effects of extreme events and to improve the energy security, this project proposes to have available at the three of the top 4 water producing stations, Belle, Hampton and Bowmanston; microturbines that will be on standby, in the event that the electric grid fails, to ensure that the population could still receive clean potable water. This will be achieved by implementing a 2 MW photovoltaic system and a 2.7 MW natural gas microturbine at the Belle, a 2.0 MW photovoltaic system combined with the existing natural gas and bio-diesel generator at the Hampton and a 0.5 MW photovoltaic system and a 0.8 MW natural gas microturbine at Bowmanston. In the event of a severe storm/hurricane that disrupts the power supply on the island, the Belle, Hampton and Bowmanston pumping stations will still be able to abstract water from there deep ground water sources, treat and pump water directly to approximately 54% of the island's population. This has to be augmented and indirectly, through trucking (tanker and tank services), to the remaining 46%. The Belle and Hampton pumping stations will support the capital of Barbados, Bridgetown; whereas, Bowmanston will support some pertinent rural agriculture communities. In the aftermath of a storm/hurricane, access to water critical for emergency service and domestic use has to be looked at in a two-fold way. With no surface freshwater source such as a river, energy is critical to providing potable water from the pumping stations. Energy is needed to lift water from the deep underground reservoirs, which is then pumped through the distribution system. In the likely event of significant damage to the network distribution system (primarily mains), the ability to transport potable water through trucking, the only alternate means, is critical.

By further diversifying the energy mix of Barbados, to include more renewable energy source (by implementing 2 MW the photovoltaic systems as outlined above at the Belle pumping station), the carbon footprint of the island will reduce, the carbon intensity of water production and distribution will reduce, the energy cost to BWA will reduce, the burden on the Net International Reserves will be reduce, the potential for increase in the price of water will be mitigated (if not reduce/curb inflationary pressures) and the general welfare of Barbadians will improve.

Baseline: Economic activities

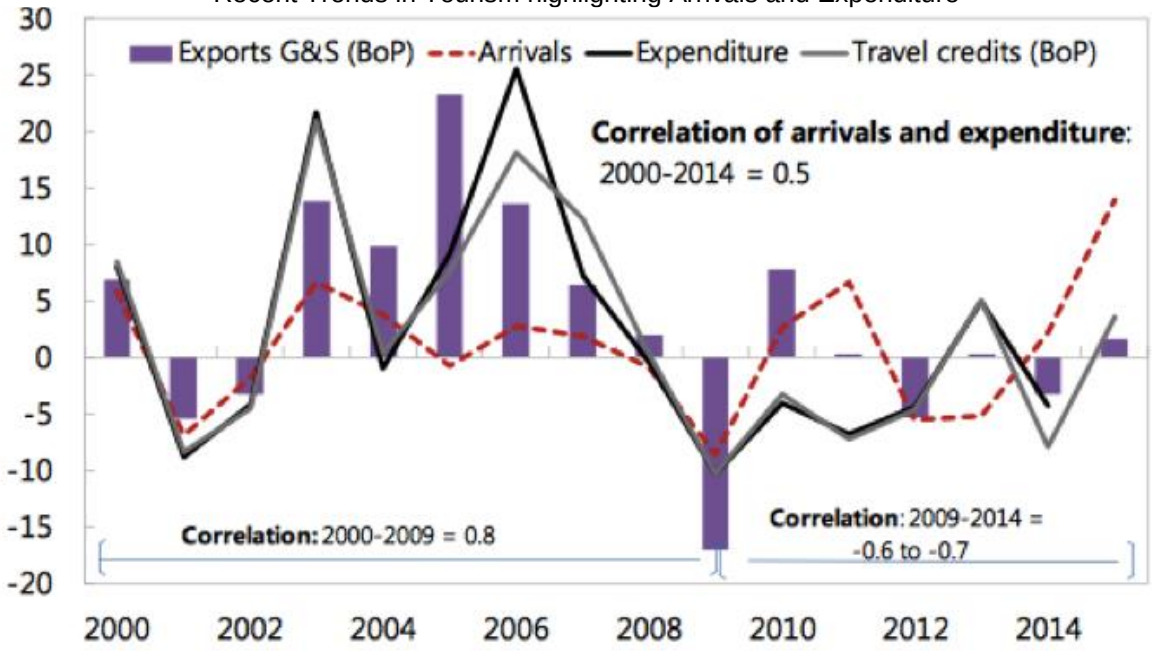
In Barbados Tourism directly accounts for about 12.9% of the GDP and is the leading sector in the economy. The indirect contribution is estimated at about 40%.[20] The tourism sector employs about 26,000 persons and about 13,000 persons are employed in the hotels.[21] In 2013, the direct contribution of travel and tourism to the GDP of Barbados' was estimated

[20] World Travel & Tourism Council 2017. Travel & Tourism, Economic Impact 2017: Barbados. https://www.wttc.org/-/media/files/reports/economic-impact-research/countries-2017/barbados2017.pdf

[21] Clyde Mascoll 2013, The Promotion of Greater Inter-Sectorial Linkages with the Tourism Sector in the Barbados Economy. Barbados Private Sector Association, ATN/ME-11627-BA; BA-M1007.

at US$510 million (or 10.9% of GDP), with the total contribution at US$1,698 million (or 36.2% of GDP) and an idea of the recent trends in Tourism is shown in the Figure below form the years 2000 - 2015.[18] Travel and tourism directly supported 14,500 jobs (11.1% of total employment) indicating a contraction in employment within the sector. However, tourism has been adversely affected by a decline of arrivals and tourism receipts from key markets, exacerbated by the sector's focus on traditional mature markets. Records indicate that between 2007 and 2012, cruisers and stay-over arrivals declined 16.1% and 6.7%, respectively, while tourism receipts fell by 17.8%.[22] Despite the downturn, tourism remains the main driver of the economy and, while the country will pursue efforts to diversify the economy, in the short-term, economic growth in Barbados will continue to depend heavily on growth and spending in the tourism sector.

Recent Trends in Tourism highlighting Arrivals and Expenditure[23]



Baseline: Policies, Legislation and Plans

The process of policy formulation is generally conducted through the work of a committee of experts and stakeholders in Barbados, which then undergoes the formal cabinet review and parliamentary process. However, the following are relevant water resources legislation and policies: Barbados Water Authority Act (1980): establishes the Barbados Water Authority; Underground Water Control Act (1953): provides for the control and use of the underground sources of water supply in the island. It establishes a Water Board for the purpose of this Act. Licenses from the Board are required for the sinking of wells and for the obstruction of underground water; Heath Services Act (1969): allows the Minister to divide Barbados into health and sanitation districts. The Minister has the power to construct sewers. This Act also prohibits taking water from public taps without permission; Irrigation Act (1967): allows the Chief of Agriculture to carry out surveys, investigation or research for irrigation purposes, to distribute water and to control or operate waterworks; Prevention of Floods Act (1951): makes provision for measures for the prevention of floods; National Strategic Plan 2005-2025 (2007): has within its goals to promote and facilitate the environmentally sustainable use of natural resources and to maintain a safe and reliable water supply; National Water Conservation Plan: comprises two parts: long-term ongoing measures such as leakage reduction and universal metering and short-term measures such as temporary shutdown of parts of the

[22] Vashtie Dookiesingh, Ruth Houliston, Gyong Joo Choe , Maria-Elena Nawar , Nobuyuki Otsuka, Winsome Leslie, Ryan Tang, Brian Muraresku 2014. Barbados. Nonreimbursable technical-cooperation funding for the project "Linking MSEs to Anchor Companies in the Barbados Hotel Value Chain" Donors Memorandum 2014. the Inter-American Development Bank, Multilateral Investment Fund. https://www.gtai.de/GTAI/Content/DE/Trade/Fachdaten/PRO/2014/12/Anlagen/PRO201412115005.pdf?v=1

[23] Thomas Dowling, Nkunde Mwase, and Judith Gold 2016. Barbados Selected Issues pp 18. 2016 International Monetary Fund. https://www.imf.org/external/pubs/ft/scr/2016/cr16280.pdf

system on a rotational basis or temporary licence restrictions on private abstractions (UN, 2004); Groundwater Zoning Policy: implemented through the Town and Country Planning Office in collaboration with the BWA, it controls development in areas of groundwater abstraction as a way of protecting groundwater resources (2008).

Actions

Barbados intends to achieve an economy-wide reduction in GHG emissions of 44% compared to its business as usual (BAU) scenario by 2030. In absolute terms, this translates to a reduction of 23% compared with the baseline year, 2008. As an interim target, the intention will be to achieve an economy-wide reduction of 37% compared to its business as usual (BAU) scenario by 2025, equivalent to an absolute reduction of 21% compared to 2008. Given the identified effects, Barbados has made attempts to adapt to the effects of climate change. To address reduction in rainfall, increased drought conditions and increased water scarcity, Barbados has sought to use desalination technology. While desalination plants have provided additional water on the island nation, its dependence on traditional energy sources (fossil fuel combustion) results in a carbon footprint of 0.4–6.7 kg CO_2eq/m^3, which is much higher than other alternatives such as increased wastewater reuse (0.1–2.4 kg CO_2eq/m^3) (Cornejo et al., 2014). If desalination technology is to become an integral part of the tool kit for combating climate change, tackling mainly the issue of water scarcity, the carbon footprint of such a technology must be reduced. One way to mitigate the carbon footprint and sustain the operations of the desalination technology is to implement and power the RO plant using renewable energy source. Besides powering desalination plants, renewable energy is an attractive alternative to fuel oil and diesel for the use in production of water in Barbados.

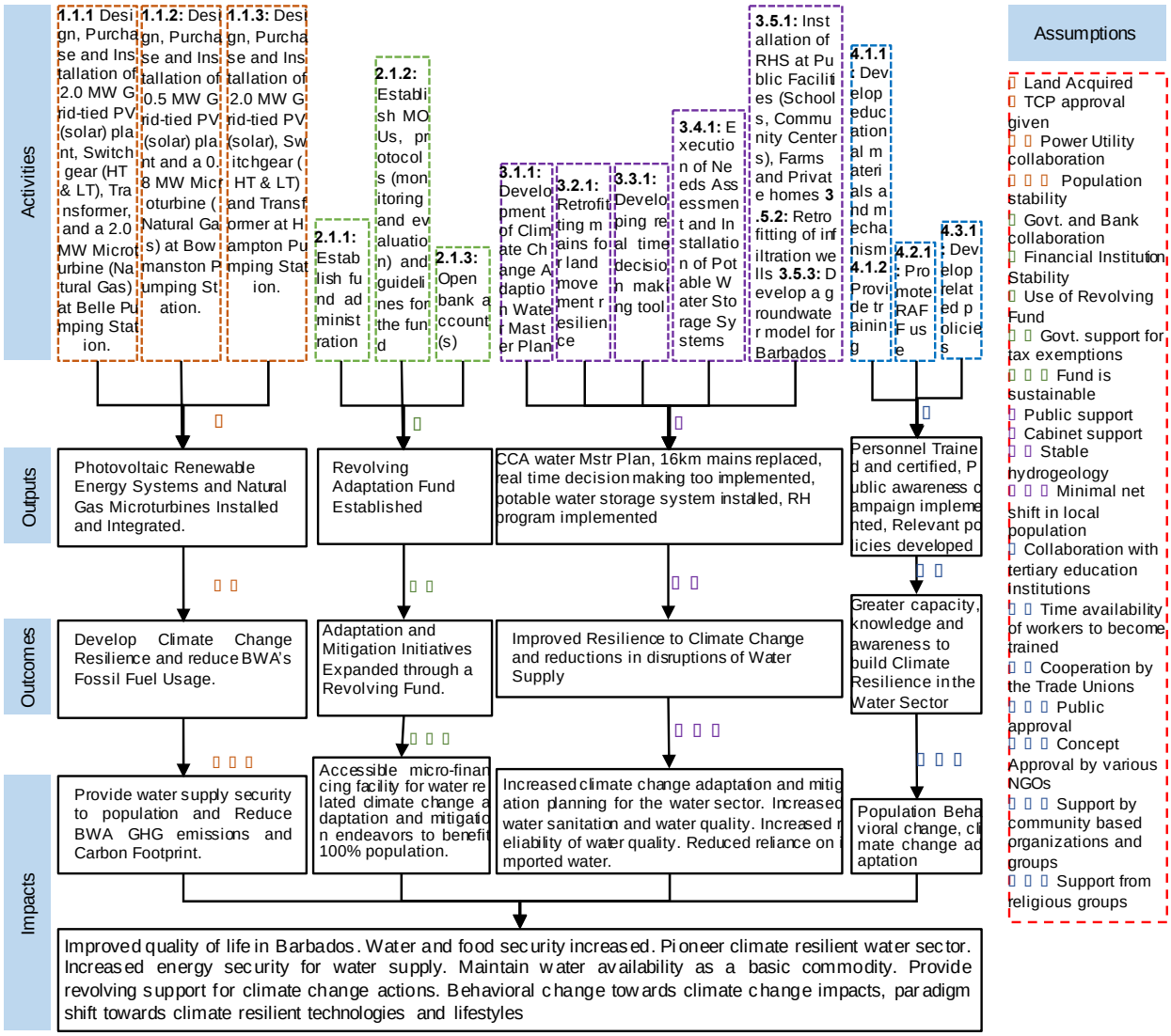
Due to the cost associated with maintaining and operating desalination plants, this project proposes two alternative actions to mitigate water scarcity. This involves: (1) implementing water loss reduction initiatives, which includes replacing mains and implementing pressure management and leak detection technologies; and (2) decentralise collection and storage, which includes rainwater harvesting at the household and community levels, particularly residences and critical community essential services and other localised support centers. The former will reduce water loss by an estimated 2.7% of daily consumption and the latter could increase rainwater harvested by 1.5%. These actions will result in greater water availability to the public, especially in periods of droughts. Further, households, communities, businesses, among others, will be empowered through knowledge about climate change, access to financing via a revolving adaptation funding facility, policies and legislations related to climate change, and a platform of knowledge and resources to support climate change adaptation.

With these actions, this project will result in a paradigm shift that makes the Barbados society aware of the water cycle and climate change impacts threatening the island's drinking water supply, create resilience to severe weather impacts, reduce greenhouse gas emission, reduce consumption, promote appropriate uses of diverse water sources and legislations to support climate smart development and water sector resilience.

C.3. Project / Programme Description

Describe the main activities and the planned measures of the project/programme according to each of its components. Provide information on how the activities are linked to objectives, outputs and outcomes that the project/programme intends to achieve. The objectives, outputs and outcomes should be consistent with the information reported in the logic framework in section H.

The Water Sector Resilience Nexus for Sustainability in Barbados (WSRN S-Barbados) programme delivers **four outcomes** (derived from components outlined in Section B.1) that are discussed in details below and are introduced in the Theory of Change Diagram below. Outcome 1 involves integrating photovoltaic renewable energy sources with a backup natural gas Microturbine into the water supply system of Barbados. Outcome 2 entails establishing a revolving adaptation and mitigation fund for using savings resulting from the reduction in energy cost to BWA from Outcome 1. Outcome 3 encompasses designing and implementing sustainable Water Loss Reduction (WLR) initiatives, decentralised water storage and rainwater harvesting initiatives. Outcome 4 comprises building capacity and raising public awareness.



Theory of Change (TOC) Diagram

Outcome 1: Improved/Increased Resilience to Storm Events and BWA's Carbon Footprint Reduced

This outcome will see the installation of a 2.0 MW PV system with a 2.7 MW backup natural gas Microturbine at the Belle Pumping Station; a 2.0 MW PV system at the Hampton Pumping Station which already has a standby dual fuel (natural gas and bio-diesel) generator and a 0.5 MW PV system with a 0.8 MW backup natural gas Microturbine at Bowmanston Pumping Station. Installing PV systems with their backup natural gas Microturbines at the selected pumping stations make those pumping stations independent of the power company (Barbados Light and Power Company). Therefore, in the event of a power failure, either island-wide or site specific, the energy needs of the selected pumping stations will not be affected; hence water production and distribution will remain intact. Furthermore, these pumping stations serve different subsets of the population.

Output 1.1: Photovoltaic Renewable Energy Systems and Natural Gas Microturbines Installed and Integrated

Activity 1.1.1 Design, Purchase and Installation of 2.0 MW Grid-tied PV (solar) plant, Switchgear (HT & LT), Transformer, and a 2.0 MW Microturbine (Natural Gas) at Belle Pumping Station
Activity 1.1.2: Design, Purchase and Installation of 0.5 MW Grid-tied PV (solar) plant and a 0.8 MW Microturbine (Natural Gas) at Bowmanston Pumping Station.
Activity 1.1.3: Design, Purchase and Installation of 2.0 MW Grid-tied PV (solar), Switchgear (HT & LT) and Transformer at Hampton Pumping Station.

The 2 MW systems for Belle and Hampton will be made up of approximately 7,000 PV modules each and the 0.5MW PV system at Bowmanston will be made up of approximately 3,000 modules. The number of modules will depend on the type of panels used. It is proposed that high efficiency modules such as mono-crystalline modules be used since they are durable and efficient in the capture of irradiance. It is also proposed that a decentralised approach be adopted for the installation of the PV systems at each pumping station. A decentralize system uses several inverters, as opposed to a centralized system that use only one large inverter. The decentralised system has the advantage of greater reliability and mitigates the loss of energy production if an inverter fails. In the decentralized system, if an inverter fails, only a small percentage of the system and energy production is affected.

The PV systems will be ground-mounted on the adjoining land for the aforementioned pumping stations - see Annex for diagram. The installation of the PV systems will also include some civil and electrical works. Civil and electrical works involves the construction of an inverter room with appropriate switch gear and the installation of electricity metering and monitoring equipment. AC power from the inverter room will routed to the switch gear at the pumping station. This power will be coupled with the main bus bar system for the pumping station incorporating an automatic transfer switch (ATS), which will be coupled either with the GENSET or with the Power Utility System. Approvals are required from the Government Electrical Engineering Department (GEED), Barbados Light and Power (BL&P) and the Division of Energy. Further details on these approvals are given in Section C.6.

Since all three systems are grid-tied and the battery technologies associated with such systems are expensive and still evolving, albeit at a fast pace, it is proposed that a natural gas (cleaner fuel) Microturbine be used as the back-up energy supply where there is currently no alternative power supply (in the cases of Belle and Bowmanston). This is to ensure the BWA achieves the objective of improving its resilience to climate change; extreme storm events which may impact the power utility for extended periods. The proposed design is such that once there is a failure on the utility grid, the PV systems will automatically shut down and the microturbines or generators will automatically switch on, therefore allowing BWA to continue supplying water to their customers. The same will happen when the sun sets. See Annex for the electrical submission providing further explanation and visual engineering design for the PV systems and its electrical interaction/interconnection with the pumping station.

As battery technology becomes more reliable and affordable, more battery backup provision will be relied on to ensure the continued advancement of resilience at pumping stations across Barbados.

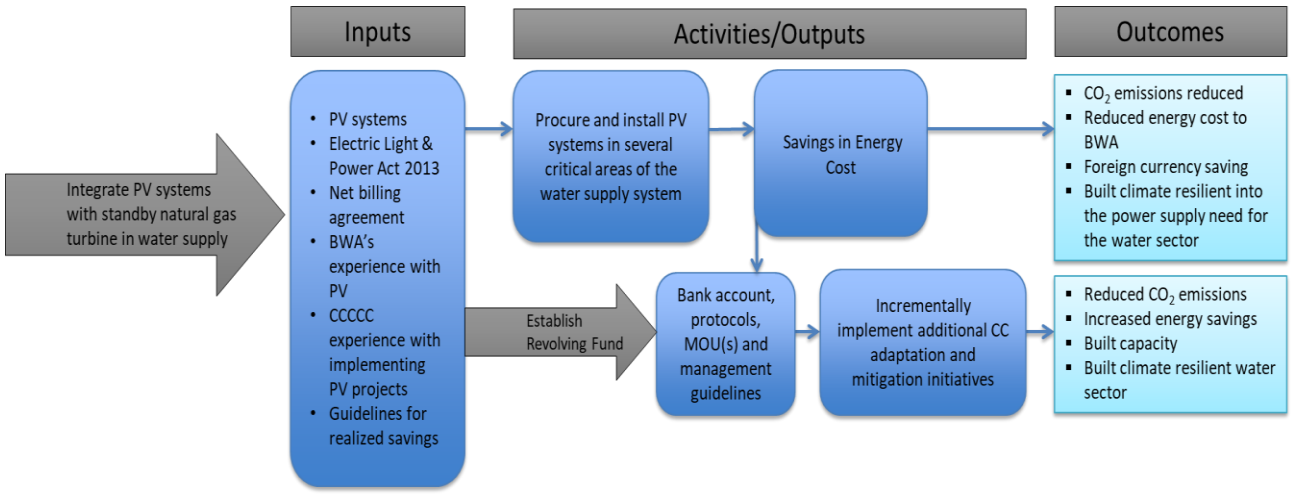


Figure: Schematic for Increasing Resilience to Storm Events and Reducing the BWA's Carbon Footprint

Outcome 2: Adaptation and Mitigation Initiatives Expanded through a Revolving Fund.
This component is aimed at mobilising funds for use in water sector adaptation and mitigation initiatives including those identified as priority in the Climate Change Adaptation Water Master Plan, which is to be developed as part of this project. This aim will be achieved through the mechanism of a Revolving Adaptation Fund Facility (RAFF). The RAFF will enable all members of the population to have access to funding (credit facilities) for climate change adaptation and mitigation related to the water sector of Barbados.

The RAFF is designed as a response to the need for increased climate change adaptation and mitigation actions in the water sector of Barbados. The enabling framework for the RAFF involves raising public awareness through education and media engagement at all levels, and strengthening legislations and regulations. It is envisaged that these actions will spur action resulting in demand for funding to combat and adapt to climate change, especially as it relates to creating a water secure Barbados.

Output 2.1: Revolving Adaptation Fund Established
Activity 2.1.1: Establish fund administration.
Activity 2.1.2: Establish MOUs, protocols (monitoring and evaluation) and guidelines for the fund
Activity 2.1.3: Open bank account(s)

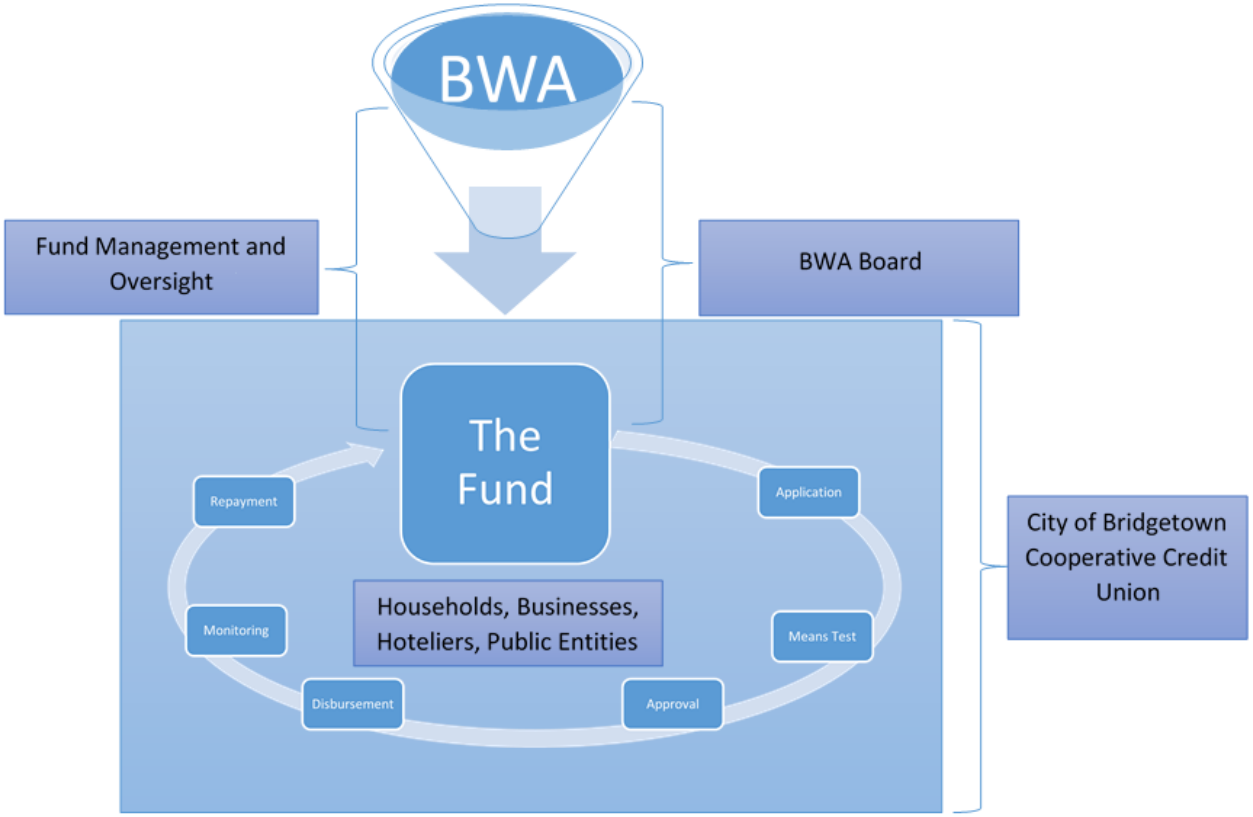


Figure: Schematic for Revolving Adaptation Fund Facility (RAFF).

The RAFF will be established using savings realised from the implementation of activities identified in Component 1. This amount of money that flows from BWA will be a percentage of the amount of energy produced by the systems at a given period of time. This percentage will be set out in Memorandum of understanding (MOU) between the RAFF (management and administration) and BWA. In determining this percentage, consideration will be given to the maintenance and operations cost of the systems.

Eligible uses of the RAFF will include:

- Design and install efficient storage and distribution system.
- Systems that reduce water consumption and promote recycling and use (small scale grey water treatment systems).
- Rainwater Harvesting systems for new and existing housing (including hotels) developments.
- Rainwater Harvesting systems for new and existing farms.
- Water efficient irrigation systems for the agriculture sector.
- Integrate small scale renewable energy systems in to water supply system.
- Improve water supply to communities and health care institutions.

- Increase water security, through decentralize storage, for women and children and differently able.

BWA has an existing relationship (MOU) with City of Bridgetown Cooperative Credit Union (COB- CCU). Currently, BWA uses a means test approach to determine if a household qualifies for grant funding under its personal tank programme, which is designed to address water shortage issues in Barbados. If households do not qualify for such support, they are directed to the City of Bridgetown Cooperative Credit Union, for which they can access a loan. A similar approach will be used to assess households that will seek financing from the RAFF. The rate of interest will also be determined on the household's income. Households registered with the social security, such as differently abled households, will get grant funding and households with income between US$6000.00-US$10,000 will get zero rated loans. Households with income US$10,000 and above will be asked to take a loan, and the interest rate will be determined based on various factors. Detailed guidelines will be developed under this project to determine how public and private sector entities could access the fund for climate change adaptation and mitigation. This will be guided primarily by the Climate Change Adaptation Water Master Plan. An MOU between the RAFF (management and administration) and COB-CCU will identify:

1. Access to the fund and identification of purposes.
2. Fee structure.
3. Parameters for the means test and applicable interest rates.
4. Guidelines for final approval and disbursement.
5. Guidelines for reporting and monitoring.
6. A Portfolio Risk Management Plan.

Outcome 3: Improved Resilience to Climate Change and Disruptions in Water Supply
Outcome 3 will see: (i) the execution of the Climate Change Adaptation Water Master Plan; (ii) Water Management and Water Loss Reduction (WLR) initiatives such as the replacement of 16km of water mains; (iii) the implementation of personal storage tanks, particularly for vulnerable populations; and, (iv) the mainstreaming of rainwater harvesting. These activities will build greater resilience to climate change and disruptions in Water Supply.

Output 3.1: Climate Change Adaptation Water Master Plan Completed
Activity 3.1.1: Development of Climate Change Adaption Water Master Plan
The objective of the Master Plan is to assess the main impacts of projected climate change on the water sector in Barbados and to identify options for building resilience. The proposed assessment includes the preparation of a climate resilient investment plan and recommendations for policy and institutional strengthening to support the integration of climate resilience in the sector. The study will contribute to the preparation of a tool for building resilience in the water sector, which could be applied throughout the Caribbean.

Output 3.2: 16 km of Mains Replaced
Activity 3.2.1: Replacing defective mains
Execution of a leak detection survey, execution of a water audit and demand analysis, execution of a foresight and pressure management study, purchase and installation of pressure management equipment and production meters, implementation of design and oversight for mains replacement, the purchase of mains and fittings, the creation of a decision matrix that considers gender and stakeholder impact to determine prioritization of mains replacement, and the replacing of 16km of mains.

BWA's non-revenue water (NRW) level estimated for the entire island is 43%[24] of potable water supplied. This figure comprises 7% commercial losses and 36% real losses. In order to reduce and manage NRW levels, BWA will control real losses through a combination of selective pipe replacement and pressure management. Selective pipe replacement will be done using the following criteria:

- Estimated Likelihood of Failure of each pipe (LOF)
- Estimated Consequence of Failure of each pipe (COF)
- Potential Level of Risk (to the BWA) for each pipe
- Gender and stakeholder impact of pipe replacement

[24] Halcrow (2012) - Population and Demand Projections Technical Memorandum

Output 3.3: Real time decision making tool implemented

Activity 3.3.1: Developing real time decision making tool

This activity involves installing OptiRamp software, installing production meters and installing detection equipment which will be used to improve the real-time management of the water supply. OptiRamp is an optimizing software which utilizes Algorithms to create what if scenarios. This tool will draw on BWA's SCADA database (e.g. groundwater levels, reservoir levels, pumping rates), and non-telemetry data (e.g. water meter data). This provides a platform that can be used to inform management, engineers, and customer service representatives. . It will also integrate with the groundwater model developed under this programme to include climate change what if scenarios. This tool increases BWA's resilience by making it proactive to climate variability and change, reducing disruptions in supply based on real time data of reservoir levels, groundwater levels, and demand.

Output 3.4: Potable Water Storage Systems Installed

Activity 3.4.1: Execution of Needs Assessment and Installation of Potable Water Storage Systems

Activity 3.4.1 includes: the installation of potable water storage tank systems at the most vulnerable residences identified based on a needs assessment; installation of potable water storage at the country's only public hospital, Queen Elizabeth Hospital (QEH); the nation's 9 Polyclinics; and, 16 primary schools. This activity significantly expands a BWA and Government of Barbados initiative, which started in October 2016 during a drought to provide water to the most vulnerable, including persons with disabilities, pensioners, and welfare recipients.

During the drought of 2016, the BWA established a Rapid Response Unit (RRU) and an Executive Water Taskforce (EWT) to help execute the programme. Currently, the RRU is in the process of installing for free 1.5 m^3 HDPE water storage tanks and pumps at 50 residences of vulnerable persons in the 5 parishes hardest hit by the drought (St. Peter, St. Andrew, St. John, St. Thomas, St. Joseph). The EWT also met with religious leaders and partnered with some to host stakeholder meetings in hardest hit communities. Some of the religious leaders then partnered with the BWA, purchasing 12 tanks and pumps and identifying vulnerable members of communities most in need of easily accessible water. They also purchased a 7.6 m^3 system for Ellerton Primary school given the fact that school days were lost due to lack of potable water for the students. The BWA provided technical expertise to install the systems purchased by the religious organizations. BWA also provided labour for these installations, however, the religious organizations started vocational construction training with 21 members of the Haynesville community with the intention of having the students gain practical experience by working with the BWA.

According to the BWA, there are an estimated 13,000 residences with vulnerable populations and households earning under US$12,500 (BDS$25,000) per year. Given climate change projected drought conditions for Barbados, it is likely that water shortages will continue to plague the island. This activity will implement a personal tank programme, which will consist of a needs assessment and survey to determine the most vulnerable physically, financially, and in terms of water shortages. The geo-coded survey will ascertain and record information such as, existing service location, identify tank location, access restrictions, type of, and size of installation (pre cast or in situ), special conditions etc. It will also provide the opportunity to inform the customer of their responsibilities prior to installation. Depending on the tank size and requirements, 1500 systems will be installed along with a solar powered water pump. In addition to HDPE tank systems, redesigned solar water heaters that can dispense water during supply disruptions will also be installed in each parish. Currently, Barbados ranks second in the world with per capita solar water heater installations, however, their plumbing prevents the use of water stored in tanks when supply is zero. This activity will support work proposed by the Ministry of Energy and retrofit installed residential solar water heaters (2 per parish for a small and large house) and engage the business community on adding this level of resilience on their products.

In Barbados, there are critical institutions that offer essential services to the island for example the QEH, local polyclinics and primary schools. To increase the climate change resilience to these institutions, with respect to the water supply, the addition of a series of larger storage tanks will be installed at the QEH, 9 polyclinics and at least 1 primary school in each parish. The tank volumes of these storage facilities at the QEH will be approximately 223m^3, and approximately 7.5 and 12 m^3 for the polyclinics and primary schools respectively. In events where water unavailability causes limited water supplies, 5 water tankers of varying capacities (1.5 – 19m^3) will be used to assist the water supply to these critical institutions.

As part of this programme a fully managed work order management system, which will plan, track and monitor all aspects of the process including logging customer details, inventory management, site specific surveys, work order creation,

status of installation, testing/commissioning, handover inspection (certificate implemented/utilised), and operations and maintenance.

Output 3.5: Rainwater Harvesting Programme implemented
Activity 3.5.1: Installation of Rainwater Harvesting Systems at Public Facilities (Schools, Community Centers), Farms and Private homes
Activity 3.5.2: Retrofitting of infiltration (suck) wells
Activity 3.5.3: Develop a groundwater model for Barbados

Rainwater harvesting (RWH) will contribute to climate resilience by increasing the availability of potable water, reducing flooding, recharging aquifers, and reducing saline intrusion. A suite of RWH activities will be implemented that range in size, scale, type, and from household to country level. This output includes rooftop rainwater harvesting at homes, schools, and community centers coupled with conservation interventions to reduce leaks, rainwater harvesting for agricultural needs with rooftop and ponding systems, rehabilitation of "suck wells" in critical recharge zones to increase infiltration and reduce flooding, and development of a countrywide groundwater model for Barbados.

Since 1996 new developments in Barbados over a certain size are required to install rainwater harvesting systems with thousands approved to date in the form of HDPE tanks, concrete cisterns, and lined stormwater ponds. Harvested rainwater would offset the water required for irrigation and household purposes like toilet flushing, thereby contributing to the water conservation needed on the island. To boost rainwater-harvesting practices in Barbados, HDPE tank systems [inclusive of gutters, tanks, pumps (preferably solar powered) and plumbing] will be installed and maintained in 800 residences, 11 primary and 11 secondary schools, and 20 community centers. While this covers 50% of the community centers in Barbados, the other installations will be spread evenly across each of the 11 parishes. The systems will be coupled with overflow being directed into a rain garden where possible. Rain gardens are a type of green infrastructure that restores natural hydrology of land, adds aesthetic value to space, and reduces irrigation requirements. Toilets will also be retrofitted with fixtures that reduce leaking in the public installations. These installed RWH systems will serve as learning sites for residents/businesses and be available for use by local plumbers to demonstrate requirements to retrofit existing buildings or install in new developments. The expertise to install these rainwater harvesting systems exist within the BWA already and they will be called upon to lead these efforts in conjunction with capacity building activities to build local livelihoods (see discussion for Outcome 4). Contractual services will be needed to re plumb the public facilities.

Agriculture accounts for 24% of the BWAs supply, with extensive use by small farmers for irrigation purposes[25]. 90% of water used in irrigation in Barbados is from ground water sources (FAO, 2016) when one couples the BWA supply and 120 private irrigation wells. However, between 61 percent and 64 percent of agricultural wells are subject to salt intrusion during the dry season, owing to excessive pumping (FAO, 2014). Small farmers are particularly vulnerable to drought as their livelihoods are threatened by low rainfall where crops are rainfed and by low water levels and increased production costs due to increased irrigation[26]. Drought ranks as the single most common cause of severe food shortages in developing countries, so this is a key issue for Caribbean food security. Use of dams, springs, streams, roof catchments and road surface as catchments is limited and rainwater harvesting coupled with smart irrigation practices presents an opportunity for farmers to adapt to increased drought periods and reduce potable water use requirements (FAO, 2016). The proposed RWH systems will be coupled with existing irrigation systems including those government-financed and operated irrigation schemes, which serve 277 small to medium size farmers as well as other farmers that might not have access to the government-financed and operated irrigation schemes. RWH activities will include both rooftop rainwater harvesting for farms with large structures/greenhouses and lined stormwater ponds. This pond RWH activity will include the installation of lined ponds, aerators, and plumbing to service farmers in the selected areas. While more established farmers, privately owned residential developments, golf courses, and polo clubs, are already using stormwater ponds for irrigation in Barbados, WSRN-S will target areas where the government of Barbados has

[25] FAO, 2015. Barbados Country Report. Retrieved on August 20, 2017 from: http://www.fao.org/nr/water/aquastat/countries_regions/BRB/
[26] FAO, 2016. The Caribbean must prepare for increased drought due to climate change, FAO Regional Office for Latin America and the Caribbean, Barbados. Retrieved on August 20, 2017 from: http://www.fao.org/americas/noticias/ver/en/c/419202/

sponsored a Land for the Landless agricultural program to boost livelihoods through local food production and recommended sites from an FAO study[27]. The sites are:

- Gibbons Boggs/Wilcox District: Forty-nine hectares of farm operated by 70 farmers are exposed to salt water intrusion in the wells during pumping in dry season.
- Spring Hall: This farm of size 182 hectares is operated by 22 farmers involved in vegetable and milk production. Water is supplied from two wells but the yield is not sufficient in dry season.
- River Plantation: This 141-hectare farmland is operated by 40 farmers with water sourced from springs, but these springs are not sufficient for irrigation during dry season. The area also experiences flooding and drainage problems during the rainy season which could be alleviated through rainwater harvesting practices.

In addition to rainwater harvesting from roofs and in lined stormwater ponds for irrigation, infiltration sites, commonly known in Barbados as suck wells, will be retrofitted to improve the harvesting of rainwater to replenish aquifers, reduce flooding, and reduce the rate of saltwater intrusion into the aquifers. There are numerous suck wells in Barbados, however, these wells were not built to deal with the increased intensity in rainfall, which causes greater turbidity that clogs the wells with mud and debris. The rehabilitation of suck wells involves implementing channels and natural filtering systems around the point of infiltration. These retrofits will build climate resilience in suck wells.

The final activity includes the installation of groundwater monitoring wells, especially around watersheds already experiencing saltwater intrusion during dry seasons, and completion of a groundwater model for Barbados. UWI CERMES researchers have a preliminary groundwater model, however, this will be vastly improved with new monitoring well data. This updated model will improve BWA's capacity to respond to changing climate and improve the country's water supply resilience.

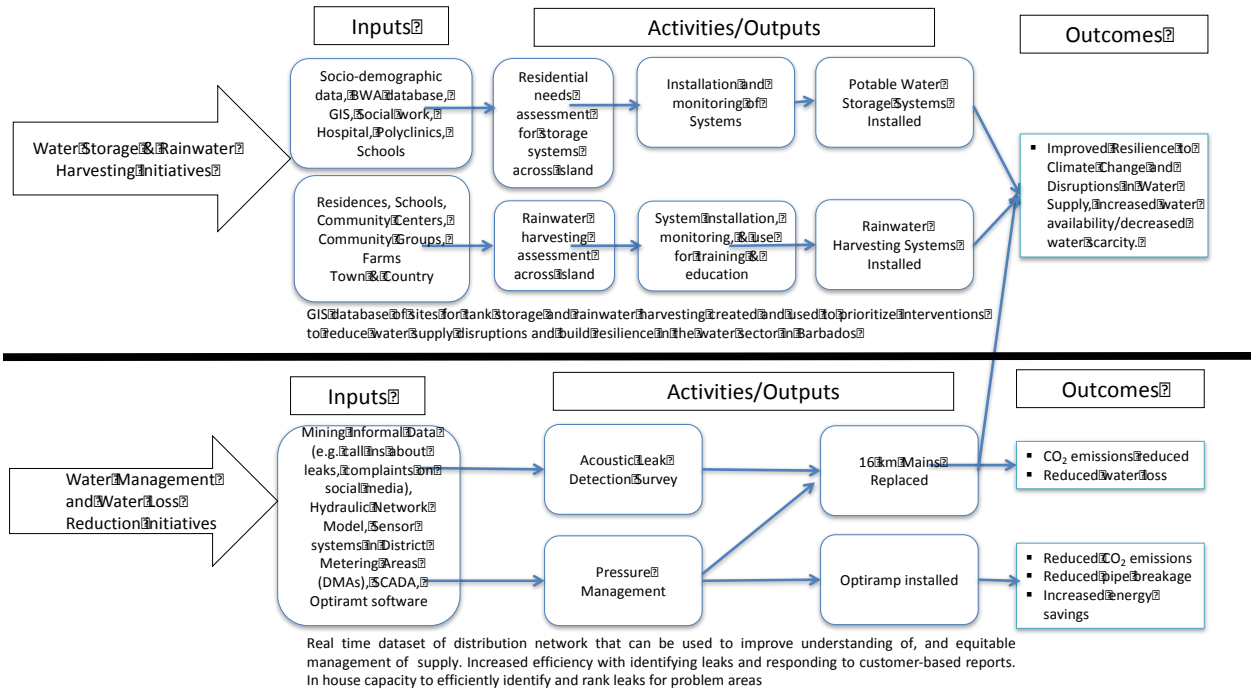


Figure: Schematic for improved resilience to water disruptions in water supply

Outcome 4: Greater capacity, knowledge and awareness to build Climate Resilience in the Water Sector

[27] FAO, 2014. Feasibility study of rainwater harvesting for agriculture in the Caribbean Subregion. FAO Subregional Office for the Caribbean, Barbados. Retrieved on August 18, 2017 from: http://www.fao.org/3/a-bq747e.pdf

Outcome 4 directly links to the project objectives of contributing to capacity building and public education and awareness. Achieving this outcome will significantly change the culture of the water sector in Barbados, building a level of partnership and professionalism that is needed to continually innovate and adapt to climate change. Outcome 4 will result in the: (1) development of a transdisciplinary education, training, and entrepreneurship network that builds climate resilience in the water sector of Barbados, (2) development of legislative frameworks needed to support innovations for climate resilience.

Output 4.1: Personnel trained and certified.

Activity 4.1.1: Develop educational materials and a mechanism that builds BWA and local capacity for climate resilient decisions, climate proofing its existing infrastructures, sustainability, incorporate stakeholder and gender considerations in all aspects of its operations, and risk reduction and safety.

Activity 4.1.2: Provide training related to the installation, operation, maintenance and monitoring of photovoltaic systems, leak detection technology and techniques, water storage systems, and rainwater harvesting.

Transdisciplinary education supports partnerships across disciplines, and outside of academia with organizations and communities, promoting widespread stakeholder engagement. The process of developing of this proposal and in engaging with stakeholders has initiated a paradigm shift in the approach to capacity building and education for water sector resilience in Barbados. Output 4.1 mainstreams that process of partnership to build capacity, job opportunities, knowledge, and water sector resilience. The activities include the development of training and educational materials (e.g. manuals, videos, ADs), and professional certifications for BWA employees and other stakeholders through project developed or existing training materials/programs, promotion of research to add knowledge on project supported water sector resilience initiatives.

The professional certifications included in capacity building are briefly described below:

1. ISO 45001 Certification. This international standard for occupational health and safety systems (OHS) is aligned with ISO 9001 (Quality Management), ISO 14001 (Environment Management and builds on OHSAS 18001 which is a framework aimed at controlling risks. This standard addresses climate change, environmental compliance, and risk, and will improve BWA's ability to deliver its services in a safer manner and lead Barbados in implementing practices that support the country's Health and Work Act 2005-12. This seven hours training will be conducted in Barbados by a licensed trainer and will be required of all BWA employees, contractors working on this project, and key stakeholders on the island. A Safety Management Plan will be developed for the BWA that also aligns with ISO 45001 with a special emphasis on climate change and risk reduction.
2. ENVISION™ Certification. Envision is a rating system and best practice resource to help persons in implementing sustainability into infrastructure projects from design though construction and maintenance. Individuals who successfully complete the Envision credential training course and exam demonstrate their expertise with the Envision Sustainability Professional (ENV SP) designation and will be able to improve infrastructural projects in Barbados, including addressing climate and risk. An ENVISIONTM certified trainer will deliver this training to the BWA project management team, project contractors and partners, and key governmental and non-governmental organizations in Barbados. Application for ENVISIONTM certification will be completed for this project with the production of learning materials using it as an example for other Caribbean nations.
3. Gender Mainstreaming Certification. The baseline gender analysis for this project revealed that Barbados did not have a gender training component that addressed infrastructure, especially in the water and energy sectors. Given the growing recognition of the importance of gender in infrastructural projects to build resilience and increase sustainability by governments and funding agencies, a training workshop will be developed for this project that can be mainstreamed across Barbados and the Caribbean. Faculty from the Institute of Gender and Development Studies at UWI, other UWI departments, USF Engineering, and BWA employees will design this training component and deliver it to all BWA employees, contractors, project partners, and other key stakeholders in Barbados with online learning modules developed for refresher courses and incorporation into a biannual Caribbean Institute for Gender and Development that hosts representatives from throughout the region.
4. Energy Efficiency Training and Certification. The BWA's investment in PV coupled with natural gas turbines for climate resilience of the water sector will require staff who can operate, monitor, and maintain these systems. The requisite staff will be trained through both locally available programs (e.g. C A R I P I T A - Photovoltaic Training 2017 with tailored emphasis on maintenance) and international training programs and workshop attendance for advanced PV certifications. Monitoring software will be purchased and persons trained on using

it for efficient management of PV systems. There will be a 3-year contract for operations and maintenance with turbines with transfer of knowledge to BWA throughout the process to selected staff.

5. Green Construction Vocational Training. Building on a collaboration established with church leaders for building drought resilience that resulted in the church offering a construction training program to 21 individuals in the Haynesville community, this project will expand that workforce development program to 5 other communities across Barbados and develop materials that better align with rainwater harvesting practices. As part of the training, trainees will be given stipends and receive hands on experience during installation of RWH project components. RWH provides water sector resilience by reducing the need for the limited potable water supplied by the BWA for purposes like irrigation and toilet flushing. While the Barbadian building codes require RWH for structures over a certain size, there is no enforcement and the majority of the island does not properly implement this practice. The vocational training and public education and outreach provided through this project will increase public demand for RWH and provide job opportunities for trainees.

Output 4.2: Public awareness campaign implemented

Activity 4.2.1: Share lessons learnt to spur greater public and entrepreneurial involvement in climate change adaptation and mitigation in the water sector resilience initiatives.

Activity 4.2.2: Promote and encourage the public to utilise RAFF and take action to mitigate, and adapt to climate variability and change.

This project will implement several transferable and integrated water and energy projects that will lead to a paradigm shift towards lower greenhouse gas-emissions and climate-resilient development throughout the CARICOM region. Through partnership with academia, knowledge will be managed in such a way that the project messages and branding are clear and uniform, climate change science, risks and resilience are appropriately described, feedback loops are integrated throughout, lifelong learning is promoted as well as citizen science, and lessons learnt are disseminated to critical channels for stakeholder reach and for contribution of knowledge to peer reviewed channels in the Caribbean and internationally. Other activities include creation of educational displays at select project sites for PV, water storage, and rainwater harvesting, promotion of entrepreneurial activities for water sector resilience that builds on the UWI Student Entrepreneurial Empowerment Development (SEED) Project, dissemination of water sector resilience educational information via seminars, webinars, workshops, community meeting, the BWA website, social media, newspapers, radio and TV, evaluation of capacity building and outreach activities to provide feedback loops for continuous improvement. Other activities include creating videos and documentaries to highlight climate change issues, especially those related to water, facing the communities and promoting RAFF as avenue for building resilience at various level of the society.

All of the performance information from the demonstration sites will be shared with the local practitioners in the community through workshops that have the dual purpose of also developing business opportunities for climate resilient water sector infrastructure in Barbados. The installation of tank systems implemented at farms and public facilities involves working with the public and private sectors to create a model for the provision of ‘green’ goods and services. This will be achieved through payment for ecosystem services as well as the installation, operation, maintenance and oversight of RWH systems. Additionally, the RWH activity will contribute to making Barbados a Green Economy and create employment.

Output 4.3: Policies for water sector resilience and PPPs in Barbados.
Activity 4.3.1: Develop policy suggestions for water sector resilience in Barbados to combat climate change.
Activity 4.3.2: Develop policy suggestions for Public Private Partnership (PPP) to combat climate change.

The legal regulatory framework does not currently support climate smart development or resilience in the water sector. An outdated piece of legislation geared at guaranteeing provision of water called the Better Security Act, CAP 160 of the Laws of Barbados is aimed at securing an uninterrupted supply of water (and light) thereby avoiding dangers to human life and to property by providing an offence punishable by $96 or three months imprisonment where service providers willfully or maliciously break their contract to supply water. The impact of the legislation is to deem water and electricity essential services the supply of which should be uninterrupted. This must be reconciled with the legislation’s possible unconstitutionality in purporting to restrict the right to strike. The Act does not suffice in meeting its objective and certainly fails to address resilience. Apart from water prohibition notices gazetted on an ad hoc basis by the BWA

in response to shortages providing a fine of $500 or one-month imprisonment, there is no definitive legislation including regulations, administrative functions or otherwise that address water resilience.

Activity 4.3.1 will bring all of the relevant stakeholders together to discuss experiences, vulnerabilities and threats with a view to identifying opportunities, solutions, interdependencies and characteristics of resilience from the water standpoint including wastewater. Stakeholders will come from public, private, academic and non-governmental organisations. This process will also identify where stakeholders are mobilized into representative groups or organisations. To the extent that there is need for formal representative organization to build up the sector, Activity 4.3.1 will assist in this important work. This stakeholder dialogue willbe formulated into policy suggestions on water sector resilience, which in turn should inform legislation through our NDA. Efforts will be made to broaden the discussion to include regional participation in order to propose model regional legislation. While there is currently no specific formal agenda noted in this regard at the Governmental level, there is progressive thinking towards this end, based on the NDA and internal stakeholder discussions.

Activity 4.3.2 will similarly engage all stakeholders in dialogue about the realities and requirements of funding and collaboration for climate change projects. Stakeholders will share experiences, expertise, needs, shortcomings with a view to informing the manner in which partnerships between government and business should be initiated, managed and evaluated. Public private sector partnerships have thus far been ad hoc with no clear mechanism established for evaluation. Good practices from countries with more experience will be additionally referenced to help guide these policy suggestions.

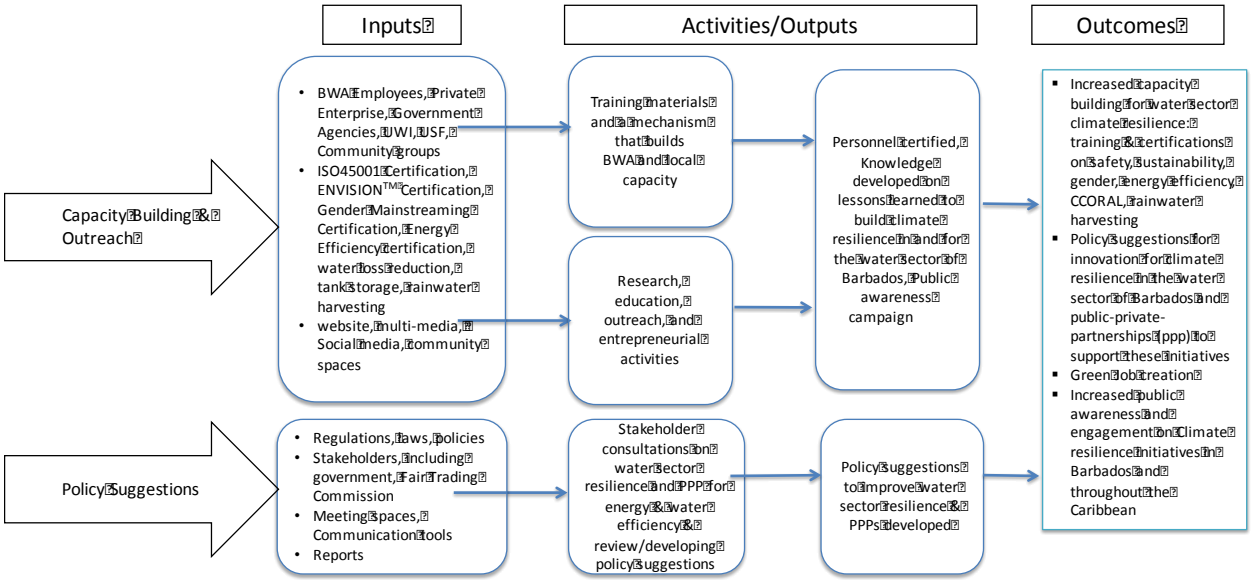


Figure: Schematic for capacity building and outreach for climate resilience in water sector of Barbados

C.4. Background Information on Project / Programme Sponsor (Executing Entity)

Describe the quality of the management team, overall strategy and financial profile of the Sponsor (Executing Entity) and how it will support the project/programme in terms of equity investment, management, operations, production and marketing. Describe financial status and how the project/programme sponsor will support the project/programme in terms of equity, management, operations, production and marketing. marketing. Describe financial status and how the project/programme sponsor will support the project/programme in terms of equity, management, operations, production and marketing.

The Caribbean Community Climate Change Centre (CCCCC) coordinates the Caribbean region's response to Climate Change, working on effective solutions and projects to combat the existing and projected environmental impacts of climate variability, climate change and extreme weather events. Guided by its Regional Strategic Framework – Achieving Development Resilient to Climate Change (2009 – 2015), and its accompanying Implementation Plan (2011-2021) to actualize the Framework, the Centre provides Climate Change related policy advice and guidelines to the Caribbean Community (CARICOM) Member States through the CARICOM Secretariat and to the United Kingdom (UK) Caribbean

Overseas Territories. This programme builds upon the Centre's more than ten (10) years of impactful experience, having been a regional leader carrying out catalytic pilot/demonstration type projects in the Caribbean region, and scaling these up with national governments to bring about transformational change.

The Centre is also the archive and clearing house for regional Climate Change data and documentation in the Caribbean and has an in-house Communications Specialist, thus making it uniquely positioned to share in issues of lessons learned from adaptation and mitigation interventions which can be scaled-up to other Caribbean territories. In its role as a Climate Centre, the entity is recognised by the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Environment Programme (UNEP), and other international agencies as the focal point for Climate Change issues in the Caribbean. It has also been recognised by the United Nations Institute for Training and Research (UNITAR) as a Centre of Excellence, one of an elite few. Through its role as a Centre of Excellence, the Centre will support the people of the Caribbean as they address the impact of climate variability and change on all aspects of economic development through the provision of timely forecasts and analyses of potentially hazardous impacts of both natural and man-induced climatic changes on the environment, and the development of special programmes which create opportunities for sustainable development, as this one is expected to do.

The CCCCC has an established and proven track-record as the leader in Climate Change adaptation planning and management studies throughout the Caribbean. They have many operational programme linkages and networks. This unique capacity will ensure effective and efficient project delivery and guarantee the sustainability of programme outcomes and impacts. More importantly, the CCCCC is the repository of current state of the art Climate Change models in the Caribbean region.

Furthermore, the Centre remains a major implementer of substantial climate change response initiatives projects, inclusive of the European Union Intra-ACP Global Climate Change Alliance (EU-GCCA) Project in the Caribbean, a Coastal Protection Project being financed by the German Development Bank, and the United Kingdom Support for the Implementation Plan Project. Additionally, the Centre was/is one of the implementing agencies of the United Nations-Economic Commission for Latin America and the Caribbean's (UN-ECLAC's) Regional Economics of Climate Change Studies (RECCS) for the Caribbean, the Inter-American Development Bank (IDB) co-financed Caribbean Carbon Neutral Tourism Project (RG-T1640); and the Database Management System for a Regional Observing Network for Environmental Change in the Wider Caribbean (RG-T1813), and the Pilot Programme on Climate Resilience (PPCR) Regional Component. All of these projects are being implemented in the Centre's Member States, with whom it has and continues to work closely.

As the Accredited Entity (AE) the CCCCC will provide overall management for the project and facilitate information sharing and marketing via its online portal. Its role as an Accredited Entity (AE) also includes having overall responsibility and oversight for the project, which involves project implementation and supervision, financial management, and project monitoring and reporting. The partners will share equally in the implementation of the respective portions of the programme.

For better project coordination, and taking a programmatic approach, the CCCCC has established the Programme Development and Management Unit (PDMU). The PDMU is comprised of Project Developers, Project Managers, Project Analysts, and a Monitoring and Evaluation Specialist. In managing this project, the PDMU will appoint/designate a special Project Manager, supported by an Accountant and Procurement Officer, and will draw upon the other collective expertise within the Centre to carry out the Project Implementation function. All activities will be scrutinised alongside the Centre's approved Environmental and Social Safeguard (ESS), Gender, Stakeholders' Consultation and Anti-Money Laundering and Countering Financing for Terrorism (AML/CFT) Policies to ensure they are in consonance with the objectives of those Policies. Furthermore, gender and no-discriminatory considerations and strict adherence to financial best practices will be pursued.

CCCCC has experience working in Barbados with different governmental and quasi-governmental entities. For example, CCCCC works closely with the Centre for Resource Management and Environmental Studies (CERMES) at the University of the West Indies Cave Hill Campus, with over 60 Master's students supported to date and US$750,000 in

scholarships and research support since 2005. In 2015, CCCCC funded a 170 kW photovoltaic system for the BWA at its Carlton Pumping Station to provide 100% of the station's current electricity needs. The Inter-American Development Bank (IDB) is currently funding a 150 kW photovoltaic system for the BWA at its Bridgetown Sewerage Treatment Plant (BSTP) to provide 25% of Plant's current electricity needs.

C.5. Market Overview (if applicable)

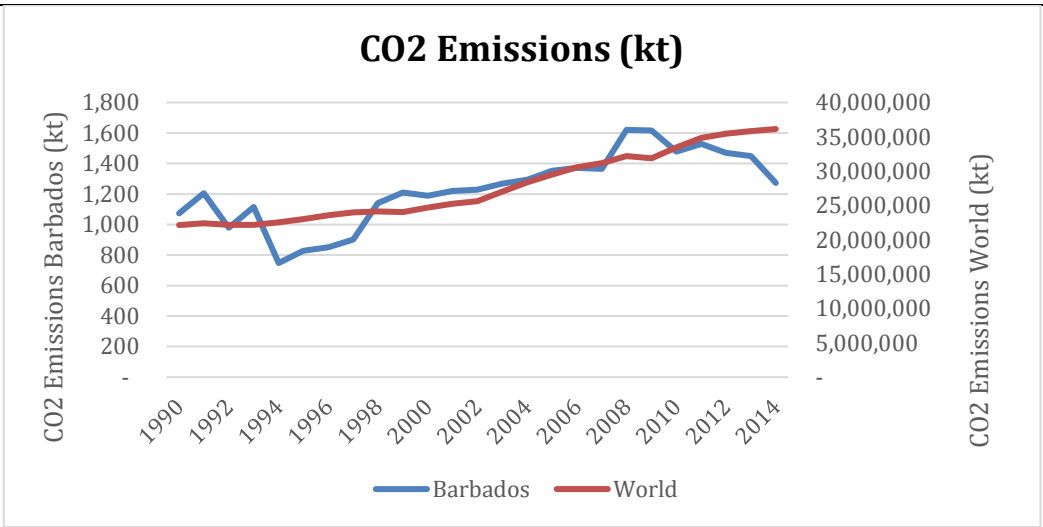
Describe the market for the product(s) or services including the historical data and forecasts. Describe the competitive environment including the list of competitors with market shares and customer base and key differentiating factors (if applicable). Provide pricing structures, price controls, subsidies available and government involvement (if any).

On September 28th, 2015, the Government of Barbados (2015) submitted its "Intended Nationally Determined Contribution" to the United Nations Framework Convention on Climate Change which recognized that Barbados will face indirect climate-related impacts including drought, flooding, and storms which will require improved management of water. Despite its low contribution to global GHG emissions generally (see figure below), Barbados plans to achieve an economy-wide reduction in GHG emissions of 44% compared to its business as usual scenario by 2030. In absolute terms, this translates to a reduction of 23% compared with the baseline year, 2008. This emission reduction will be achieved through the mitigation actions in the energy and waste sectors, which accounted for 88% of GHG emissions in Barbados in 2008. Energy consumption accounted for 72% of Barbados' GHG emissions in 2008 and is therefore the focus of its mitigation activity. Within the energy sector 67% GHG emissions arises from energy generation and 33% from transport. Three sub-sector contributions identified in the Intended Nationally Determined Contribution that are relevant to this programme are:

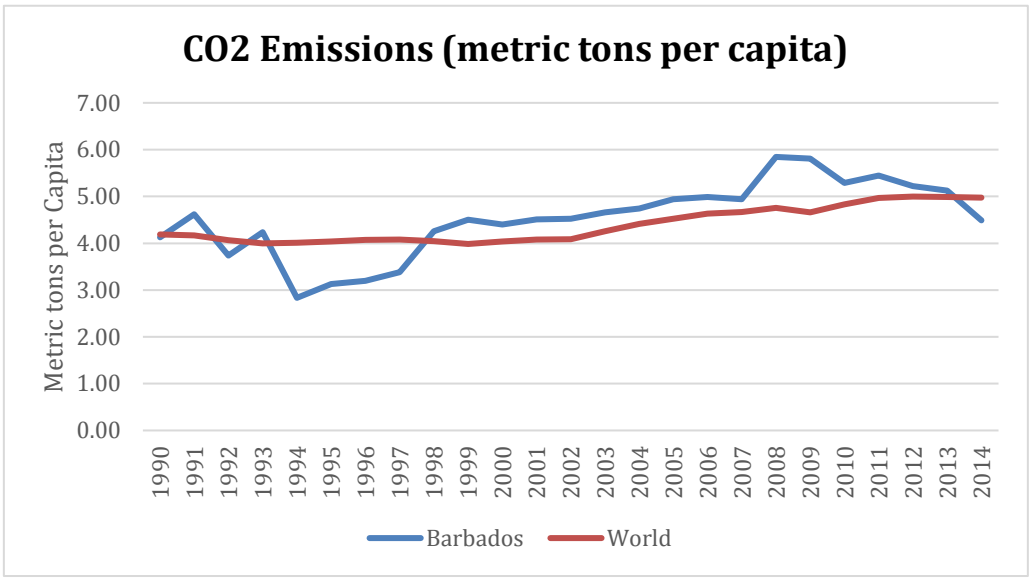
i. **Renewable energy**: contributing 65% of total peak electrical demand by 2030. The country has made huge strides in this regard; for example, distributed solar photovoltaic (PV) installation is growing exponentially and this trend is expected to continue. Other planned measures include waste-to-energy and biomass generation plants, wind, distributed and centralized solar PV and capture and use of landfill gas for energy generation.

ii. **Electrical energy efficiency**: a 22% reduction in electricity consumption compared to a business as usual scenario, including the 'Public Sector Energy Efficiency and Conservation Programme'.

iii. **Solar Energy Emergence:** In the early 1970s, in response to rapid increases in oil prices, the Government of Barbados, recognizing the potential of solar energy to reduce its dependence on fossil fuels, partnered with a private entity to promote the use of solar water heaters (SWHs) across the island. It was demonstrated that the use of the solar water heater as oppose to gas could translate to a 70% reduction in energy consumption. In 1974 the Government of Barbados introduced a tax exemption for the materials used to produce SWHs, saving 20% of the production cost. The Government also levied a 30% tax on electric water heaters, significantly increasing their price. In 1980, the Government of Barbados made the full cost of a SWH, installation tax deductible, at household level; this model has subsequently been replicated across the Caribbean and parts of Latin America. By 2009, two in every five households, in Barbados, had SWH systems installed.



Source: WDI, 2016



Source: WDI, 2016

In 2008 the Government of Barbados, through the Office of the Prime Minister and Division of Energy and Telecommunication, enacted the Sustainable Energy Framework with the goal of 30% renewables and 22% energy efficiency by 2030. Government support for renewable energy has resulted in the following import and Valued Added Tax –VAT clause:

1. Exempted from Import Duty as Per 1st Schedule Part 2B Items 87(b) of the Customs Act Cap. 66 amendment No.9 Order 2009
2. Exempted from VAT as Per Ministry of Finance Memo. Reference # 501/2/49 Vol.2 Date 19/07/2012

These governmental amendments have resulted in unprecedented penetration of renewables (99. 5%% PV- ~10 MW) from 2008 – present and the establishment of small businesses as a result of the renewable market in such areas as:

a. Design & Installation – Residential and Commercial Systems
b. Sale & Supply of PV materials – PV modules and Inverters
c. Increased sales of electrical items which represent 40% of balance of materials for PV systems

Through the Barbados Light and Power, GE Energy Management Consulting conducted the Barbados Wind and Solar Integration Study (February 2015) and found that without mitigation measures and under certain operating conditions, the existing grid can accommodate up to 20 MW of distributed PV, 15 MW of Wind, and 20 MW of centralized PV.

Across the Caribbean, Non-Revenue Water (NRW) is high, ranging up to 70% in some territories. In Barbados NRW is currently estimated at 49% and close to 35% of which may be attributed to leakage from the water mains as a result of the ageing infrastructure and land slippage that causes pipe bursts. This high NRW level not only results in loss of income for the BWA, but also contributes to higher operating costs through unnecessary energy and chemical treatment usage as well as contributing to GHG emissions through the use of fossil-based energy sources. This is an untenable situation in a country with very limited water availability and ranks high on the water scarcity index. Water losses from the distribution system have resulted in several areas across the island suffering from frequent disruptions in supply due to frequent bursts, low water pressures and reduced capacity to meet demand.

The BWA recently completed the implementation of an IDB funded mains replacement programme to replace 49km of water mains. This was expected to contribute to a 10% reduction in NRW. However, this only amounts to a replacement of about 5% of the existing 2,500km of water mains. In order to improve the estimates and understanding of NRW, the BWA is currently implementing a three (3) year Smart Meter Replacement Project funded by the Canadian Commercial Corporation (CCC) that will replace 98,800 domestic customer meters. This is in addition to an in-house replacement programme of commercial customer meters. Production meters at pumping stations are also earmarked for replacement such that there can be more accurate measurement of the levels of water supplied to the distribution system. In addition to improving revenue collection these initiatives will enable better use of consumption and demand data for understanding leakage behavior patterns for targeted interventions, evidenced based water supply planning, network optimization and supply-demand balance.

To improve its management and control of NRW, the BWA recently established a designated Non-Revenue Water Reduction Unit and is currently in the process of providing adequate staffing to meet its assigned mandate. It is also in the process of establishing more defined DMAs which will aid the targeting of water loss reduction actions. In addition, the University of the West Indies-CERMES together with the PWG at the University of Sheffield, UK is working with BWA is investigating pipe water loss behaviour with a better analysis in targeting mains replacement and thus optimising investment in new mains. The PWG (https://www.sheffield.ac.uk/penninewatergroup) is an international centre of excellence and the largest academic urban water research group in the UK in the field of water asset management. The Group carries out research into leakage and bursts including fundamental mechanisms of pipe failure and the development and application of innovative soft computing/artificial intelligence techniques.

Reducing NRW is an essential part of guaranteeing water security and security of supply in Barbados. BWA being the largest producer of potable water has its role to play in guaranteeing water security in Barbados. Therefore, minimising it's operational and maintenance cost is also critical to achieve water security. One way to achieve this, is to reduce the energy cost; however, reduction in energy cost does not preclude reduction in NRW. In fact, the public sector energy efficiency target in the Intended Nationally Determined Contribution includes reduced NRW for the BWA. The combination of these actions will result in increased water available to the public at a reasonable price, which is less susceptible to external shocks. Furthermore, the positive spill-off effects to sectors such as Tourism and Agriculture is important for the economy of Barbados.

Agricultural production using irrigation has also been impacted by water availability, high levels of NRW and salt water intrusion and constrained its expansion as envisaged under the Agriculture Policy Framework. Irrigation water demand is met from supplies of licensed irrigation wells, public water supply system and utilises with similar quality and sources of water as that used for drinking water purposes.

C.6. Regulation, Taxation and Insurance (if applicable)

Provide details of government licenses or permits required for implementing and operating the project/programme, the issuing authority, and the date of issue or expected date of issue. Describe applicable taxes and foreign exchange regulations. Provide details on insurance policies related to project/programme.

Government Licenses/ Permits

The following requirements are needed for renewable energy integration:

1. The Barbados Light Power Co. Ltd. application is accompanied with designs and drawings. Renewable energy installation approval is normally granted within a 2-3 week period.
2. The Barbados Government Electrical Engineering Department application is made for inspection of all alternative energy systems to be grid connected. This department certifies all renewable energy systems, and grants a certificate of inspection and compliance. The inspection is based on the NEC electrical code, and the original certificate is given to the utility company.

Division of Energy – As of April 20th 2015, Electric Light and Power ACT, 2013 came in to effect. In 2015, the Electric Light and Power (Fees) Regulations were established. The Minister, in exercise of power conferred on him by Section 33 of the Electric Light and Power Act, 2013, makes Regulations: See Appendix for fees set out in the schedule which are payable in respect of the matter specified therein.

For ground mounted PV systems, Town and Country Development Planning Office (TCDPO) permission is required and was successfully received for the Carlton and Bridgetown systems implemented.

Requirements for NRW and Mains Replacement

As a statutory body, the BWA is exempted from seeking TCDPO approval to install or replace water mains. Under the BWA Act, BWA can enter any property for the purposes of laying water mains for public water supply, subject to providing necessary compensation for damages resulting from the implementation of such works.

Requirements for Rain Water Harvesting

Since 1996 the Town and Country Development Planning Office has required that all new developments and refurbishment of existing facilities over 1,500 sq ft are required to install rainwater harvesting systems. The requirements vary depending on whether the building is domestic or commercial. There is however no requirement that the stored water be used and there are regulatory restrictions on the uses that stored rainwater can be used for, enforced by the Environmental Protection Department (EPD), whilst public health related matters are regulated by the Environmental Health Department.

Taxes and Foreign Exchange Regulations

BWA is usually exempt from Value Added Tax (TAX) for projects upon written requests. There has been a new tax, the National Social Responsibility Levy(NSRL) for which the BWA is not exempted, but a general application has been submitted to the Ministry of Finance for this exemption. It is usual that tax emptions apply for project undertaken for the BWA.

Foreign Exchange is managed carefully by the Central Bank of Barbados and funding is typically approved in allotments. For projects managed by the BWA approval is usually forthcoming.

Insurance Policies Related to Project

There is General insurance for all BWA staff and Public Liability Insurance for all persons working on project at the BWA.

All systems to be grid connected must provide evidence of public liability coverage for their property. This is normal built in with insurance terms of schedules. Insurance must not be less than US$50,000 (BDS$100,000) for residential properties and US$250,000 (BDS$500,000) for commercial properties. The BWA has successfully demonstrated and applied all of the above for grid connections of a 40kW PV system at the Golden Reservoir pumping site.

As a regional organization, the CCCCC is exempted from certain taxes and duties in CARICOM member states. Goods and Services procured with the GCF Proceeds for the implementation of the Project will be exempt from eligible taxes and duties accorded under Article XIX and Article XXVI of the Caribbean Community Climate Change Centre (CCCCC) Act, 2015 and Article 19 of the Agreement Establishing The Caribbean Community Climate Change Centre (CCCCC).

C.7. Institutional / Implementation Arrangements

Please describe in detail the governance structure of the project/programme, including but not limited to the organization structure, roles and responsibilities of the project/programme management unit, steering committee, executing entities and so on, as well as the flow of funds structure. Also describe which of these structures are already in place and which are still pending. For the pending ones, please specify the requirements to establish them. Describe construction and supervision methodology with key contractual agreements. Describe operational arrangements with key contractual agreements following the completion of construction. If applicable, provide the credit analysis of key counterparties of key contractual agreements and/or structural mitigants to cover the counterparty risks.

Caribbean Community Climate Change Centre (CCCCC) as the accredited entity will implement this project in accordance with its accreditation credentials as well as guided by the terms to be agreed in the funding agreement between CCCCC and the GCF. The CCCCC will be responsible for all fiduciary (banking, procurement and hiring an independent auditor at the end of the project to audit the project). The CCCCC will procure all major goods and services for the project using international best practice and the appropriate procurement method in accordance with the procurement plan. The project will be implemented over a five-year and three-month period with CCCCC, as Accredited Entity. The CCCCC and the Barbados Water Authority as “Executing Entities” will jointly execute the project. This arrangement was deemed best as it is most efficient and mitigate exchange rate control and risk.

The Accredited Entity shall sign a Subsidiary Agreement with the BWA to govern those activities that will be executed by the BWA. The Subsidiary Agreement will be legally binding and outline the detailed financial, procurement and implementation, as well as contain the relevant provisions for the compliance by BWA with the requirements of the AMA and FAA. CCCCC will not on grant any monies to the BWA nor will BWA on grant monies to the CCCCC. Although BWA will have responsibility for the expenditures related to its co-financing, BWA will report to the CCCCC all procurement, expenditure and accounting records associated with its co-financing.

CCCCC will manage, procure and account for all activities associated with the GCF proceeds. In relation to activities co-financed by CCCCC and BWA, CCCCC will act as the Executing Entity and procure services from BWA, who will act as a procured party.

As a co-Executing Entity for this Project, BWA will:

a) Provide technical support to CCCCC for the development of ToRs and the procurement of equipment, goods and service to realise all Outputs; and,
b) Be a part of the evaluation team that will review all expressions of interest, and technical and financial proposals related to the Project.

BWA will report to the CCCCC and guided by the terms set out in the Subsidiary Agreement, procurement guidelines of the CCCCC and or those of the Government of Barbados. BWA will report to CCCCC on a quarterly basis detailing accomplishments, status of project activities, foreseeable delays and other risk at the time of reporting. These quarterly reports are essential to ensure compliance with CCCCC policies and accreditation credentials. These quarterly reports will also feed into annual and mid-term reports that will be submitted to the GCF. These reports will be coupled with field visit and site monitoring missions, which will include primary data collection and observations. There will be a final report at the end of the period of implementation. This report will also be accompanied by the final project financial audit to be completed by an independent and accredited auditor. All records on this project will be kept for at least five years for review by the GCF or its authorized bodies after project completion.

Responsibilities of Executing Entities

Output	Activity	Executing Entity(ies) in Charge
Output 1: Photovoltaic Renewable Energy Systems and Natural Gas Microturbines Installed and Integrated	1.1.1 Design, Purchase and Installation of 2.0 MW Grid-tied PV (solar) plant, Switchgear (HT & LT), Transformer, and a 2.0 MW Microturbine (Natural Gas) at Belle Pumping Station.	CCCCC
	1.1.2.1 Design, Purchase and Installation of 0.5 MW Grid-tied PV (solar) plant at Bowmanston Pumping Station.	CCCCC
	1.1.2.2 Purchase and Installation a 0.8 MW Microturbine (Natural Gas) at Bowmanston Pumping Station.	BWA
	1.1.3 Design, Purchase and Installation of 2.0 MW Grid-tied PV (solar), Switchgear (HT & LT) and Transformer at Hampton Pumping Station.	CCCCC
Output 2: Revolving Adaptation Fund Established	2.1.1 Establish fund administration.	BWA
	2.1.2 Establish MOUs, protocols (monitoring and evaluation) and guidelines for the fund	BWA
	2.1.3 Open bank account(s)	BWA
Output 3.1: Climate Change Adaptation Water Master Plan Completed	3.1.1: Development of Climate Change Adaption Water Master Plan	BWA
Output 3.2: 16 km of Mains Replaced	3.2.1 Replace defective mains	BWA
Output 3.3 Real time decision making tool implemented	3.3.1.1 Develop real time decision making tool: ▪ procure and install OPTIRamp software	CCCCC
	3.3.1.2Develop real time decision making tool: ▪ Supply, install and commission of insertion meters for DMA's ▪ Supply Leak Detection Equipment (Acoustic Noise Loggers [50], Noise Logger Receiver [1], Pressure Logger [2], Insertion Flow Meter [1], GPS Equipment [1], Advance Noise Correlator [1] etc.) ▪ Supply Leak Detection Services for approximately 300 miles of main/pipe	BWA
Output 3.4: Potable Water Storage Systems Installed	3.4.1.1: Execution of Needs Assessment and Installation of Potable Water Storage Systems: ▪ Needs Assessment (Consultant) ▪ Purchase and Install Personal Tank at homes ▪ Purchase and Install Storage at QEH ▪ Purchase and Install Storage at Polyclinics ▪ Purchase and Install Storage at Schools ▪ Procure and supply tankers	CCCCC

	3.4.1.2: Installation of Potable Water Storage Systems: ▪ Purchase and Install Personal Tank at homes	BWA
Output 3.5: Rainwater Harvesting Programme implemented	3.5.1: Installation of Rainwater Harvesting Systems at Public Facilities (Schools, Community Centers), Farms and Private homes	CCCCC
	3.5.2: Retrofitting of infiltration (suck) wells	CCCCC
	3.5.3: Develop a groundwater model for Barbados	CCCCC
Output 4.1 Personnel trained and certified.	4.1.1: Develop educational materials and a mechanism that builds BWA and local capacity for climate resilient decisions and climate proofing its existing infrastructures, sustainability, stakeholder and gender, and risk reduction and safety.	CCCCC
	4.1.2: Provide training related to the installation, operation, maintenance and monitoring of photovoltaic systems, leak detection technology and techniques, water storage systems, and rainwater harvesting.	CCCCC
Output 4.2: Public awareness campaign implemented	4.2.1: Share lessons learnt to spur greater public and entrepreneurial involvement in climate change adaptation and mitigation in the water sector resilience initiatives.	CCCCC
	4.2.2: Promote and encourage the public to utilise RAFF and take action to mitigate, and adapt to climate variability and change.	CCCCC
Output 4.3: Policies for water sector resilience and PPPs in Barbados.	4.3.1: Develop policy suggestions for water sector resilience in Barbados to combat climate change.	CCCCC
	4.3.2: Develop policy suggestions for Public Private Partnership (PPP) to combat climate change.	CCCCC

The Government of Barbados through the Ministry of Agriculture, Food, Fisheries & Water Resource Management, will be kept up to date on the process of the project and, where necessary, provide feedback on the project and its process. The BWA's board of directors is expected to reports to the Ministry on the status of various activities identified in this proposal.

The CCCCC will procure, using international competitive bidding, the services of a Project Manager, a Project Engineer, a Procurement Officer, a Finance Officer and a Project Administrator that will work closely with BWA's Project Management Unit. In partnership with CCCCC, this project will be implemented under the management of the Project Management Unit (PMU) of the BWA headed by the Director, Projects. This department is staffed with Project Coordinators (one of which will be assigned to this project and will liaison closely with CCCCC), Procurement and Accounting Officers, Project Engineer and Engineering Assistant and will also draw upon the available collective resources of the BWA and project implementation partners. In addition, the Project will be monitored by a Project Steering Committee comprising key stakeholders and chaired by the BWA General Manager. The PMU will report to the General Manager, who in turn will report to the BWA Board of Directors and the Project Steering Committee (PSC).

The PSC is to provide a mechanism for support, feedback, guidance, stakeholder participation and interagency coordination during project implementation, and to act as a catalyst for an ongoing coordination mechanism after

implementation has been completed. The Committee will be required to meet as required, but not less than quarterly. The duties of PSC shall be as follows:

a) familiarisation with the arrangements for project implementation, including the intended project outcome, outputs, scope, financing arrangements, reporting requirements, implementation schedule, and other details contained in the appraisal report and financing agreements;
b) monitor progress in implementation of the Project towards achievement of the project output and project outcome;
c) ensure that potential threats to timely project implementation are identified and addressed;
d) facilitate the taking of policy decisions by the relevant authorities to ensure timely fulfilment of loan conditions;
e) review work plans on a semi-annual basis and ensure that recommendations with respect to adequate budgetary allocations are made, procurement activities are executed as scheduled, and that adequate controls;
f) ensure that stakeholder participation is appropriate and sustained throughout implementation and that stakeholder expectations are addressed;
g) ensure that the Project remains aligned to the policy and strategic objectives of GOBD;
h) discuss the perspective of the entities from which its members are drawn on various issues, informed by the consultation of PSC members with their respective organisations;
i) monitor the performance of the Project Implementation Team; and
j) champion the Project, advocating for achievement of the project outcomes.

The PSC will be chaired by the General Manager of the BWA, with Project Manager (PM) or Project Coordinator (PC) serving as Secretary. In addition, PSC shall comprise the following members:

a) PS, Energy & Telecommunications, or his/her nominee;
b) Permanent Secretary (PS), MOA, or his/her nominee;
c) PS, MOF, or his/her nominee;
d) PS, MOH, or his/her nominee;
e) Head, EPD, or his/her nominee;
f) Chief Town Planner of TCPD, or his/her nominee;
g) Head of the Bureau of Gender Affairs, or his/her nominee;
h) Representative, Barbados Chamber of Commerce; and
i) Representative, Government Press and Public Relations
j) PS, Ministry of Education, Science, Technology and Innovation, or his/her nominee;
k) PS, Ministry of Social Care, Constituency Empowerment and Community Development, or his/her nominee

As mentioned above, currently BWA has an existing relationship (MOU) with City of Bridgetown Cooperative Credit Union (COB- CCU). This relationship will be strengthened further with establishment of the RAFF. The BWA will develop the fund; however, management of the fund will be independent of its operations.

UWI and USF will provide support through partnership with BWA and the Government of Barbados. This Partnership will be particularly impactful in the building capacity within BWA, scientific research for decision making, and reaching out to households and communities.

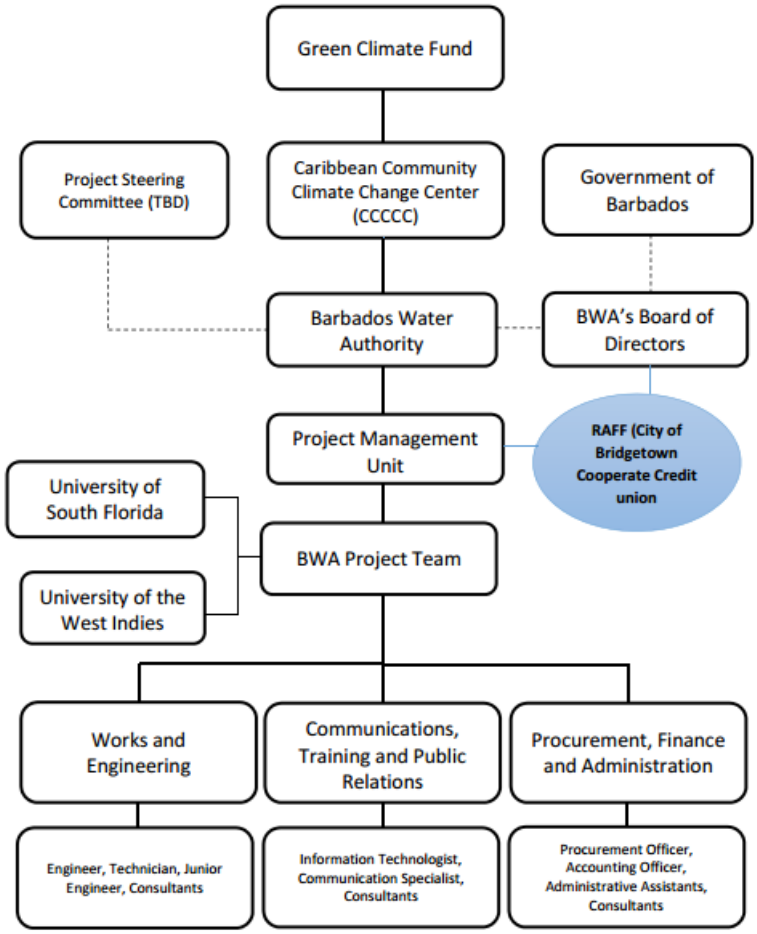


Figure: Project Management and Reporting Structure

C.8. TIMETABLE OF PROJECT/PROGRAMME IMPLEMENTATION

Please provide a project/programme implementation timetable in section I (Annexes). The table below is for illustrative purposes. If the table format below is used, please refer to the activities as numbered in Section H. In the case of outputs, please mark when all the required activities will be completed.

See Annex for detailed Timetable.

D.1. Value Added for GCF Involvement

Please specify why the GCF involvement is critical for the project/programme, in consideration of other alternatives.

The GCF's involvement is justified because the proposed intervention is recognised by Barbados and regional governing agencies (e.g. CARICOM) as a mitigation and adaptation priority for the region. The programme addresses a fundamental and growing vulnerability of the Caribbean region that is recognised by the Intergovernmental Panel on Climate Change (IPCC), and which will affect hundreds of thousands of people if not dealt with urgently. Barbados does not have the resources to implement the programme at the scale that is required, especially in capacity building for regional expansion. It is also directly aligned with the Regional Climate Change Mitigation and Adaptation Strategy Implementation Framework which has been endorsed by the CARICOM Heads of Government as guiding the region's response to Climate Change. The Implementation Framework recognised the key role that climate financing played in achieving climate resilient development in the Caribbean Region, given the inherent difficulties in a disaster prone region in providing funding for addressing climate resilient development.

GCF approval and funding will provide much needed resources to build the Barbadian and Caribbean regional capacity that is required to scale-up and replicate existing successful models of water management. Like most CARICOM member states, Barbados is highly indebted. Barbados central government debt to GDP ratio increased from 97.5% in 2010 to 128.9% in 2013 (WDI, 2016), which is one of the highest in the region. This curbs the fiscal space that Barbados central government has to implement well needed adaptation and mitigation projects. While the primary focus of many developed countries is mitigation, developing countries like Barbados must consider mitigation and adaptation options as complements since the adverse effects of Climate Change are already upon these small island developing states. Despite current efforts to mitigate greenhouse gas emission, these effects will be exacerbated in the medium to long term.

Barbados is one of 22 countries in the Partnership for Action on the Green Economy which aims to put sustainability at the heart of economic policies and practices to advance the 2030 Agenda for Sustainable Development and support the reframing economic policies and practices around sustainability to foster economic growth, create income and jobs, reduce poverty and inequality, and strengthen the ecological foundations of economies. This follows from Barbados' Green Economy Scoping Study which identified water and energy as critical sectors for transitioning the country to a more sustainable economic model. This project is complementary and will be supported by the policies and interventions being made by the Government to facilitate green economic growth.

The funding being sought for the implementation of this project is necessary to prompt change and structural shift needed for energy and water production in Barbados. It is critical to guarantee water security as actions are needed to reduce NRW and increase water availability. The BWA operating as is will struggle to meet the increased demand for water and face increased cost of producing water, especially as it relates to its energy needs. Given BWA current operations and maintenance cost and the magnitude of actions needed to reduce NRW and increase water availability, an incremental approach to mitigation and adaptation is required. In the context of Climate Change and with Barbados almost at peak utilization of ground water sources, the BWA needs to become more efficient and/or expand its' production. Increase in temperature will lead to faster rates of evaporation and evapotranspiration whilst reduced rainfall will mean that aquifers are not recharged at the same rate.

GCF support in the implementation of this project will help to guarantee water security in Barbados. It will facilitate in raising awareness about the feasibility of integrated water and energy demonstration sites that mitigate greenhouse gas emissions whilst adapting to Climate Change adaption. Since water is cross-cutting, this programme has far-reaching effects both immediate and in the long term for the entire population of Barbados as well as the Caribbean region. It creates employment, reduces carbon emissions, reduces the use of commercial fertilizers, improves resilience against Climate Change and extreme climate events, reduces nutrient load to coast waters and its impact on reefs, results in foreign currency savings due to the reduction in the importation of fossil fuel and fertilizers and raises awareness.

Funding from the GCF will aid the BWA. It will enhance the BWA operations making it more resilient to different scenarios of Climate Change; whilst demonstrating how climate mitigation can generate revenue for use in the implementation of other mitigation and adaption indicatives. GCF support will help to build capacity within the BWA and the community. BWA staff involved in the implementation of this project will develop a wealth of knowledge, which is important for

replicating and scaling some activities of the programme. Additionally, training and outreach programmes will raise greater awareness of the issues facing the water sector in Barbados, especially in the context of Climate Change and the contribution of GCF in helping to mitigate Climate Change and building greater resilience in various sectors. GCF contribution to this project would help to foster relations and collaborative efforts between BWA and UWI-CERMES, demonstrating the importance of co-ordination and collaboration in combating Climate Change.

D.2. Exit Strategy

Please explain how the project/programme sustainability will be ensured in the long run, after the project/programme is implemented with support from the GCF and other sources, taking into consideration the long term financial viability demonstrated in E.6.3. This should include a description of strategies for longer term maintenance of physical assets (if applicable).

After the GCF intervention the programme would become economically viable and be self-sustaining. This will be achieved through several means:

- The PV systems will reduce energy expenditures for the BWA by 10% of its present energy cost per year. This allows BWA to allocate funds to implement additional PV systems and repair leaks in the distribution system. The savings in electricity cost will be used to establish a revolving/investment fund, which will be reinvested into activities that will further reduce the operation and maintenance costs, reduce NRW/leakages and advance other income generating activities.
- The NRW interventions will reduce costs and increase the volume of available water for sale to customers. This allows BWA to meet the demand for water and increases its revenue, which is critical to covering its operational and maintenance expenditure.
- The better understanding of the inter-relationship between understanding the demands on and the efficient delivery of water services will contribute to evidence based planning of future water resource management and service delivery that are technically efficient, socially equitable and economically sustainable.
- Maximisation of RWH adaptation potential.
- The reduction in energy expenditures and maintenance costs associated with leaky infrastructure. This allows BWA to reallocate funds away from energy and maintenance costs to other actions needed to guarantee water security and increase and improve access.
- The involvement of the BWA staff in the implementation of this project will result in human development, which will significantly benefit the BWA, Barbados and The Region.
- The training courses developed will be offered to others in the Caribbean region at a fee and will continue after this programme has ended. The development of continuing education programmes will be on a cost recovery basis and any funds generated will be re-invested in further training, research and scholarships.

Once the funding for the project actions has come to an end, through the costs savings achieved, the reduction in operating costs and the generation of income activities, the BWA should be in a stronger financial position to continue investing in infrastructure renewal, without the need for further grant aid. The setting up of a Non-Revenue Water section will result in on-going cost reductions and the increased institutional collaboration between UWI and BWA is expected to result in an increase in development activities which will result is further optimisation of BWA operations and an increase in Research and Development outcomes within the UWI-CERMES. Although these would initially be of direct benefit to Barbados, they will also be of benefit to countries of the Eastern Caribbean, all of which experience similar operational issues. Furthermore, involving students, to actual problems encountered by utilities, will build regional capacity not just in operation and maintenance but also in the teaching of climate resilient water infrastructure.

With GCF funding at the implementation of adaptation and mitigation phase, the people of Barbados and the region will greatly benefit from these initiatives which the region must own. This project is designed in such that at the end of its implementation it will be owned by the BWA. BWA responsibility is to maintain its infrastructure, which includes those implemented under this project as well as optimally generate revenue needed to sustain its operations and safeguarding water security. Through stakeholder involvement and consultations, a wide cross-section of the society has helped to shape its components and deems it important.

In this section, the accredited entity is expected to provide a brief description of the expected performance of the proposed project/programme against each of the Fund's six investment criteria. Activity-specific sub-criteria and indicative assessment factors, which can be found in the Fund's Investment Framework, should be addressed where relevant and applicable. This section should tie into any request for concessionality made in section B.2.

E.1. Impact Potential

Potential of the project/programme to contribute to the achievement of the Fund's objectives and result areas

E.1.1. Mitigation / adaptation impact potential

Specify the mitigation and/or adaptation impact, taking into account the relevant and applicable sub-criteria and assessment factors in the Fund's investment framework. When applicable, specify the degree to which the project/programme avoids lock-in of long-lived, high emission or climate-vulnerable infrastructure.

Impact Statement: This project builds resilience to climatic natural disasters, such as droughts, tropical storms and hurricanes, into livelihoods and the water sector of Barbados whilst resulting in a paradigm shift of 1) energy used in the production and distribution of water in Barbados away from fossil fuel combustion to renewable and cleaner energy namely PV and natural gas systems, and of 2) silo'd institutions to utility/university/community/private sector partnerships that mainstream gender, promote stakeholder engagement, exchange knowledge, build workforce, and foster entrepreneurship opportunities. It addresses issues related to supply, distribution, quality, availability, equitable access, and sustainable utilization of water in Barbados and provides benefits that cut across several industries, sectors, communities, and vulnerable groups, while integrating gender considerations throughout. It will benefit Barbados' only public hospital and all of its polyclinics, community centers, schools, farms, and households, especially those with differently abled persons, welfare recipients, pensioners, and economically disadvantaged. Its value-add to society in the short-term is as important as the long term avoided greenhouse gases emissions and problem-solving education through capacity building and outreach activities. It builds a strong suite of actions needed to safeguard and guarantee water security in Barbados and bolster Barbados' resilience to climate change.

E.1.2. Key impact potential indicator

Provide specific numerical values for the indicators below.

GCF core indicators	*Expected tonnes of carbon dioxide equivalent (t CO_2 eq) to be reduced or avoided (Mitigation only)*	*Annual*	7339.46 *tCO_2 eq*
		Lifetime	220,184 tCO_2 *eq*

	• *Expected total number of direct and indirect beneficiaries, disaggregated by gender (reduced vulnerability or increased resilience);* • *Number of beneficiaries relative to total population, disaggregated by gender (adaptation only)*	*Total*	Direct Beneficiaries:[28,29,30,31,32] Total no.: 189, 002 Gender disaggregation: Males: 90, 532 Females: 98, 470 Indirect Beneficiaries Total no.: 284 996[33] Gender disaggregation: Males: 136, 498 Females: 138, 498
		Percentage (%)	Direct Beneficiaries Total: 66.3% Gender disaggregation: Males: 31.7% Females: 34.6% Indirect Beneficiaries Total: 100% Gender disaggregation: Males: 47.9% Females: 52.1%
Other relevant indicators	This value includes all the residents benefitting from the Belle, Hampton and Bowmanston areas, as well as the 1,300 vulnerable households, hospitals, polyclinics, community centers, and schools. 1. Improved resilience to Climate Change and Disruptions in Water Supply, which include: ○ Reduced leakage and the related number of disruptions.		

[28] Note: This value was calculated as (a) + (f) based on the following information: residents supplied with water from the Belle, Hampton and Bowmanston stations:152, 875 (a), an estimate of additional residents based on vulnerable households (b), hospitals (c), polyclinics (d), community centers and schools (e): 39,000 (f). Vulnerable households total 3,770 (b) due to an estimate of 1,300 households at an average of 2.9 persons per household. The Queen Elizabeth Hospital occupancy was estimated to be 24, 221 (c) and was based on the existing facilities available. The QEH has 600-beds and has an occupancy rate of about 122.3% in the Department of Medicine and in 2012, 20597 (d.i) patients were admitted to the QEH, plus the occupancy of 3,624 (d.ii) persons in the Accident and Emergency Department who stay for more than 18 hours but less than 24 hours. Polyclinics account for about 2,411 persons (d). Community centres and schools account for about 18, 526 persons (e) and was based from the location of community centres and schools in these areas. To minimize redundancies due to overlap errors a baseline of 20% was anticipated to give value (f) as 0.8(b+c+d+e). Gender disaggregation was estimated at the ratio provided by the WorldBank report 2017.

[29] Barbados Country Assessment of Living Conditions 2010 Volume 1: Human Development Challenges in a Global Crisis: Addressing Growth and Social Inclusion, http://www.caribank.org/uploads/2012/12/Barbados-CALC-Volume-1-MainReport-FINAL-Dec-2012.pdf, 12 November 2017.

[30] Report of the Chief Medical Officer 2010-2012, Government of Barbados, Ministry of Health. https://www.barbadosparliament.com/uploads/sittings/attachments/05530f55cc1d0cd01198dbc26b76209b.pdf 12 November, 2017.

[31] Banerjea, K., & Carter, A. O. (2006). Waiting and interaction times for patients in a developing country accident and emergency department. *Emergency medicine journal*, *23*(4), 286-290.

[32] Barbados - Urban population, Trading Economics 2017. World Bank Collection of Development Indicators. https://tradingeconomics.com/barbados/urban-population-wb-data.html 12 November, 2017.

[33] United Nations Population Division, 2017 Revision of World Population Prospects, https://data.worldbank.org/country/barbados 12th November 2017.

	○ Increased water available to the public. ○ Stable price for water. ○ Increased water and food security via storage and rainwater harvesting. ○ Improved/Increased Resilience to Storm Events. ○ Increased access to adaptation and mitigation financing (Micro- adaptation and mitigation funding). 2. Climate data integrated into groundwater model. 3. Increased potable water storage for the most vulnerable populations as well as hospital, polyclinics, schools and community centers. 4. Increased rainwater harvesting for Agriculture and replenishing of aquifers. 5. Reduced BWA energy cost. 6. Enhanced capacity, knowledge and climate resilience in institutions, households and communities. 7. Improved knowledge on water conservation and recycling. 8. Improved policy and legislative environment for climate proofing and building climate resilience.

Describe the detailed methodology used for calculating the indicators above. Describe how the project/programme's indicator values compare to the appropriate benchmarks (i.e. the indicator values for a similar project/programme in a comparable context).

The avoided lifetime emissions of 220,184tCO_2eq (30 years) are avoided emissions associated with the PV systems implemented at the selected pumping stations. Avoided emissions for the PV systems are calculated using the following methodology.

In accordance to the UNFCCC Version 6 of the "Table to calculate the emission factor for an electricity system"[34] the value for CO_2 Emission Factor (EF_{CO2}) was determined as the default IPCC value for Fuel Oil. The Barbados Light and Power (BL&P) Company Limited supplies electricity to the electricity grid by converting Fuel Oil (No. 6 fuel oil or Bunker 'C') into electricity. However, recently the BL&P has been investigating the use of solar photovoltaic panels and wind turbines and are referred here to as low-cost/must run resources. Since these low-cost/must run resources account for less than 1% of the electricity supplied to the grid, these resources were not considered in these calculations.

Due to the absence of all data necessary to calculate the operating margin (OM) for Barbados under Option A, Option B has been used instead to give a more clearly defined solution. The average OM emission factor is calculated based on the net electricity supplied to the grid and total fuel consumption of the system. The average operating margin CO_2 emission factor is calculated using the following equation:

$$EF_{grid,OM-ave,y} = \frac{\sum_i FC_{i,y} \, X \, NCV_{i,y} X \, EF_{CO_2,i,y}}{EG_y}$$

Where: $EF_{grid,OM-ave,y}$: average operating margin CO_2 emission factor in year y (t CO_2/MWh), $FC_{i,y}$: amount of fuel type i (Fuel type no.6) consumed in the project electricity system in year *y* (ton), $NCV_{i,y}$: net calorific value (energy content) of fuel type I (Fuel type no.6) in year y (GJ/ton), $EF_{CO2,i,y}$: CO2 emission factor of fuel type i (Fuel type no.6) in year y (t CO_2/GJ), EG_y: net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year y (MWh), i: Fuel Type No.6 combusted in Barbados in the project electricity system in year y, y: 2008, 2009 and 2010. The IPCC default values for $NCV_{i,y}$, at the lower limit of the uncertainty at a 95% confidence interval, are used for the following parameters:

[34] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.pdf/history_view

The resulting GHG emission calculations are presented below in the following table (See Annex for detailed Methodology). The results are presented for different scenarios capacity factor, ranging from a minimum of 20.1% to a maximum of 27%. The mean GHG emission is used to estimate potential GHG emission reductions for this project.

Scenarios	Station	Supply (MW)	Capacity Factor	Annual Power (MWh)	Grid Emission Factor (tCO2 /MWh)	Annual GHG reductions (tCO2)
A	Bowmanstan	0.5	0.201	880.38	0.7906	696.0284
	Hampton	2	0.201	3521.52	0.7906	2784.114
	Belle	2	0.201	3521.52	0.7906	2784.114
B	Bowmanstan	0.5	0.2355	1031.49	0.7906	815.496
	Hampton	2	0.2355	4125.96	0.7906	3261.984
	Belle	2	0.2355	4125.96	0.7906	3261.984
C	Bowmanstan	0.5	0.27	1182.6	0.7906	934.9636
	Hampton	2	0.27	4730.4	0.7906	3739.854
	Belle	2	0.27	4730.4	0.7906	3739.854

The avoided emissions associated with the use PV vs energy produced using combustion, as is the case for the majority of the energy produce by Barbados Light and Power Company Limited, is 7339.46 tCO_2eq per year. There is also the benefit of having energy to power the distribution of water during times of natural climatic disasters such as tropical storms and cyclones, which are usually associated with significant cloud cover and loss of power from the grid. The direct beneficiaries of this component are those persons that directly consume water produced at the Belle, Hampton and Bowmanston Pumping Stations as well as persons who will be directly employed to manage and implement the project and BWA's employees who will be in charge with maintaining the infrastructure implemented by the project. The Belle, Hampton and Bowmanston Pumping Stations serve approximately 152,875 persons, which is approximately 53.6% of the population.

Under the Personal Tank Programme at least 10% (1,300 households) of the total 13,000 households with physically challenged person(s) or differently abled individuals will benefit from the personal water tanks. Under this programme, Barbados' only hospital will also benefit by having increased water storage from 14 hours to between 72 to 96 hours, which is the recommended emergency needs specified by the Pan American Health Organization (PAHO). Additionally, BWA ability to response in the case of droughts, storms/hurricane and other disasters will be enhanced.

Beyond the direct beneficiaries, the implications of the project are far reaching and crosscutting. It will benefit the agriculture sector and tourism sector by increase the amount of water available to the public. There is also the multiplier effect associated with the injection of capital and the increase employment associated labour income. Furthermore, there will be the reduced demand for foreign exchange, which will help to create an investor friendly environment. These benefits coupled with the size of Barbados and the integrated economic system that exists causes the indirect benefits to extend to the entire population of Barbados. Barbados' population is estimated at 284,996.[35]

[35] United Nations Population Division, 2017 Revision of World Population Prospects, https://data.worldbank.org/country/barbados 12th November 2017.

E.2. Paradigm Shift Potential

Degree to which the proposed activity can catalyze impact beyond a one-off project/programme investment

E.2.1. Potential for scaling up and replication (Provide a numerical multiple and supporting rationale)

Describe how the proposed project/programme's expected contributions to global low-carbon and/or climate-resilient development pathways could be scaled-up and replicated including a description of the steps necessary to accomplish it.

Given the urgency and seriousness of Climate Change, this project will implement several transferable and integrated water and energy demonstration projects that will enable Barbados to mitigate greenhouse gas emissions and implement climate adaptation strategies. The proposed suite of actions has great potential to catalyze impact beyond Barbados to other Caribbean Water Utilities. This will lead to a paradigm shift towards lower greenhouse gas-emissions and climate-resilient development throughout the CARICOM region. The technologies and strategies to be employed in this project can be easily adapted to local cultural and geographical contexts in the region. Furthermore, the theme of this proposal fits with a new paradigm emerging in water and wastewater management (the One Water concept) that emphasizes minimizing energy use and associated carbon footprints.

This proposed programme has great potential for scaling up and demonstration in Barbados and the wider Caribbean. Although Barbados is the focus of this proposal, it has similarities to many other Caribbean islands in terms of environmental stressors associated with increasing water and energy demand, overdependence on fossil fuels, presence of water scarcity, saline intrusion, ageing infrastructure and the importance of water in implementing strategies to mitigate and adapt to Climate Change (discussed in Section 2.1). Water scarcity, particularly acute in the dry season, is a problem throughout the Caribbean and in fact, a list of the 17 most severely water stressed countries in the world included Antigua and Barbuda, Barbados, Dominica, Jamaica, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago (Gassert et al., 2013).

With CCCCC as the executing entity, this project will benefit from CCCCC experience in project design, management and implementation. Additionally, CCCCC is a hub for information that will be critical to successful scale and replicate this and other adaptation and mitigation projects in the region. Since 2005, CCCCC has been coordinating The Region's response to Climate Change as such it has wealth of information on these issues. CCCCC has helped to design, manage and implement several projects for all vulnerable sectors across The Region; therefore, prescription, policy advice and guidelines are accessible from the CCCCC repository. There are several manuals, tools and models available to help co-ordinate and build climate resilience and sustainability into The Region's development agenda. CCCCC has experience in building climate resilience, which includes implementing renewable energy technology, in the water sector and has replicated some of these in different parts of the region. On the other hand, as an accredit entity to the GCF, CCCCC was assessed against the GCF's fiduciary principles and standards; GCF's interim environmental and social safeguards (ESS); and, GCF's gender policy. Therefore, CCCCC must adhere to these guiding principles in the execution of this project.

This proposed project from the onset identifies scaling and replicating as important. Therefore, to truly guarantee water security in Barbados in the medium to long term, several activities identified in this project proposal must be replicated and if possible scaled. The revenue and cost-cutting components of the programme should generate enough resources necessary to replicate this project (if not in its entirety some aspects such as the personal tank programme and rainwater harvesting initiatives) at least in the medium term. As for replication in other parts of the Caribbean, once the necessary funding is secured, replication could take place in the short to medium term since the CCCCC would be willing to provide guidance as well as the lessons learnt from the implementation of this project and others available from the CCCCC repository.

E.2.2. Potential for knowledge and learning

Describe how the project/programme contributes to the creation or strengthening of knowledge, collective learning processes, or institutions. Describe how the proposal contributes to innovation, market development and transformation. Examples include: Introducing and demonstrating a new market or a new technology in a country or a region. Using innovative funding scheme such as initial public offerings and/or bond markets for projects/programme

Within this project there are provisions for intricate collaboration among key educational institutions that have contributed to the development of the water sector of Barbados. With these institutions working together, this is the BWA, University of West Indies, Cave Hill Campus (UWI-CHC) and University of South Florida (USF), it is anticipated that a sharing platform will be developed that will incubate the generation of novel ideas in the effort to combat the impact of climate change and also to propel the discussion on climate change adaptation and mitigation. This project proposes to gather the relevant human resources from these institutions and form a team of scientists and engineers to drive the in-depth operational research to build capacity. This is to aim to realize innovative measures to ensure that the knowledge gaps, (with respect to integrated energy-water management that reduces impact of Climate Change in the Caribbean region), that are discovered can be filled though south-to-south learning initiatives. It is advantageous in some aspect that Barbados has the highest Human Development Index in the Caribbean. In this manner, Barbados can serve as a brilliant example to be a model for south-to-south cooperation for the rest of the Caribbean in these water sector initiatives. In this regard, the dissemination of knowledge would not only be at the employee level with practical and theoretical training; but must also ensure that the various stakeholders are involved in the knowledge strengthening. In this manner it is only then possible to ensure that there is a behavioral change that this project also seeks to have as an impact on the local community of Barbados.

It is therefore critical that this project includes public workshops, demonstrations and knowledge activities to be conducted as a mechanism to ensure that there is a high change of reaching the members of the community that are vulnerable to impacts of climate change on the water sector. Importantly, the BWA, CCCCCs, University of West Indies (UWI) Cave Hill Campus have a history of collaboration and strong technical, business, and outreach expertise to manage successful implementation and dissemination of the various activities. It is expected that as the project is implemented that there will be new experiences due to the nature of the project and the new learning platforms and networks that will be created. The CCCCC, with its established and proven track-record as the leader in Climate Change adaptation planning and management studies throughout the Caribbean, has many operational programme linkages and networks. To this end the BWA, UWI-CHC and USF would be able to share this critical information to other members of the Global-South that may be embarking on similar activities in the future. This unique capacity will ensure effective and efficient project delivery and guarantee the sustainability of programme outcomes and impacts. This project also encourages investment in environmentally sustainable technologies that support economic growth which is one reason this programme links with training efforts of faculty and students at the UWI-CHC and USF.

The proposed capacity building component will train persons in energy efficiency, water loss reduction, resilience response programme, and rainwater harvesting. Additionally, it will organize education/outreach activities and deliver via seminars and workshops to communities and government agencies as well as foster research for use in informing development. Of these initiatives it is important that the documentation of the project progress be a resource that everyone who is interest can access due to the valuable information that can be contained in the document. From project initiation to project conclusion, there will be valuable lessons that will be learned as institutional knowledge, but through proper dissemination through media and other related e-formats, this institutional knowledge can be retained and shared with others for the development of similar programs and also key methods in South-South engagement.

E.2.3. Contribution to the creation of an enabling environment

For SIDS, “any water crisis is a governance crisis” (HLPW Action Plan 2016) and therefore the supportive role of Governments and/or their derivative champions is pivotal towards fostering the right framework and enabling environments. The significance of this role requires awareness and long-term visioning. This project will contribute to creating this framework and enabling environments.

Barbados as a location is easily accessible to other stakeholders in the Caribbean and there are facilities and staff that can assist in training and dissemination efforts for the new knowledge generated in this project. Barbados also recognizes, like other Caribbean stakeholders, that Climate Change’s impact on the region’s water resources is critical to support the tourism economy of the region as well as social and economic development. This includes the important role that climate mitigation and climate adaptation strategies related to implementing more sustainable water management play in supporting a viable and sustainable tourism industry.

Developing Climate Change Adaptation Water Master Plan will contribute to the creation of an enable environment by providing a suite of actions needed for the water sector of Barbados. These actions should include initiatives related to legislations, regulations, financing, adaptation and mitigation activities, capacity building and public awareness. The Climate Change Adaptation Water Master Plan will also develop a strategy for implementing this plan. The revolving adaptation fund facility will serve as model for other countries to follow. It will mobilise funds that would have otherwise been used to pay for energy produced using fossil fuel to further water sector adaptation and mitigation efforts in Barbados. This fund targets the most vulnerable in the Barbados but does not exclude anyone from accessing financing for water sector related adaptation and mitigation; hence creating an enabling environment for all to adapt to climate change and variability

The development of alternate renewable energy and community outreach water servicing programmes through the use of the revolving adaptation fund also facilitates capacity building through transformative programs and processes which in turn serves as lures for more specialized skillsets in several areas; as the use of technology improves and as the demands for improved technically and administratively trained personnel increases.

E.2.4. Contribution to regulatory framework and policies

Describe how the project/programme strengthens the national / local regulatory or legal frameworks to systematically drive investment in low-emission technologies or activities, promote development of additional low-emission policies, and/or improve climate-responsive planning and development.

The need to develop regulatory framework and policies is necessary as it fosters an enabling environment that will allow Barbados to further its best practices’ mode in its drive to improved climate resiliency in support of its development strategy to finance identified mitigation and adaptation programmes.
As a number of government corporations and agencies have sought to develop key

programmes, the lack of public capacity has catalyzed measures of resourceful thinking, including consideration of various funding vehicles (UNESCAP 2011). Public-Private-Partnerships (PPP’s) has been one such source of funding which has enjoyed particular usage and it has been recognized at least by BWA as an active participant, that it is now necessary to have appropriate safe guards via supporting legal framework and/or policy documents governing how PPPs should work. The development of such framework is in advance stages in Jamaica where all actors subscribe to one methodology for the employment of PPPs. In Canada, the Government’s audit division plays a keener role in providing direct oversight and approval at key stages of the PPP tendering process to ensure that there is complete transparency and minimal risk to the participants who follow set guidelines. Activity 4.2.2 is aimed at producing a policy paper that could form the basis for addressing this legislative gap. Additionally, The Climate Change Adaptation Water Master Plan will contribute significantly to identifying needed legislations and regulations. These legislations will complement the climate change adaptation needs identified in the Master Plan.

The project also proposes raising greater public awareness at various levels, including government officials and entities. This component should aid in the development of legislation and regulation as well as encourage enforce of existing applicable water sector, energy, or environmental legislations. There is already government support for this project, which is the first step towards greater engagement and collaboration with Government and public entities.

E.3. Sustainable Development Potential

Wider benefits and priorities

E.3.1. Environmental, social and economic co-benefits, including gender-sensitive development impact

The economic, social and environmental implications of this project include (but is not limited to):

Economic

- Reduced energy cost to BWA resulting in savings and greater sustainability in the long-run.
- Reduction in NRW/leakages due to the replacement of 20km of mains and due to the establishment of demand management areas (DMAs) as part of leakage control measures informed by analysis of consumption data.
- Built climate resilience in the agriculture sector
- Foreign currency saving due to the reduction in the importation fossil fuel and fertilizers.

Social

- Greater awareness and data about Barbados water system and water conservation.
- Development of vulnerable population and pro-poor water affordability initiatives.
- Enhance capacity in the BWA and the communities.
- Create employment
- Gender driven development

Environmental

- Improved resilience against Climate Change and extreme climate events.
- Avoided Carbon Emissions by using renewable energy source in the production and distribution of water

The implementation of the PV system will reduce BWA's expenditure on energy. It is estimated that the PV system will reduce BWA expenditure on energy by US$1.1 million in the first year. The benefits of implementing the PV system increase if there is inflationary pressure on fuel prices. Furthermore, the savings realized is critical for developing the climate change adaptation fund, replicating this project and building greater resilience into the water sector in Barbados.

The project will replace 16 km of mains reducing leakage by 0.03 MGD per km. This will result in greater availability of water, which when valued, at the current cost of water is an avoided cost to the society of US$1.3 million. Increased availability of water will reduce the instances of water outages currently being experienced by many customers. Previous instances of outages have had the adverse effects of persons reporting for work late or absent from work and businesses closing. Schools have had to close due to lack of water and the potential unsanitary conditions are likely to increase health treatment costs. In addition, there have been some cancellations of tourist stays and bookings. Whilst difficult at this point to value, these losses in household income and tourist receipt and the additional charges to the welfare system represent an economic cost to the country. Without intervention, deterioration of the water supply system can be expected to accelerate with a concomitant rising economic impact. The water supply capacity is at its limit and the lack of an assured supply has curtailed development and investment. Leakage reduction and mains replacement coupled with the personal tank programme and rainwater harvesting initiatives will provide greater assurance of supply and contribute to conditions conducive to the realization of planned developments.

Tourism is one of the backbones of Barbados economy. In 2014, the total contribution of tourism and travel accounted for 36.1% of GDP and employed 37.5% of total employment (WTTC, 2015). Another vital sector is agriculture. Agriculture, which in 2014 contributed 1.4% (value-added) of GDP and employed 2.7% of total employment (WDI, 2016), is essential for food and nutrition security and household income. From the feasibility study, it was found that Barbados' already dwindling water resources are not sufficient to meet demand in medium to long terms. Implicit in that analysis is the demand for water by the tourism and agriculture sectors. Recent research has indicated that with the expected changes in climate the agricultural sector will have to increase its use of water in order to maintain food production and that this will entail the greater implementation of irrigation technology (Gohar & Cashman, 2016). Given the rising and competing demands for water across sectors it will be even more imperative to maximize existing sources of supply such as harvested rainwater. Rainwater harvested coupled with innovative irrigation system, that could be funded from the revolving adaptation fund, could help to secure the agriculture sector, hence the food and nutrition security of Barbados.

It is against this background that the replacement of 16 km of mains is complemented with a Personal Tank Programme and a Rainwater Harvesting Programme. The Personal Tank Programme will increase water available to 1,300 differently abled households. This is 10% of the total number of households registered a households differently abled with the Ministry of Social Care, Constituency Empowerment and Community Development. This programme will also benefit Barbados' sole public hospital by increasing its emergency storage capacity from 14 hours to between 72-96 hours. Polyclinics and schools, which usually serve as hurricane shelters, will also be retrofitted with emergency water supplies. The Rainwater Harvesting Programme will target farmers and households that are vulnerable to decrease rainfall (droughts) but cannot use water or do not have access to potable water produced by the BWA.

This project contributes to the stability of Barbados' macroeconomic environment, mitigates its susceptibility to inflationary pressures and external shocks and increases revenue to the government. Barbados will benefit from foreign currency savings resulting from reduced dependence on fossil fuels due to the PV installation. Barbados import US$322.7 million (2014) in crude oil and a significant portion is used in the production of electricity and transportation. It is estimated by BWA that the proposed PV systems will potentially save US$244,494 per year in foreign currency. Additionally, the replacement of leaky mains will reduce the amount of energy needed to pump water through the distribution system; hence, resulting in foreign currency saved that otherwise would have been used to purchase crude oil for energy production. It is estimated that NRW reduced from 43% to 38% has the potential to save US$3,500,000 per year in foreign currency.

The reduction in demand for foreign currency and imports helps to reduce Barbados susceptibility to inflationary pressures and external shocks. Increases in price of crude oil on the international market tend to increase the price for energy locally and in the medium term is passed on to end users, businesses and households, in the form of price increases. As highlighted in the feasibility analysis in Section F.1, inflation has the potential to undermine the success of this project and Barbados' ability to provide water service to the population at a reasonable price. Inflationary pressures cause the operating and maintenance costs of BWA to grow faster than its revenue; therefore, in the long-run it would make a loss, assuming small to moderate changes in water tariffs rates and historic population growth rates. Additionally, inflationary pressures curb the fiscal space of the central and local governments, limited their ability to react both in the short and long –run.

This project will help to mitigate imported inflation, contagious shocks from trade and the stressor of the NIR. Barbados as a small open economy has a fixed exchange rate regime as such managing the demand for foreign currency and the stock Net International Reverse (NIR) is essential to maintaining its pegged to the US$ at 2:1. The design of this project encompasses this by aiding in reducing the burden place on the NIR, through reduction in imported crude oil for energy production.

This proposed project will also increase revenue to the Government and create jobs. The direct benefit to the Government of Barbados is an additional US$70,000 in revenue for the license needed to produce and sell electricity in Barbados. This project is expected to create 30 new jobs. 15 of the 30 new jobs will be created at the Belle pumping station. The efforts to reduce NRW, implement rainwater harvesting initiatives will create another 15 new jobs.

Pivotal to this proposal and replication in different localities in Barbados and other Caribbean countries is the capacity building component under this project. Capacity building will be achieved through training of technical staff at the BWA and other water utilities of the Caribbean, university students, and visitors to the demonstration sites. Through this programme 15 operators from the BWA will receive certification, and 50 will undergo training in the various aspects of the project. Training courses will be established by UWI based on the WSRN S-BARBADOS programme that will be open to others in the region as interest in efficiency grows. University students will have the opportunity of working on

various aspects of the WSRN S-BARBADOS programme, particularly research projects that also provides valuable information for the programme. This is in line with the UWI Strategic Objectives of increasing learning opportunities.

The cross-cutting nature of the water supply and demand across several sectors and fabric of society reiterates the importance of this proposed project in safe-guarding the supply, distribution, quality, availability, access, utilization, and stability of water in Barbados. Put differently, water is life and this project will provide greater water security to the population of Barbados and visitors to the island. Additionally, reducing leakages has the potential to improve the health and safety of the environment by reducing mosquito breeding sites and generally create a cleaner environment. Experience with prolonged failures in water supply to urban areas in recent years has highlighted the associated social consequences; loss of productivity and household incomes, increased school absenteeism, increases in domestic troubles (Barnett, 2011).

Gender issues are also considered. This project considers gender-sensitive policies and development impact by pledging to balance and rebalance male and female participation and contribution in the implementation of this project as well as equity in the distribution benefits of this project. The WSRN S-BARBADOS programme aims to broaden participation of underrepresented groups in the various aspects of the programme. The university programmes associated with WSRN S-BARBADOS will be evaluated for their gender diversity and in the cases where imbalances exist, this programme will recruit with an aim to strike a better balance. The proportion of men and women recruited for the jobs for WSRN S-BARBADOS will depend on the targeted numbers to bring diversity to each of the programme areas. PV installation at the BWA's previous sites had 13% female employees and the aim of this project will be to increase the participation of females from 13% to at least 30%.

Within UWI-CERMES there are more women postgraduate students and researchers than men; therefore, similar actions as above may be required to strike a better gender balance. It is anticipated that of the five employment opportunities within UWI-CERMES, 60% will be awarded to women. During the other research activities identified by CERMES, on past experience at least 60% of the researchers are likely to be female based on knowledge of persons with the necessary skill sets to undertake the work.

Besides gender policy guided employment, the proposed project will make provision for the sustainable and consistent supply of water that will greatly benefit women and men alike. Less disruption in water supply will reduce the need to be absent from work in order to care for children who cannot go to school for reason related to disruption in water supply.

Reduced air emissions from fossil fuel burning to power the Belle pumping stations, coupled with the reduced energy requirements to pump water through leaky mains will result in improved air quality for Barbados and improved health.

PV installation and reduction in non-revenue water will reduce the electricity purchased from the Barbados Light and Power. This means that less fossil fuel will be burnt as a result of these components, translating into improved air quality and reduced greenhouse gas emissions. The implementation of PV systems is expected to reduce carbon emission by 11,100 tCO_2 *eq* per year. The EPA, (2015) estimates the social cost at US$36 per ton, which means that this project would avoid a cost to the society of US$399,600 per year.

The harvesting of rainwater and storm-water specifically for the purposes of enhancing resilience will mitigate the adverse effects associated with localized flooding and waterlogging as well as the transport of sediments and nutrients into the near-shore marine environment.

E.4. Needs of the Recipient

Vulnerability and financing needs of the beneficiary country and population

E.4.1. Vulnerability of country and beneficiary groups (Adaptation only)

Describe the scale and intensity of vulnerability of the country and beneficiary groups, and elaborate how the project/*programme addresses the issue (e.g. the level of exposure to climate risks for beneficiary country and groups, overall income level, etc).*

Barbados is classified as a water scarce country that is currently experiencing a prolonged period of drought. Over the past few years Barbados has also experienced an increase in extreme weather events as well as changes in temperature and precipitation patterns[36]. In addition, observations confirm that there have also been increases in sea levels, groundwater saline intrusion and, coral bleaching events occur more frequently[37]. These critical observations provide evidence to support the notion that climate change is seriously affecting Barbados and, climate modeling projections by Simpson et al. 2012, based on these past observations, indicate that in the future Barbados will encounter, inter alia, an increase in the frequency and intensity of storms and hurricanes to the area. This is the current reality for Barbados and these effects of climate change will continue to have a negative impact on the water, energy, food and health security of Barbados among others, which ultimately affect the livelihoods of Barbadians.

Based on the increasing effects of the impact of climate change in 2015 the Government of Barbados developed the Intended Nationally Determined Contributions (INDC), which stated that it is anticipated that climate change impacts will limit the availability of fresh water, reduce agricultural productivity, increase land degradation and reduce fish stocks caused by the migration of fish to cooler waters beyond the Caribbean region. The combination of reducing precipitation (and hence aquifer recharge) and salt water intrusion from sea level rise will compound the issue of insufficient water availability (through salinization of ground water aquifers), further affecting the productivity of both agriculture and fisheries. Barbados will face indirect climate-related impacts including more frequent and intense droughts, flooding, and storms (physical damage), increased pest outbreaks, the spread of invasive species, the increased probability for the occurrence of vector borne and heat related illnesses and the destruction of key ecosystems which all threaten national productivity and may undermine the potential for real growth.

Location: The location and geography of the Caribbean, which is to the west of the Atlantic Ocean, makes it vulnerable to Atlantic hurricanes, tropical storms and earthquakes. It is projected that the intensity and frequency of these hurricanes and storms are expected increase owning to a changing climate[38].

Temperature: Projections from the Regional Climate Model (RCM) ensemble indicate increases between 2.4°C -3.2°C in mean annual temperatures by 2080s in higher emissions scenarios. Results for using the A1B emissions scenario within RCMs project an increase in the number of days and nights where temperatures exceed 35ºC during the day and 25ºC at night (Campbell at al., 2010).

Precipitation: Numerous models by Hall et al. 2012 have projected that there will be decreases in rainfall ranging between 25-50% of the current values by 2018 and this work is supported by the General Circulation model (GCM), RCM using HadCM3 and ECHAM4 boundary conditions. This results in a decrease in the potential of the internal renewable water resources to replenish the groundwater aquifers, thus increasing the vulnerability of food security the already water scarce Barbados. This is then further compounded as the projection by Hall et al. 2012 indicates that during the summer raining season the rainfall will decrease by 30% for Barbados. Analysis of the mean daily precipitation projects a 10–15% decrease in higher-intensity rainfall. Changes in precipitation intensity and the overall rainfall projections for 2075–

[36]Stephenson, T.S., Vincent, L.A., Allen, T., Van Meerbeeck, C.J., McLean, N., Peterson, T.C., Taylor, M.A., Aaron-Morrison, A.P., Auguste, T., Bernard, D. and Boekhoudt, J.R., 2014. Changes in extreme temperature and precipitation in the Caribbean region, 1961–2010. *International Journal of Climatology*, *34*(9), pp.2957-2971.

[37] Taylor, Michael A., Jhordanne J. Jones, and Tannecia S. Stephenson. "2 Climate change and the Caribbean." *Climate Change and Food Security: Africa and the Caribbean* (2016): 31.

[38] Allison, E.H., Perry, A.L., Badjeck, M.C., Neil Adger, W., Brown, K., Conway, D., Halls, A.S., Pilling, G.M., Reynolds, J.D., Andrew, N.L. and Dulvy, N.K., 2009. Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and fisheries*, *10*(2), pp.173-196.

2099 suggest a shift in rainfall distribution patterns for Barbados and the Eastern Caribbean with increasing drying in the late dry season and early wet season.

Sea Surface Temperatures (SST): GCM projections indicate increases in SST throughout the year. Projected increases range between +0.8℃ and +3.0℃ by the 2080s across all three emissions scenarios.

Sea Level Rises: As global temperatures increase it is predicted that sea levels will also increase, hence countries at low elevations, similar to Barbados, are at high risk of being adversely affected by the effects of climate change. In addition, since about 50% of the population of Barbados lives on the west and south coasts of the island, thousands of people will become increasingly vulnerable to flooding and these higher sea levels would then force these persons to have to abandon their homes and relocate. As the seawater moves further inland, destructive land erosion, flooding or wetlands, contamination (including saline intrusion) of aquifers and agricultural soils occur. Thus, increasing the vulnerability of the habitats for fish, birds and plants or the entire loss thereof. With respect to weather systems, higher sea levels increase the size and strength of storm surges that can have devastating effects on land, causing in some cases loss of life or livelihood. Barbados has already started to feel the effects of saline intrusion as about 10% of the wells (Villamarie, Aston, Trents, Hope among others) used to pump water have been closed from mid-2015, due to saline intrusion, thus decreasing the availability of groundwater to be used a potable water.

Tropical Storms and Hurricanes: Over the past 30 years the Caribbean has experienced intensified strengths of Atlantic hurricanes and tropical. There have been 31 Category 5 (Cat-5) hurricanes and only five times has more than one Cat-5 hurricane form during a single season[39]. Two of these events occurred recently in 2005 and 2007. In addition, from 2001 there have been 22 Category 4 (Cat-4) Atlantic hurricanes[40]. These storms severely impact the water security of Barbados and also the capacity to adequately deliver water to the population, thus resulting in decreased levels of sanitation and health security during and after extreme weather events. As these hurricanes impact the island they bring rain, however, these rainfall periods are not prolonged and does not permit the recharging of the groundwater aquifers, as most of the volume of rainfall is lost as stormwater runoff. Furthermore, during storms water pumping power is often lost due to power failures, resulting from downed power lines, as experienced during Hurricane Tomas and Ivan that left some Barbadians, who rely on the protection of public hurricane shelters or that seek refuge at family members, without water during critical times as health and sanitation are important during extreme weather events in crowded places.

The WSRN S-BARBADOS programme directly addresses the risks of reduced freshwater supplies associated with climate change. The principal risk to freshwater supplies will be manifest through impacts on aquifer recharge the investigation of which forms part of this project. Research conducted to date has indicated that the combination of increased temperatures coupled with reduced precipitation will significantly reduce aquifer recharge. Other work looking at coastal flooding suggests even though overall rainfall is likely to reduce the changes in precipitation patterns, particularly increases in rainfall intensity (including the effects of tropical storms) will increase storm-water run-off. Increased storm-water run-off would divert water away from recharge. However, the impact of the combination of reduced recharge and sea level rise particularly for the coastal aquifers has not been evaluated. Understanding the potential impact of changes in temperature, precipitation patterns and sea level rise and their effect on water availability forms one of the actions under this project.

This project will draw on recent work being undertaken by CERMES-BWA that is considering the climatic effects on the water distribution system and levels of leakage. The research considers how changes in rainfall patterns affect levels of leakage.

In addition to the above, the extent to which climate change might have an impact on potential power generation from PV systems will be explored. The effect is likely to be through changes in cloud cover as well as ambient air temperatures. These could affect the overall generation efficiency of PV systems as well as the number of sunshine

[39] National Hurricane Center; Hurricane Research Division (April 11, 2017). "Atlantic hurricane best track (HURDAT version 2)". United States National Oceanic and Atmospheric Administration.

[40] Dybas, C., and D. Terraso. "Number of Category 4 and 5 Hurricanes Had Doubled Over the Past 35 Years." *Press Release* (2005): 05-162.

hours and intensity of incident radiation. Vulnerability assessments arising from storm and hurricane activity on infrastructure put in place under this programme will form part of the detailed planning process.

In respect of rainwater harvesting the effects of changes in the amount of rainfall received and in precipitation patterns would have to be included. On the other hand, RWH systems can provide resilient water supply solutions that reduce vulnerability to storms and hurricanes.

The NRW activity through reducing the amount of water being wasted, promoting water use efficiency and the use of reclaimed wastewater for groundwater recharge and for agriculture production, will conserve existing freshwater resources and provide resilience against drought conditions.

The country's Debt to GDP ratio has been put at 130 percent thus making it critical not to incur additional indebtedness while seeking to grow the economy and maintain necessary social and infrastructure services. Thus the need to seek grants wherever feasible to implement projects such as this which are necessary and needed for economic development.

E.4.2. Financial, economic, social and institutional needs

Describe how the project/programme addresses the following needs:

- *Economic and social development level of the country and the affected population*
- *Absence of alternative sources of financing (e.g. fiscal or balance of payment gap that prevents from addressing the needs of the country; and lack of depth and history in the local capital market)*
- *Need for strengthening institutions and implementation capacity.*

Barbados is a small island developing state that is classified by the Worldbank as a high income country. In 2014, its GDP was US$4,353 million, which is a reduction from US$4,447 million in 2010. The financial crisis had adverse effects on Barbados' growth during the period 2008-2014 The average real GDP growth rate was -0.3%; however, in 2015, there was some recovery as real GDP grew by 0.8%. Although Barbados recorded positive real GDP growth in 2015, its trade balance was –US$1,135 million. In 2014, the Barbados' balance of payment account was reported at –US$248 million, a worsened position from 2010 when the balance of payment was –US$236 (UNData, 2016).

In a recent IMF briefing it was noted that (IMF, 2016),
"while favorable external developments have provided some room for maneuver, Barbados remains highly vulnerable and may not realize its potential without deep-seated reforms to align revenues and expenditures, and reduce debt...to reverse large increases in debt and place it on a downward trajectory, the mission recommends fiscal adjustment of at least 3.5 percent of GDP over the next three years…This adjustment would put the debt ratio below 100 percent by FY2019/20 (about the FY2014/15 level), and, if sustained, would shift the trajectory solidly downward."

The same IMF report also noted that,
"The financial system is stable and non-performing loans declined, while private sector credit growth remains cautious. The current account deficit has narrowed significantly, reflecting lower oil and other import prices—despite an increased volume of oil and intermediate goods imports—while exports grew modestly. Net international reserves fell by US$57 million since the beginning of 2015, reflecting lower foreign direct investment and debt amortization."

The current economic environment does not leave much fiscal space for public sector spending and as noted, the capital market remains cautious. Furthermore, although this project returns significant benefits to the society, the cash flow implication for BWA are not favorable, at least in short-term. Additionally, the activities proposed under this project are just a subset of the work needed to fully respond to climate change and its potential impact on all spectrum of Barbados; however, this project provides a basis on which several adaptation and mitigation initiatives will be built. It is against this background, that grant funding is being requested to implement 60% of the activities identified in this project.

E.5. Country Ownership

Beneficiary country (ies) ownership of, and capacity to implement, a funded project or programme

E.5.1. Existence of a national climate strategy and coherence with existing plans and policies, including NAMAs, NAPAs and NAPs

Please describe how the project/programme contributes to country's identified priorities for low-emission and climate-resilient development, and the degree to which the activity is supported by a country's enabling policy and institutional framework, or includes policy or institutional changes.

This project is also aligned with several of the recently agreed sustainable development goals (SDGs), which CARICOM and by extension Barbados has endorsed. These include climate action, clean water and sanitation, affordable and clean energy, responsible consumption and production and decent work and economic growth. Nationally, the project encapsulate the Barbados' Growth and Development Strategy broad objectives of: reducing dependence on fossil-fuels, ensuring environmental sustainability and combating Climate Change; building human and social capital base; infrastructure upgrade and modernization; and, ensuring more modern and efficient public and private sector institutions.

It is also aligned with the BARBADOS' National Climate Change Policy, which was approved by Cabinet in May 2012. The primary goal of the policy is to establish a national process for adapting to Climate Change effects and minimizing greenhouse gas emissions over the short, medium and long term, in a manner that is co-ordinated and consistent with the broader sustainable development aspiration which was one of the mitigation demonstration measures approved by the Climate Change Committee. Similarly, component 1 of this project is aligned with the BARBADOS' National Climate Change Policy.

Technological development strategies linked to environmental sustainability have been encouraged in the region by UNEP (2010). Increased use of undervalued and underutilized education and training programmes that assist residents and visitors is also recognized as an import link between water and energy management, health of ecosystems, and mitigation and adaptation to Climate Changes that are all integral to this proposal.

The rainwater harvesting activity complement the Town and Country Development Planning Office policy, which mandates that all new developments and refurbishment of existing facilities over a certain size are required to install rainwater harvesting systems, by engaging and retrofitting with existing houses and farms.

The project is designed with consideration for BWA's responsibility to the communities it serves, which includes monitoring, assessment, control and protection of the water resources in the public's interest. It buildings on an ongoing policy of education on water conservation and empowering the most vulnerable persons living in districts susceptible to water outages due to drought conditions.

E.5.2. Capacity of accredited entities and executing entities to deliver

Please describe experience and track record of the accredited entity and executing entities with respect to the activities that they are expected to undertake in the proposed project/programme.

The **Caribbean Community Climate Change Centre** (CCCCC - http://www.caribbeanclimate.bz) will be the Implementing Agency and will have overall responsibility for the delivery of the Programme. CCCCC will work with a range of executing agencies to implement various components of the programme as outlined in the diagram below (Framework of Activities and Role of Main Partners). Specific agreements (sub-contracts) will be developed with the following executing agencies:

As an accredited GCF entity, CCCCC is positioned to appraise the specific objective of projects identified and submitted for funding from the GCF. CCCCC employs a **SMART** approach to evaluate this specific objective, which is quantitatively or qualitatively verifiable. This means that the objective should be:

- **S**pecific: to avoid differing interpretations
- **M**easurable: to allow the monitoring and evaluation of implementation
- **A**ppropriate: to adequately address the problems
- **R**ealistic: achievable and meaningful
- **T**ime-bound: with a specific time for achieving it.

Additionally, a well formulated specific objective identifies directly or implicitly WHO will be reached, WHAT change will occur, in WHAT time period and WHERE the change will take place.

The CCCCC has applied the SMART approach in several projects they have implemented in the Caribbean. Some of these projects include:

- The installation of a Salt Water Reverse Osmosis (SWRO) plant and renewable energy technology in Bequia, St. Vincent and the Grenadines and Carriacou, Grenada for US$1 million;
- Strengthened critical coastal infrastructure by retrofitting and installing a Photo Voltaic (PV) system and rainwater harvesting storage for the Marchand Community Centre in the Castries area, Saint Lucia for US$300,000;
- Piloting of a rainwater harvesting and grey-water processing system for sustainability of Water Resources and Supply of the Vieux-Fort, Saint Lucia for US$286,610;
- Implementating an irrigation system for adaptation measures in the bio-diverse Morne Diablotin National Park and its Neighbouring Communities–and develop and implement an Integrated Ecosystem Management for the Morne Trois Pitons National Park, Dominica for US$244,625;
- Installing Photo Voltaic (PV) used for power switching for water pumps in Carlton, Barbados and Caye Caulker, Belize for US$643,000;
- Strengthen community-base fish sanctuaries through the C-Fish Ecosystem Adaptation Project by providing resources, training and alternative livelihoods in Grenada, Jamaica, Saint Lucia, and Saint Vincent and the Grenadines for US$3.3 million;
- Cultivate plants and crops in a sustainable manner through a community agro-forestry project within a forest reserve in Belize for US$250,000;
- Provided support for the replanting of aged cocoa plantations and establishing new forest zones for small farmers, increasing livelihood and income while reducing deforestation in Saint Lucia for US$171,000;
- Supported electrification using renewable energy provided by a Photo Voltaic system in the Kalinago Indigenous Community of Dominica for US$482,000; and,
- Supported a bio-mass pilot project that aids a community that is predominantly dependent on natural resources for their livelihood in Flowers Bank, Belize for US$500,000.

The **Barbados Water Authority** (BWA - http://barbadoswaterauthority.com) will be the main implementing partner and the implementation site for some project activities. The BWA is a Statutory Body established by an act of Legislature on October 8, 1980 to replace the Waterworks Department of Government. It commenced operations on April 1, 1981. It is responsible for managing, allocating and monitoring the water resources of the island with the view to ensuring their best development, utilization, conservation and protection in the public interest. The BWA is a large and complex operation with a staff complement of over eight hundred (800) and an annual budget of over $90 million. The facilities of the Authority are situated in a number of locations across the country and these include pumping stations, reservoirs and major storage centres at Bowmanston, St John and the Belle, St Michael. The BWA supplies 97% of the island with water and obtains its water supply from twenty-four (24) groundwater wells, two (2) springs, one (1) main privately owned reverse osmosis desalination plant as well as a small containerized desalination plant. This water is distributed through a network consisting of approximately two thousand five hundred kilometres (2,500 km) of water mains, twenty-eight (28) reservoirs located both under and above ground and seventeen (17) re-pumping stations (booster-pumps). It is also responsible for the designing, construction, acquisition, provision, operation and maintenance of water and sewerage works for the purpose of supplying water for public purposes and the receiving, treating and disposing of sewage, respectively. Though the water system is island-wide, the sewerage works consist of two centralized systems, the Bridgetown Sewerage Treatment Plant, a secondary treatment facility commissioned in 1980, and the South Coast Sewerage Treatment Plant, an advanced preliminary treatment plant commissioned in 2003. Combined, the two sewerage treatment plants currently treat 5 MGD.

Additional support for implementation of activities will be provided by the University of the West Indies and the University of South Florida.

The **University of the West Indies** (UWI - http://www.uwi.edu/index.asp) is a public university system serving 18 English-speaking countries and territories in the Caribbean. The University consists of three physical campuses; at Mona in Jamaica, St. Augustine in Trinidad and Tobago, Cave Hill in Barbados, and the virtual Open Campus. UWI staff at Cave Hill and St. Augustine campuses will play an important role in the Technical Working Group and in the

implementation of the research, education, and outreach components. Faculty from the Cave Hill Faculty of Science and Technology and St. Augustine Civil Engineering programme will work on the design, monitoring, and evaluation aspects of the various demonstration technologies. Faculty from Management Studies at Cave Hill will work on business development and entrepreneurship expansion based on the demonstration projects. The Department of Economics will partner with the Centre for Resource Management and Environmental Studies (CERMES) to jointly work on the development of economic incentives for RWH. The CERMES at Cave Hill will work on Climate Change impacts, aquifer modelling, RWH and non-revenue water aspects and, on demonstration technologies and enabling policy environments for mainstreaming demonstration technologies in Barbados and across the Caribbean region. The UWI CERMES has implemented several water resources and Climate Change adaptation research projects throughout the Caribbean Region over the last 10 years and together with the Climate Studies Modelling Group at UWI Mona has been one of the leading research organisations in the region. CERMES will partner with Environmental Protection Department (EPD) and BWA with respect to RWH and with BWA in respect of the NRW work.

The **University of South Florida** (USF - http://www.usf.edu) is a public university that serves more than 48,373 students with a $1.5 billion annual budget, and an annual economic impact of $4.4 billion. It is one of 12 universities within the State University System of Florida, one of the nation's top public research universities, a leading metropolitan research university, and is recognized as one of Florida's top three research universities. The university also ranks tenth worldwide among universities granted U.S. utility patents and Sierra Club ranked USF as a top 10 green cool school in 2014. The Civil and Environmental Engineering department leads a U.S. Environmental Protection Agency (EPA) funded Centre for Reinventing Aging Infrastructure for Nutrient Management (RAINmgt) which aims to achieve sustainable and healthy communities in a cost-effective manner by re-thinking aging coastal urban infrastructure systems for nutrient recovery and management. Faculty from this department will work on the non-revenue water systems as well as Life Cycle Assessment and Costing for project demonstration technologies and expansion to the wider Caribbean region.

E.5.3. Engagement with NDAs, civil society organizations and other relevant stakeholders

Please provide a full description of the steps taken to ensure country ownership, including the engagement with NDAs on the funding proposal and the no-objection letter. Please also specify the multi-stakeholder engagement plan and the consultations that were conducted when this proposal was developed.

The WSRN S-BARBADOS project team includes 4 core partners namely: the BWA, which is government own public utility; The CCCCC, a regional organization mandated to chart the Caribbean's response to climate change, and UWI and USF, which are universities that work closely on research needed to inform decision making. The aforementioned partners have met in person and virtually to conceptualize and complete the GCF proposal since September 2015. UWI departments represented include Centre for Resource Management & Environmental Studies (CERMES), Management Systems, Chemistry, and Institute for Gender and Development Studies. USF departments represented include Environmental Engineering.

At the regional Caribbean Water and Wastewater Association conference held in Miami in September 2015, presentations by the BWA, USF, UWI and the Caribbean Community Climate Change Centre, on various topics associated with this proposal, including gender and water, were well received by attendees. The BWA received the best technical award, "A Real World Application of Photovoltaic to Water and Wastewater Companies" and UWI received the best poster award, "Modeling the Impact of Climate Change in a Water Scarce Island Context". Given the relevance of those topics to climate change adaptation and mitigation, a short meeting was held to ascertain the level of the BWA's interest in applying for GCF grant funding through the 5Cs. A week later, representatives from USF and CCCCC met with the BWA in Barbados, including the general manager, board members, chairman of the board, and engineers. Subsequent to this meeting, several meeting were held between CCCCC, USF and BWA, to design a project that represented the views of some major stakeholders including: Minister of Agriculture, Food, Fisheries and Water Resource Management, Ministry of Environment, and Drainage, Management of the Public Hospital, the NDA, households, farmers, businesses and management and staff of BWA.

Representatives from all partners contributed to the writing of the GCF application with in person meetings held in Barbados in September 2015, July 2016, October 2016, November 2016, January 2017, May 2017 and July 2017 (a summary of those meetings can be found in the Appendix). The NDA did not attend any of the group meetings, however,

he was kept abreast of the proposal via email and phone. As a protocol CCCCC informs the NDA and or climate change focal point of its presence in country when scoping or developing a project. Depending on the availability of the NDA or climate change focal point meetings would be arrange to update the government on the state of the project as well as garner feedback on the project.

In May 2017 team members from BWA, 5C's, USF, and UWI met with the Minister of Agriculture and Water, who is responsible for the BWA. While the BWA board had made him aware of this project since its conceptualization, this was the first in person meeting with the team. He was supportive of the project. Meetings with the opposition party are expected prior to a public meeting scheduled fourth quarter of 2017.

The team decided that USF would combine its research strengths with graduate education and complete the Stakeholder Analysis, Gender Analysis, Environmental and Social Impact Assessment (ESIA), and Feasibility Studies. Details on stakeholder consultations to receive feedback from civil society organizations and other relevant stakeholders can be found in the Stakeholder Analysis Appendix, however a summary is provided below. The Financial and Economic Analysis was conducted by CCCCC's Project Development Specialist/Economist.

Stakeholder consultations were conducted during October 23rd to November 8th, 2016 using focus groups, interviews, and social media overview. Focus groups included Barbados Water Authority (BWA) employees (Pipes Replacement Project Manager, Water Quality Technician, Safety and Health Officer, Financial Controller, General Manager of Utility, Customer Service Supervisor, Administrative Assistant, Utility Board Members, and University of West Indies faculty (Gender Studies Unit), and key informant interviews with BWA employees (Customer Service Provider, Financial Controller), funding agencies, private enterprises, regulatory agencies, international agencies, and various groups of community members. Anonymous surveys were conducted with 229 persons across the country. Social media review was also conducted using commercially available software. Overall there was support for the components proposed in this project with support for renewables and reduced leakage.

The country was experiencing drought conditions during the stakeholder analysis period and many customers experienced inconsistent supplies. There was an overarching concern for vulnerable communities, particularly households with young children, elderly individuals, and women, with inconsistent supplies. Respondents mentioned the BWA hotline, website, and customer service desk as the main mechanisms for contacting the BWA. However, qualitative data from the same survey revealed those mechanisms as sometimes inefficient at addressing individuals' concerns and ineffective at serving vulnerable populations within the BWA customer base.

The following list of recommended goals are incorporated to facilitate more access to information, knowledge, and shared decision-making in the WSRN S-BARBADOS.

- Increase the diversity of equitable means by which a broad group of stakeholders, particularly those considered the most vulnerable (i.e. individuals who are ill, economically disadvantaged, and/or with physical disabilities), can access information, express concerns, pose questions, and develop a better understanding about BWA projects, bills and services, and strategic plans for development.
- Develop protocols for following-up on concerns of vulnerable stakeholders.
- Broaden the current approach for using online platforms, especially social media, in such a way that content is not only informative, but educational and engaging in order to encourage greater buy-in from the public (e.g. inform individuals about long-term inconveniences associated with BWA projects, change consumer behavior by promoting household behaviors that reduce water demand).
- Provide meaningful learning opportunities for diverse stakeholders, including various forms of media, to demystify BWA's operations and increase BWA staff's capacity to lead those opportunities.
- Provide a variety of ways for local stakeholders to contribute their opinions and perspectives to decision-making regarding water projects impacting their communities.

- Conduct service work according to a publicly posted schedule that affords the impacted households and communities the opportunity to adjust their daily agendas and assist vulnerable persons in accessing water.
- Integrate stakeholder analysis that runs parallel to the WSRN S-BARBADOS project components as they are implemented to streamline meaningful stakeholder engagement at all times.

E.6. Efficiency and Effectiveness

Economic and, if appropriate, financial soundness of the project/programme

E.6.1. Cost-effectiveness and efficiency

Describe how the financial structure is adequate and reasonable in order to achieve the proposal's objectives, including addressing existing bottlenecks and/or barriers; providing the least concessionality; and without crowding out private and other public investment. Please describe the efficiency and effectiveness, taking into account the total project financing and the mitigation/ adaptation impact that the project/programme aims to achieve, and explain how this compares to an appropriate benchmark. For mitigation, please make a reference to E.6.5 (core indicator for the cost per tCO2eq).

The instrument of funding requested for the implementation of this project is a combination of grants from the GCF and co-financing from the BWA. Although the funds will be used for adaptation and mitigation actions that are revenue generating activities, it serves the purpose building greater resilience into the water sector of Barbados. From a purely financial point of view, the benefits of the project are not mainly redeemable by the BWA but create an enabling environment so that it can better deal with the looming effects of Climate Change on the water sector of Barbados. The business as usual scenario for Barbados, is one in which BWA continues to maintain its operation, supplying whatever water is available and repairing and maintaining its assets as best as it can; however, this project presents an opportunity for Barbados to adapt to Climate Change whilst mitigating greenhouse gas emissions and building greater sustainability into the water authority's operations.

To measure the efficiency and effectiveness of this project it must be placed in the context of Barbados' fresh water resources and the water authority previous actions, current operations and the challenges the water authority faces going forward.

The mains sources of Barbados' fresh water resources are: 2 springs; 24 wells, all ranging in depth from 119.5 to 322 feet; and, desalination. Barbados is extracting approximately 90% of it ground water sources; therefore, water produced at the Desalination Plant using the reverse osmosis process is mixed with the groundwater from the wells to complement BWA's general supply.

Previous actions of BWA have help to shape the outlook of this project. One such action is the implementation of energy efficient and cost saving measures, which has resulted in reduction in energy consumption by 9,682MWh per year. These measures were primarily aimed at updating BWA's equipment such as pumps, switchgear and lighting. Additionally, BWA has so far integrated three PV systems into its operations, albeit small relative to those proposed under this project. It is against this background coupled with its drive to adequately supply water to the population at a reasonable price, that BWA proposes increasing the share of energy produced from a renewable source used in its production and distribution of water. The installation of renewable energy source drives down the energy cost to BWA, resulting in price stability overtime and savings that could be used to further diversify its energy mix. From a purely financial perspective, the PV systems will save BWA 10% of its present energy cost per year, which in 2016 was US$7.5Mn, From a broader economic point of view, it will reduce emissions at a cost of US$45.87per tCO2eq.

Currently, BWA is inefficient in its distribution of water. This is mainly due to failing infrastructure resulting, in part, in 49% of daily production unaccounted for. In fact, 36% or more is as a direct result of leakage from the distribution system. With this project, BWA will replace 16KM of main; however, significantly more mains need to be replaced if NRW is to be significantly reduced or eliminated. BWA's recognizes that a one-off project to replace all mains is not possible as such there are plans to incrementally replace these faulty mains.

By replacing 16km of dilapidated main, BWA will improve its efficiency. This component of the proposed project will result in 0.6 MG saved per day. If valued at current market rate this amounts to US$1.28 million in potential revenue per year. This increase availability of water also reduces the number of disruptions in the water supply. Given estimated current per capita water demand of 62.30, an additional 11,500 persons could have access to water per day.

Given the potential impact of Climate Change on Barbados water resources, the Government of Barbados and BWA recognizes that the water authority operations as is, is inadequate to cope with potential increases in the demand for water. With ground water extraction at over 90 percent, BWA needs to increase the water available to the public. All component taken together results in a well-rounded cross-cutting initiative; encompassing adaptation and mitigation actions that will benefit the entire population of Barbados. Financially, if BWA was to pay to implement the project the PV of its net revenue would decline because after implementation it would be required to repay a loan and absorb the operational and maintenance cost of the infrastructure implemented under the project. This would limit its ability to take further well needed Climate Change adaptation and mitigation actions. The project is a worthwhile investment as the demand for water increases. With no increase in the demand for water the IRR is 19%; however, with a mere 0.5% increase in demand the IRR increase to 19%. Economically, the project is desirable whether there are increases in demand for water or not. With benefits attributed to carbon emission reduction and reduction in NRW, the project net benefit to society ranges from US$43 million to US$46 million with corresponding IRR of 43% to 46%, depending on how much demand for water increases in the future and assuming BWA will be able to meet that demand. These estimates are conservative as the economic analysis ignores the built resilience in the pumping stations to tropical cyclone, employment created, foreign currency savings and associated spill-off effects. If these benefit were taken into consideration the benefit to society (economic, social and environment) of this project would be significantly more.

E.6.2. Co-financing, leveraging and mobilized long term investments (mitigation only)

Please provide the co-financing ratio (total amount of co-financing divided by the Fund's investment in the project/programme) and/or the potential to catalyze indirect/long term low emission investment. Please make a reference to E.6.5 (core indicator for the expected volume of finance to be leveraged).

The Government of Barbados does not have the fiscal space to accommodate the climate action need for the water sector using financing in the form of a loan. With an estimated 2000 km of faulty mains to be replaced and several infrastructure upgrade needed, BWA efforts are mainly directed at upgrading its infrastructure and implementing cutting edge technology to improve its efficiency. Under this project, it is committed to spending US$16.6 million to update it infrastructure and build resistance to climate change over the next 5 years. Barbados is seeking another US$26 million in grant funding from the GCF to complement the commitment made by BWA. The activities identified in this proposal are cross-cutting, including both adaptation and mitigation actions. Notwithstanding, the co-financing ratio is 3:2, GCF grant funds to BWA funds.

E.6.3. Financial viability

Please specify the expected economic and financial rate of return with and without the Fund's support, based on the analysis conducted in F.1. Please describe financial viability in the long run beyond the Fund intervention. Please describe the GCF's financial exit strategy in case of private sector operations (e.g. IPOs, trade sales, etc.).

An abstract from the financial and economic analysis of this project is presented in section F.1. Assuming no change in the demand for water and useful life of 30 years, financial rate of return is negative; however, increases in the demand for water of 0.5% per year results in returns of 19%. From an economic perspective, with no change in demand for water the rate of return is 24%. It increases further as the demand for water increases. Arguably, the demand for increased water use has been constrained based on the country's ability to supply. As it stands Barbados' Town and Country Planning unit has informally related that there are a number of applications in hand for at least 1,600 residential house plans in the South of the island, which approval will have to be delayed until BWA can support an ability to supply. Similarly, BWA will need to expand on its Northern Upgrades to support expansion opportunities in hand both of a commercial and domestic nature.

Without GCF funding the pace at which climate change adaptation and mitigation initiatives are implemented will be drastically reduced, since BWA is constrained financially and its priority whilst including adjusting to climate change has

to upgrade dated infrastructure. Climate change adaptation and mitigation initiatives that complement these upgrade works will significantly benefit the society as a whole. If BWA was to totally fund this project it would reduce its ability to carry well needed operational and maintenance works. If there is no increase in the demand for water, the projected NVP of BWA revenue, both with and without the implementation of project, is negative. There are three ways in which BWA could avoid the potential loss in net revenue in the long-run. These include: (1) increasing the water tariff (2) structurally adjusting its operation and maintenance cost; and/or (3) increasing water available to the public to adequately satisfy any increase in demand for water.

Unfortunately, the current macroeconomic environment in Barbados might not be so accommodating of an increase in water tariff, particularly given the current regulatory, political and socio-economic environments.

Barbados Utility companies are all now regulated by the Fair Trading Commission, which sets and determines tariff rates. In that regard, if the water utility company is unable to quickly streamline its operations, effective January 2018, it will be subject to the imposition of further expenses through stringent regulatory oversight in the form of fees and penalties based on the obligation of set service guaranteed standards.

Barbados' is highly indebted and its economy is currently recovering from the effects of the global financial crisis; therefore, leaders and the population might not be willing, at this time, to accept an increase in water tariff.

The second option (structurally adjusting its operation and maintenance cost) is one that is desirable but it is easier said than done. Currently, BWA's major operation and maintenance costs are wages and salaries, desalination, electricity and transportation. In 2016, these accounted for 55% of BWAs total operation and maintenance costs. Reducing these costs would involve (but not limited to) reducing the labour force and/or wages, reducing or stopping the production of water by desalination, reducing BWA's energy usage and or improving BWAs energy efficiency. The former two options, reducing the labour force and/or wages and reducing or stopping the production of water by desalination, are not attractive given their socio-economic implications; however, reducing BWA's energy usage and or improving BWAs energy efficiency are desirable options, but this requires substantive investment in energy efficiency equipment and renewable energy sources. BWA recognises this reality and has already taken step to become more energy efficient as well as reduce the its carbon footprint. This project will contribute to reducing BWA's carbon footprint and energy cost whilst making selected pumping stations resilience to tropical cyclones.

The savings in energy cost and the potential revenue from the reduction in NRW will guarantee increased sustainability of BWA's operations in the long-run as well as empowering households and community through the revolving adaptation fund that will be created using the savings (revenue) generated from activities associated with this project. The revolving adaptation fund will mobilise funds to continue building resilience in the water sector of Barbados.

Capacity building under this project is not limited to the term structure of this project as the lessons learnt under this project will be used to replicate other projects and another set of individuals will be trained. Replication in other locations will also expose different individuals to the work done under this project and best practice needed to make this project a success. The recently concluded realigned organization structure of the BWA, inclusive of its recently established PMO office, will ensure that institutional knowledge and capacity building opportunities are realized in an even more formalized manner.

Once the project is completed BWA will take ownership of the infrastructure implemented. As mentioned above, it will become BWA's responsibility to maintain the infrastructure and safe-guard the viability of their operations. It is in BWA's interest to do so. Furthermore, the benefits to Barbados should prompt the relevant authorities such as the Ministry of Agriculture, Food, Fisheries and Water Resource Management, Ministry of Health and Ministry of Energy to provide oversight and guidance. Interestingly though, already with increased confidence in the newer management team and with several concluded projects on the ground other Ministries mentioned are in fact now looking to the BWA for guidance and best practice approaches for the completion of such projects.

Engagement with stakeholders such as government, households and the private sector will also contribute to the financial sustainability of the project beyond GCF funding. The innovative revolving adaptation fund facility is one way of demonstrating that BWA is serious about taking actions to build greater resilience to climate change in the water sector.

E.6.4. Application of best practices

Please explain how best available technologies and practices are considered and applied. If applicable, specify the innovations/modifications/adjustments that are made based on industry best practices.

BWA's experience in integrating PV systems puts it in a position to implement such systems using lessons learnt and built capacity. Through collaboration with private contractors, BWA has enhanced its capacity to implement and monitor the PV systems as well as estimate avoided carbon emission and compare these to baseline estimates.

The replacement of mains is guided by research, primarily work done by The Centre for Resource Management and Environmental Studies at the University of the West Indies. The Centre for Resource Management and Environmental Studies has identified the hotspots for leaks in BWA's water distribution system and as such areas of concern in the distribution systems have been identified. This demonstrates BWA's data and research guided approach to building sustainability in to operations. At the back-end, BWA embarked on significant IT upgrades to its customer user interfaces, work management systems, financial and data correspondence systems, SCADA, GIS mapping and geo-tagging, all with a view to seamlessly integrating its oversight and data analytical and management coverage.

The Personal Tank programme draws on BWA's experience in implementing water tanks and complementary pumps. Since the programme started BWA has modified the design of the system to make it more efficient. One of the major modification was implementing a more efficient pump with the water tank. The RWH systems will draw on these lesson learnt but may not utilise pumps but gravity fed system; however, the beneficiary want to purchase and implement a pump the revolving adaptation fund facility could accommodate such want. In expanding this programme with funding from the revolving adaptation fund, where a gravity fed system is not feasible a renewable energy such as solar will be used to offset the energy needs of the systems such as the energy needed operate the pumps. Additionally, in the not so distant future monitoring of these system could involve incorporating smart technology, which potentially link these systems as part of an Internet of Things (IOT).

CCCCC, the executing entity and accredited to the GCF, has clear project management, accounting and procurement guidelines that must be adhered to. CCCCC also has the track record of implementing similar projects and a knowledgebase of experts and documents that can be called upon to guide the implementation of this project. Furthermore, CCCCC coordinates projects that cut across industries, sectors and countries.

E.6.5. Key efficiency and effectiveness indicators

GCF core indicators	Estimated cost per t CO_2 eq, defined as total investment cost / expected lifetime emission reductions (mitigation only)
	Describe the detailed methodology used for calculating the indicators (d) and (e) above. Please describe how the indicator values compare to the appropriate benchmarks established in a comparable context. The funding needed to implement all components, both mitigation and adaptation, is approximately US$42.6 million with an additional contingency of US$2.6Mn. Assuming a useful life of 30 years for the PV systems, which is the upper limit of their estimated useful life, the avoided emissions amounts to 220,184tCO_2eq. Given the total cost of the project, the estimated cost per tCO_2eq is significantly above the estimated social cost of US$36 for carbon emissions (US-EPA, 2016); however, the estimated expected lifetime emissions reductions overtime is conservative as it does not consider the spill-over effects, both financially and otherwise, of this project into others that will follow. Considering only the cost for the PV systems, which are the main mitigation actions embedded in this project with an estimated to cost US$10.1 million, the estimated cost per tCO_2eq is US$35.46.

	This is below the social cost of carbon emissions, which is estimated at US$36 tCO_2eq (US-EPA, 2016). If the estimated cost per tCO_2eq is set equal to the US-EPA estimated social cost of carbon, then minimum useful life of the PV systems and backup natural turbines must be approximately 29 years. To achieve this, BWA is committed to activity monitoring and maintaining the PV systems and backup natural gas turbines. (a) Total project financing (PV Systems) — US$10.1 Million (b) Requested GCF amount — US$10.1 Million (c) Expected lifetime emission reductions overtime — 220,184 tCO_2eq (d) Estimated cost per tCO_2eq (d = a / c) — US$45.87 / tCO_2eq (e) Estimated GCF cost per tCO_2eq removed (e = b / c) — US$45.87/ tCO_2eq Besides reducing CO_2, these systems are critical to building resilience to storms and cutting cost associated with the production and distribution of water in Barbados. It is important to reiterate that these estimates ignore the spill-over effects on future projects from implementing these PV systems.
	Expected volume of finance to be leveraged by the proposed project/programme and as a result of the Fund's financing, disaggregated by public and private sources (mitigation only)
	Describe the detailed methodology used for calculating the indicators above. Despite BWA's budgetary constraints, it recognises the importance of this project and has commitment to successful implement this project. BWA had US$2 million committed to implement a Develop Water Resilience Programmeme, which was as a result of the severe outages, particularly experienced by customers in the central and northern areas during the period 2015 to 2016. It also committed US$8.5 million replace mains including the purchase of equipment and the implementation of meters needed to better inform mains replacement. Another US$1 million is committed to the purchase of turbine for Bowmanston Pumping Station and US$0.1 million to develop and operationalise the Revolving Adaptation Fund Facility. Lastly, but critical to the successful implementation of this project, BWA has committed to utilize as much of possible its asset including lands, equipment and labour during the implementation of this project. BWA's total committed to the project is US$16.6 million, which is approximately 40% of the total project cost.
Other relevant indicators (e.g. estimated cost per co-benefit generated as a result of the project)	The cost of the project US$150 per person (US$42.6/population).

**** The information can be drawn from the project/programme appraisal document.***

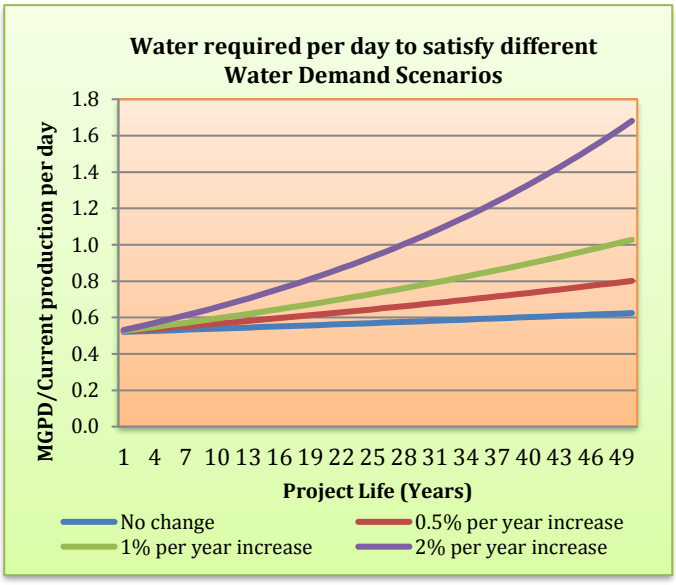
F.1. Economic and Financial Analysis

Please provide the narrative and rationale for the detailed economic and financial analysis (including the financial model, taking into consideration the information provided in section E.6.3). ***BASED ON THE ABOVE ANALYSIS, PLEASE PROVIDE ECONOMIC AND FINANCIAL JUSTIFICATION (BOTH QUALITATIVE AND QUANTITATIVE) FOR THE CONCESSIONALITY THAT GCF PROVIDES, WITH A REFERENCE TO THE FINANCIAL STRUCTURE PROPOSED IN SECTION B.2.***

This project is assessed by way of a Cost-Benefit Analysis (CBA) and is set within the operations of BWA. Assuming a useful life of 30 years, it utilizes baseline information for BWA operation and maintenance costs for 2016 and 2017 and projection made by the BWA for 2018. These costs are adjusted for inflation annually, with the exception for wages, salaries and allowances which are adjusted for inflation every 5 years. Besides wages and salaries, the largest line item in BWA operation and maintenance costs is the cost of electricity. Electricity cost was 16% of total operation and maintenance costs in 2016; however, due to energy efficiency initiatives that BWA implemented the energy cost as a percentage of total operational and maintenance is expected to decline marginally. In 2016, wages, salaries and allowances and desalination account for approximately 39% of total operational and maintenance. Depreciation is approximately 12% per year and maintenance and repairs expenses is approximately 1% per year.

On the revenue side, two approaches are used to project revenue and evaluate the financial and economic viability of this project. The first assumes that current per capita water demand is 62.30 gallons per person per day (Halcrow, 2011). The water demand by the tourism sector is not explicitly modelled and is implicit in the 62.30 gallons per person. Population growth is assumed at 0.37% per year. This is the average population growth for Barbados over the past 10 years (WorldBank, 2015). Water is priced at US$1.55 per cubic meter and waste water is priced at half this cost. These are the current market rates for water in Barbados for normal needs. The demand for water is presented using four different scenarios: (1) no change per year in the per capita water demand of 62.30 gallons per person per day; (2) 0.5% increase per year in per capita water demand; (3) 1% increase per year in per capita water demand; and, (4) 2% increase per year in per capita water demand. These scenarios are aligned with those presented in Halcrow (2012) water demand study for Barbados. The second methodology uses BWA's projected revenue of US$75 million for 2018 and assume a one to one relationship between increase demand and increases in revenue. That is, the aforementioned scenarios correspond to no increase in revenue, a 0.5% increase revenue each year, a 1% increase in revenue each year and a 2% increase in revenue each year. Both approaches give the same results but differ in scale (size of profit(loss) or benefit(cost) to society). The following results are a summary of the latter approach.

BWA operation is sensitive to the macroeconomic environment of Barbados. More specifically, inflation could have significant effects on the company's profit. These effects may occur through two channels: (1) BWA's operation and maintenance costs; and, (2) the demand for water. As identified above, electricity cost is the largest operational cost faced by BWA and this project will reduce this cost by approximately 10% annually. This would free monies for use in the maintenance and repairs and the incremental implementation of other mitigation and adaptation initiatives. The proposed PV systems will also reduce BWA's exposure to inflationary pressures and curb the burden that fuel needed for electricity generation places on the foreign currency reserves of Barbados.



Critical to the issue of water security is a better understanding of Barbados' water needs and water resources available. Further research is needed to derive the elasticity of demand for water in Barbados especially as it relates to the tourism, agriculture and commercial sectors. It is expected that demand for water is inelastic as such increasing water tariff would result in minimal reduction in water demand and if such cost is passed on to consumer, this could hurt the tourism sector and more broadly the economy of Barbados.

Given that BWA is already extracting at least 90% of all groundwater sources as well as the impending impacts of climate change, reducing NRW is a necessary, but not a sufficient, condition for water security. This statement is strongly satisfied under the scenarios of 1% and 2% increases per year in per capita water demand; however, it is weakly satisfied under the scenarios of 0% and 0.5% increases per year in per capita water demand. Therefore, BWA must complement the reduction in NRW with other initiatives, such as desalination, rainwater harvesting and waste water recycling, which expands production and the quantity of water available to the public. It must also take the lead in raising public awareness about the need to reduce, reuse and recycle water.

Financial and Socio-economic Analysis

The proposed project, through the replacement of mains will reduce NRW by 4% and reclaim 6 MGD hence increasing water available to the public. Assuming a useful life of 30 years for the project and that BWA does not embark on similar projects subsequent to the implementation of this project, it would be able to:

- satisfy the demand for water under the scenario of no change per year in per capita water demand for the entire useful life of the project.
- satisfy the demand for water under the scenario of 0.5% increase per year in per capita water demand for up to 30 years of the useful life of the project.
- satisfy the demand for water under the scenario of 1% increase per year in per capita water demand for up to 19 years of the useful life of the project.
- satisfy the demand for water under the scenario of 2% increase per year in per capita water demand for up to 11 years of the useful life of the project.

Since this project is one increment in building greater climate resilience in BWA's operations, the assumption that BWA does not embark on similar projects subsequent to the implementation of this project is relaxed. Instead it is assumed that BWA will meet the demand for water for all the aforementioned water demand scenarios. With this assumption and holding tariff rates constant, in the long-run operational and maintenance costs outpace revenue. Therefore, BWA needs to realize savings now to accommodate the potential increase in demand for water whilst at the same time driving down its production cost.

From a financial perspective, the net present value (NPV) of BWA net revenue with the implementation of the project is less than if BWA does not implement this project. The reduction in the NPV of its net revenue position is approximately US$0.4 million (present value) per year for 30 years. This demonstrates the limiting ability of the project activities to generate sufficient revenue to service a loan, without increasing the tariff rate. It also demonstrates that country ownership of this project is essential for the financial sustainability of the project.

Summary of Financial Analysis (US$)

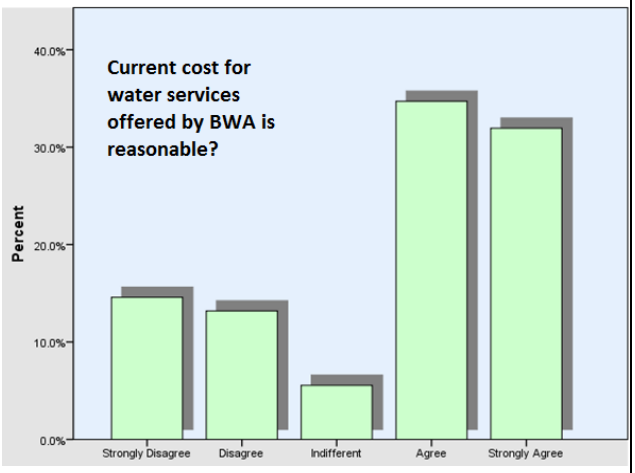
Water Demand Scenarios	NPV without Project	NPV with Project	IRR
No change	($52,889,332.07)	($65,907,075.69)	-
0.5% per year increase	($26,931,114.12)	($39,948,857.74)	-
1% per year increase	$873,117.93	($12,144,625.69)	-
2% per year increase	$62,682,834.14	$49,665,090.53	19%

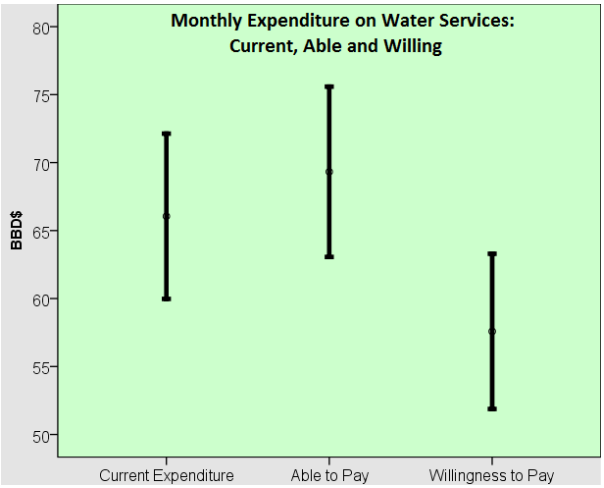
Assuming no increase in water demand, the NPV of BWA's net revenue is negative. However, there are three ways in which BWA could avoid these potential losses over 30 years. These include: (1) increasing the water tariff above the

current rate; (2) structurally adjusting its operation and maintenance costs; and/or (3) increasing water available to the public to adequately satisfy any increase in demand for water.

Increasing the water tariff will allow BWA to increase its operating revenue. Unfortunately, the current macroeconomic environment in Barbados might not be accommodating. Barbados' is highly indebted and its economy is currently recovering from the effects of the global financial crisis; therefore, leaders and the population might not be willing, at this time, to accept an increase in water tariff. Furthermore, this could trigger inflation that could have adverse effects on BWA operations, and more broadly the economy.

When BWA's customers were asked if the current cost for water service is reasonable, two-thirds thought it was reasonably priced and approximately a quarter thought it was not reasonably priced. As can be seen from the figure below, when asked about their current monthly expenditure on water services the average was found to be US$33 (BBD66) per month per household. Although, households on average are able to pay US$35 (BBD70) per month, the average willingness to pay US$29 (BBD58) per month is below the current rate and their ability to pay. This could be the result of several factors including the quality of service, economics as well as the value the population place on such environmental goods. It is therefore critical that leaders and institutions such as the BWA take the lead in innovating and mitigating the risk of climate change and climate variability whilst raising awareness within localities.





The second option is one that is desirable but it is easier said than done. Currently, the major operation and maintenance costs are wages and salaries, desalination and electricity. In 2016, these accounted for 55% of BWA's total operation and maintenance costs. Reducing these costs would involve (but not limited to) reducing the labour force and/or wages, reducing or stopping the production of water by desalination, reducing BWA's energy usage and or improving BWA's energy efficiency. The former two options, reducing the labour force and/or wages and reducing or stopping the production of water by desalination, are not attractive given their socio-economic implications; however, reducing BWA's energy usage and or improving BWA's energy efficiency are desirable options but this requires substantive investment in energy efficiency equipment and renewable energy sources.

The proposed PV systems to be implemented under this project will save BWA 10% of its present energy cost per year but majority of this saving will flow into the Revolving Adaptation Fund. Although the proposed project helps to improve BWA financial position, majority of the benefits accrued (revenue and otherwise) is to the benefit of the wider population. In the medium- to long- run the NPV of BWA's net revenue is negative as such it is critical that some savings in electricity cost is reinvested into activities that will further reduce BWA's operation and maintenance costs. This might be through special access to the Revolving Adaptation Fund Facility. Replicating this project and drawing on the lessons learnt from its implementation should be a priority.

Financially, the feasibility of this project will depend on: (1) how the project is funded, (2) the demand for water (price and growth), (3) BWA's ability to minimize it operation and maintenance costs, and (4) the macroeconomic environment of Barbados. To mitigate these, it is recommended that:

- Given the current state of BWA's finances, the macroeconomic environment in Barbados and the significant benefits accruing to the wider population this initiative is funded using majority grant funding coupled with BWA's resources.

- the monies saved from the implementation of this project should be used to develop the proposed fund, which should be used to build greater climate resilience in the water production and distribution systems and communities and where possible bolster BWA's operations.
- adaptation initiatives such as rainwater harvesting should complement, not compete with, BWA's operations.

These are critical to achieving greater water security in Barbados.

When consideration is given to the economic, social and environmental implications, the project is desirable. Considering other benefits, besides the savings from implementing the PV systems, the project will have a positive impact on the society for all water demand scenarios considered. The broader economic, social and environmental implications considered include:

- Avoided Carbon Emissions (PV vs. Fossil Fuel Combustion) of 7339.46 tCO2eq per year priced at US$36 per ton of carbon. US$36 is the assumed social cost of carbon (EPA, 2015).
- Reduction in NRW due to the replacement of 16km main.
- Improved resilience against climate change and extreme climate events.

Other benefits identified but not value, due to lack of accurate information, includes:

- Employment Creation.
- Foreign currency saving due to the reduction in the importation of fossil fuel and fertilizers.
- Greater awareness and data about Barbados' water system and water conservation.

From a socio-economic and environmental perspective, the NPV of the project to society is positive across all water demand scenarios considered. The NPV of the project to society is calculated as a sum of the expected revenue of the activities to be implemented and all economic, social and environmental net benefits less the cost of the project. Assuming no change per year in per capita water demand and that BWA is able to meet this demand, the NPV of the project to society is US$28.8 million with an internal rate of return of 28%. The project becomes more desirable if the demand for water increases (revenue increases for BWA). With increases in the demand for water (increases in the revenue of BWA) of 0.5%, 1% and 2% per year the project become desirable with a NPV of the benefits to society is US$54.7, US$82.5 and US$144.4 million, which correspond to internal rate of returns of 31%, 34% and 39% respectively. If the NPV of BWA's revenue is ignored the NPV of the project to society is US$94.7 million.

Summary of Socio-economic Analysis (US$)

Water Demand Scenarios	NPV of the Project to Society including NPV of BWA's Revenue	IRR
No change	$28,783,474.64	28%
0.5% per year increase	$54,741,752.35	31%
1% per year increase	$82,546,048.52	34%
2% per year increase	$144,355,907.64	39%

The model is sensitive to the selected inflation rate, initial value of per capita water demand, population growth, water tariff (rate of increase in revenue), cost per unit of electricity and discount rate. With sensitivity analysis (See full report), it was found that from a financial perspective increases in the inflation rate and reduction in the initial value of per capita water demand will threaten the worthiness of the project; however, from a socio-economic perspective with different assumptions for the aforementioned variables, the value-add to society is still positive.

F.2. Technical Evaluation

Please provide an assessment from the technical perspective. If a particular technological solution has been chosen, describe why it is the most appropriate for this project/programme.

The technical evaluation consisted of screening and assessment processes. Screening was used to reject technologies not suitable in a particular context and focused on addressing two questions, 1) is there a need for this technology? 2) Is the implementation of this technology feasible in this region? Results from the screening process indicated that none of the proposed technologies could be rejected. Because the screening process was favorable for the technology, a more comprehensive assessment took place. For the comprehensive assessment, no equipment (i.e., water meters, leak detection equipment) was assessed. The comprehensive assessment addressed thirteen questions that had social, economic, and environmental dimensions.

For the integrating photovoltaic renewable energy" component, the technologies of grid-tied PC (solar) plants and a micro turbine natural gas generator were found to previously be used in the area, were identified to serve regional or national priorities, and no comparable technologies that perform the same technologies were found that also reduce or mitigate carbon emissions. The technology providers were also identified to have necessary skills and resources to ensure this technology can be sustainable and scalable. The technologies were also found to not be in conflict with cultural traditions and habits and not excluded the disabled, elderly, or the very poor. BWA has piloted PV systems. The PV system will be ground mounted because of inefficient roof area. Additionally, the PV systems will be decentralized because this design reduces possible energy losses significantly as opposed to a centralized power system. For example, centralized systems tend to have inverters with capacities between 250-500kW and when one of these malfunctions on a 1MW plant the losses could be as high as 30%. However, in a decentralized system where the inverters are between 25-30kW the highest losses will only be 3% if one inverter malfunctions. The systems will use a patented east west design to minimize subterranean damage, and negate any effects of soil compaction. This will allow for downward filtration of rainwater into the subsurface.

Key Features of the Photovoltaic Systems:

- Ground mounted systems due to inefficient roof area.
- Decentralised type system
- Patented East West design to minimise subterranean damage, and negate any effects of soil compaction, thus still allow for natural downward filtration of water into the aquifers.
- Utilize a design that minimises land requirements and the impact on storm water runoff.
- Inverters will be IP67 rated or greater and will be either grid interactive or operate in standalone with batteries/GENSET systems; that is, they will be able to function in a system with either batteries and natural gas fuel economy or batteries and diesel/natural gas fuel economy technology and if needed be grid interactive also. They will consist of mono-crystalline modules as these have better levelised cost of electricity (LOCE)

Several of the technologies that support the "water loss reduction" component (e.g., pressure and flow meters, pressure management, acoustic leak detection equipment) are widely used in the water supply industry. Rainwater harvesting is also a widely used technology in the area that can be implemented at small to larger scales. Groundwater recharge is considered an appropriate technology that is used in parts of the Americas facing salt water intrusion and water scarcity and requires widely used equipment such as pumps and subsurface piping. The groundwater recharge plan will be based on monitoring and field instrumentation to obtain input data, applying industry standard 3-D groundwater modeling software.

F.3. Environmental, Social Assessment, including Gender Considerations

Describe the main outcome of the environment and social impact assessment. Specify the Environmental and Social Management Plan, and how the project/programme will avoid or mitigate negative impacts at each stage (e.g. preparation, implementation and operation), in accordance with the Fund's Environmental and Social Safeguard (ESS) standard. Also describe how the gender aspect is considered in accordance with the Fund's Gender Policy and Action Plan.

(i) Environmental and Social Impact

The project proposal was assessed against the eight Performance Standards (PS) of the GCF: PS1: Assessment and Management of Environmental and Social Risks and Impacts; PS2: Labor and Working Conditions; PS3: Resource Efficiency and Pollution Prevention; PS4: Community Health, Safety and Security, PS5: Land Acquisition and Involuntary Resettlement; PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources; PS7: Indigenous Peoples, and PS8: Cultural Heritage. The main outcomes of the assessment is summarized as follows:

1. The project is a category B project having "activities with potential mild adverse environmental and/or social risks and/or impacts that are few in number, generally site-specific, largely reversible, and readily addressed through mitigation measures.
2. Mitigates biased distribution of benefits towards a certain group, e.g. businesses or wealthier communities, gender, for human right to water.
3. Reassure the safety and health of persons working on and in close proximity to projects, especially during preparatory and maintenance phases.
4. Mitigates adverse impacts on gender equality based on distribution of jobs required to implement project and handle monitoring and operation.
5. Has little to no potential to released hazardous contaminants to the environment, and avoids unsustainable practices that increase waste generation and greenhouse gas emissions throughout the project lifecycle.
6. Mitigates adverse impacts to habitats and/or ecosystems and ecosystem services from project activities, in particular due to changing land use for PV installations, rainwater harvesting for agriculture, and infiltration well rehabilitation.
7. Mitigates impact from hurricanes, and other natural disasters, theft and sabotage.
8. Considers cultural heritage in materials developed for training, education, and outreach to promote climate resilience in the water sector.
9. Considers solution for creating a more enabling legislative and regulatory environment in Barbados that a specific to building climate change resilience in the water sector, although current environment does not limit the implementation and expansion of the project to support water sector resilience.
10. Mitigates contribution to water-borne or other vector- borne diseases like dengue and zika due to water storage and rainwater harvesting.
11. Limits contentious land tenure scenarios for PV and other project installations.

Overall, the WSRN S-BARBADOS will have many positive impacts for Barbadians. It is expected to improve water supply from the BWA, reduce air emissions from non-renewable energy sources, increase adoption of sustainable rainwater harvesting practices and therefore increase residential water security, increase groundwater recharge through green infrastructure implementation and rehabilitation of recharge wells, increase opportunities for the BWA to reinvest in climate innovative strategies for resilience, integrate gender across all areas of BWA operations, mainstream stakeholder engagement across all areas of BWA operations, improve communications between BWA and the public, build long term partnerships between the BWA and university programs for capacity building and research, improve safety and sustainability training of BWA employees, develop the BWA workforce to adapt to the human-technology interface of its water infrastructure, and reduce Barbados' government expenditure on the BWA and therefore have more foreign exchange available for other critical development projects.

Listed below is the Environmental and Social Management Plan describing how the project will avoid or mitigate negative impacts at each stage.

a. Summary of Risk

1. Biased benefit of project towards a certain group, e.g. businesses or wealthier communities, for human right to water (PS1)
2. Compromised safety and health of persons working on and in close proximity to projects, especially during preparatory and maintenance phases (PS2, PS4)

3. Potentially adverse impacts on gender equality based on distribution of jobs required to implement project and handle monitoring and operation. (PS2)
4. Released hazardous contaminants to the environment, and unsustainable practices that increase waste generation and GHG emissions throughout the project lifecycle. (PS3)
5. Potential adverse impacts to habitats and/or ecosystems and ecosystem services from project activities, in particular due to changing land use for PV installations, rainwater harvesting for agriculture, and infiltration well rehabilitation. (PS6)
6. Potential impact from hurricanes, and other natural disasters, theft and sabotage (PS4)
7. Disregard for and/or misuse of cultural heritage in materials developed for training, education, and outreach to promote climate resilience in the water sector. (PS8)
8. Limited expansion of project components for water sector resilience by non- supportive laws and regulations in Barbados. (PS1)
9. Increased exposure to water-borne or other vector- borne diseases like dengue and zika due to water storage and rainwater harvesting (PS4)
10. Contentious land tenure scenarios for PV and other project installations. (PS5)

b. Mitigation Measures (corresponding to numbering above)

1. Socio-economic factors considered throughout project decision making process. Needs Assessment conducted prior to identification of water supply storage and rainwater harvesting sites, and the results of these factored into installations supported as a part of the project. Stakeholder engagement and knowledge exchange throughout these processes to eliminate biases and ensure, vulnerable populations and gender are properly considered. These actions should avoid this risk.
2. Updating of BWA's Safety and Health plans and dissemination across utility and online. OSHA training of BWA employees and contractors to meet ISO45001 certification and provision of safety equipment needed to properly manage project activity. Appropriate measures taken to inform potentially impacted persons, including proper signage.
3. Targeted recruitment to reach persons underrepresented in given job positions associated with project will be completed. Development of a gender training program in conjunction with the UWI Institute of Gender Studies that builds capacity to address gender and infrastructure across the island and beyond.
4. ENVISIONTM Training and certification integrated with project and applied to all aspects. Criteria require addressing TORs included
5. Terms of Reference for PV projects include requirements for minimizing impacts to habitats and ecosystem services and more specific biodiversity surveys as part of the individualized EIAs required for Barbados. Green infrastructure will be prioritized for stormwater management at sites. Land is currently overgrown and was once mainly sugarcane. Incorporate agricultural activity with black belly sheep from community grazing there.
6. Project in itself is designed to avoid risks posed by drought to water supply. CCORAL Training with 5Cs included to further identify climate vulnerabilities. TORs for project components will detail requirement that contractors minimize threats from hurricanes, earthquakes, landslide, flooding etc.. Sites identified for PV installation already have taken those threats into consideration. Water storage and rainwater harvesting systems will be designed to include straps to secure from wind, and located in places that do not flood or actions taken to implement green infrastructure with property owner to reduce flooding. Stakeholder engagement and knowledge exchange will promote sense of project ownership amongst all Barbadians to reduce threat of human induced disaster like theft or sabotage. Additionally, PV sites will be fenced and monitored by BWA security, and pumps for water storage systems will be secured in padlocked units.
7. Outreach and Workshops planned to engage stakeholders, including parliamentary representatives, that would result in two policies pertaining to water sector resilience and private-public partnerships for the water sector.
8. Design storage system with continuous pump to reduce stagnation of BWA treated water and include backflow preventers to reduce contamination of supply if pressure is low. Design rainwater harvesting to eliminate mosquito breeding with mesh etc.. Ensure buy-in from persons/places where systems

will be installed and ensure proper maintenance and operational techniques will be implemented. Randomly monitor systems after installation, perform maintenance where needed to reduce risk of disease, and continuously exchange knowledge with stakeholders to track performance and needs.

9. Siting of PV systems on BWA or crown lands with permission given to use, or on lands not currently being used with no structures. Mutually agreed upon compensation for privately owned land (required from 2 MW installation at Hampton Pumping Station). Added community value to land (e.g. sheep rearing under PV systems).

The table below shows a summary of environmental and social impacts assessed. Impacts are characterized by type (D-direct or I-indirect), nature (P-positive or N-negative), and duration T-temporary or M-permanent). The detailed methodology for the table results is shown in Appendix C of the Environmental and Social Impact Assessment.

Summary of Environmental and Social Impacts

Impact	*Mains Replacement*	*Photovoltaic Installation*	*Water Resilience Programmeme*	*Rainwater Harvesting*
Environmental				
Air quality	D, N, T	D, N, T	D, N, T	D, N, T
Water quality	D, P, M	I, N, M	D, P, M	D, P, M
Soil cover	D, N, T	D, N, T/P	D, P, M	D, P, M
Biodiversity	D, N, T	I, N, M	D, P, M	D, P, M
Noise	D, N, T	D, N, T	D, N, T	D, N, T
Land use	D, N, T	D, N, T/P	D, P, M	D, P, M
Social				
Health and safety	D, N, T	D, N, M	D, P, M	D, P, M
Sanitation	I, P, M	D, N, T	D, P, M	D, P, M
Socio- economic	I, P, M	I, P, M	D, P, M	D, P, M
Road network	D, N, T	D, N, T	D, N, T	D, N, T
Visual amenity	D, N, T	D, P, M	D, N, M	D, N, M

(ii) Gender

This project proposal has seriously considered the gender aspect in accordance with the GCF's Gender Policy and Action Plan. A Gender Analysis was conducted during the period August 8 – November 18, 2016 (see Appendix). It has subsequently been identified based on this analysis that the BWA has to move more rapidly towards the adopting of a gender sensitive approach to be better able to contribute to gender development and understanding in its operation. The GCF's Gender Policy is based on six fundamental principles that enable commitment, inclusiveness, accountability and country ownership among others. Owning to the fact that most of the individuals in the technical and leadership roles of the BWA are in the middle or near the end of their careers, this presents the BWA with an opportunity to foster a paradigm shift in its gender practices to actively balance the gender field to ensure that with this project proposal the GCFs Gender Policy and Action Plan can be adopted as suited for future project and recruitment policies.

The Gender Analysis identified key areas that have the potential to catalyze the gender aspect paradigm shift, given as: 1) identify clear gender objectives and targets prior to project implementation to ensure their incorporation in the project, 2) allocate budget to appoint a gender focal point who would coordinate these activities, 3) develop a gender policy for the BWA, 4) target training and recruitment for jobs that will be rewarded through this project to increase representation of the under-represented sex for each position, and

5) include socio-economic information as a criterion for prioritization of locations for project interventions. All of these recommendations are included in the budget.

These recommendations have been developed to incorporate gender findings throughout the project, or to assist in further understanding issues that this project can address:

- Create a gender-responsive budget that allocates resources for a gender focal point to coordinate integration of gender analysis findings, and reflect commitments to gender objectives.
- Gender training to recognize and raise awareness of the disparity in stakeholder representation and take corrective action(s) to balance stakeholder views.
- Institutional commitments to gender integration in organizational policies. Set reasonable targets for increased participation of underrepresented groups in instances of job creation that goes above baselines and that are supported by appropriate recruitment efforts.
- Develop clear communication policies (inclusive of a social media presence) on information dissemination and follow-up to address stakeholder concerns.
- Include social factors such as gender impacts and presence of vulnerable groups in criteria for prioritizing operation and maintenance activities.
- Produce educational materials on the rationale for inclusion of gender perspectives as smart economics in water sector development projects, and recruit M.S. and Ph.D. students for the UWI IGDS to pursue research that directly support WSRN S-BARBADOS project goals.
- Explore the potential of decentralized projects like rainwater harvesting in increasing customer resiliency during water supply shortages and natural emergency situations.

The table below shows a summary of gender impacts. Impacts are characterized by type (D-direct or I-indirect), nature (P-positive or N-negative), and duration T-temporary or M-permanent). The detailed methodology for the table results is shown in Appendix C of the Environmental and Social Impact Assessment.

Gender Impacts

Impact	*Mains Replacement*	*Photovoltaic Installation*	*Water Resilience Programmeme*	*Rainwater Harvesting*
Job Training	D, N, T/M	D, P, M	D, P, M	D, P, M
Economic Empowerment	D, N, T	D, P, M	D, P, M	D, P, M

(III) GRIEVANCE REDRESS MECHANISM

A Grievance, an official statement of a complaint over something believed to be wrong or unfair, can be filed by anyone engaged with this project, including BWA employees (internal) and communities affected by the project (public/external). Grievance mechanisms will be put in place very early for the project, detailing procedures for responding to and managing grievances. The BWA already has grievance procedures that are managed through its Human Resources department for internal grievances. These include protocols for filing complaints through all other required paperwork until the matter is resolved. The BWA is currently updating the BWA Employee Handbook and will include this information. In terms of external grievances from the public, the BWA follows procedures determined by its insurance and legal commitments. Grievances can be addressed to:

The Director of Human Resources
The Barbados Water Authority
Pine Commercial Estate, The Pine St. Michael
P.O. Box 1260, Bridgetown, BB11000
Tel. + 1 (246) 434-4200
Fax +1 (246) 435-3636
Email: humanresources@bwa.gov.bb

F.4. Financial Management and Procurement

Describe the project/programme's financial management and procurement, including financial accounting, disbursement methods and auditing.

Financial Management and Accounting
As an accredited GCF entity, CCCCC's Financial Management, Accounting and Procurement procedures are aligned with the standards required by the GCF. This project will be subjected to the same financial management and accounting standards, unless otherwise agreed with the Donor. These are detailed in the CCCCC Financial Manual and summarized below.

It is the CCCCC's practice to open a new foreign currency bank account for all externally funded projects. The utilisation of an old or existing bank account for a new project is prohibited. The signatories for the new bank account are authorised by the Executive Director of the CCCCC. Closure of the project's bank account takes place within 180 days of a final financial audit or the last disbursement if a financial audit is not undertaken within those 180 days.

Project budgets are prepared and agreed during the conceptualization and form part of the final proposal and project agreement between the CCCCC, an Executing Agency and a Donor. All project budgets are uploaded to the accounting software to form the budget baseline required for accounting and financial tracking and reporting, which is necessary for variance analysis and time-specific analysis. The Project Manager/Coordinator is responsible for the provision of detailed budgets to the Financial Administrator.

The financial year for the project is dependent on the stipulations within the Project Agreement including the official commencement date of the project; however, Project Financial Reports are generated on a periodic basis (monthly, quarterly, and annually) or as otherwise required by the Project Manager/Coordinator or stipulated in the Project Agreement. Financial reports include the following information to date (in both currency and percentages):

- Commitments
- Expenditure
- Un-committed funds
- Undisbursed
- Variance
- Counterpart (if applicable)

Project payments and disbursements must be executed in alignment with the approved Project Agreement and related budget (or its most current amendment). All payments are initiated by the Project Manager/Coordinator and request for payments are signed by the Project Manager /Coordinator and clearly outline the following:

- The Name of the Project (as per Agreement)
- The name and code of the budget line(s) and against which the payment(s) should be made
- The amount to be paid
- Approved signed supporting documents which verify delivery or acceptance of the item to be paid (such as invoice, approved deliverable, and signed deliverable slip)

CCCCC financial records are audited annually by an independent accounting firm, which is selected using a competitive bidding process every 5 years. To allow for a smooth and timely audit, CCCCC provides assistance to the independent auditors in the following areas of planning, involvement, interim procedures as well as provide schedules, documents and information requested by the auditors in a timely manner. Upon receipt of the completed audited financial statements and accompanying report(s), the CCCCC reviews and responds in writing to all management letter or other internal control and compliance report findings and recommendations made by the independent auditor. These audited financial statements and accompanying reports are subject to review and scrutiny by members of the broad of directors who form the Finance Committee.

Procurement
As delivery partner, i.e., CCCCC, will manage the funding garnered for the implementation of the project and would be responsible for providing and contracting the goods and services required for the successful

implementation of this project, as well as periodically reporting on the progress of the project's implementation in close coordination and under the supervision of the NDA. The procurement will be processed in accordance with the procurement guidelines and policies of CCCCC. Procurement with third parties is carried out using the general policy of the Centre's procurement standards in the first instance. However, the Centre also carries out its own due diligence of such entities. If the Third Party entities already have Procurement Standards the Centre will review such standards to ensure that they are in consonance with the Centre's. If they are then the entity is allowed to use that Procurement Standard. If the Standards are not in consonance with the Centre's then the Centre's Procurement Standards are applied. Information on the process and the results of procurement undertaken are usually included in the first report document, and in interim progress or completion reports once such procurement has been undertaken and completed. Further, No Objection is usually sought from the NDA.

In preparation for project execution a Procurement Plan is usually developed, which includes:

The following methods of procurement are utilized by CCCCC:

- International Competitive Bidding
- Limited International Bidding
- Regional Competitive Bidding
- Shopping
- Direct Contract
- Community Participation

The methods selected are determined by a threshold model. These thresholds are detailed in CCCCC procurement manual.

All major all contracts for goods, works, and/or services, expected time frame for execution of works required to successfully complete the project and contracts and related reviews are detailed in the schedule in Annex.

G.1. Risk Assessment Summary

Please provide a summary of main risk factors. Detailed description of risk factors and mitigation measures can be elaborated in G.2.

Summary of environmental and social impacts assessed for each aspect of the WSRN S-BARBADOS project. Impacts are characterized by type (D-direct or I-indirect), nature (P-positive or N-negative), and duration (T-temporary or M-permanent).

Impact	*Mains Replacement*	*Photovoltaic Installation*	*Water Resilience Programmeme*	*Rainwater Harvesting*
Environmental				
Air quality	D, N, T	D, N, T	D, N, T	D, N, T
Water quality	D, P, M	I, N, M	D, P, M	D, P, M
Soil cover	D, N, T	D, N, T/P	D, P, M	D, P, M
Biodiversity	D, N, T	I, N, M	D, P, M	D, P, M
Noise	D, N, T	D, N, T	D, N, T	D, N, T
Land use	D, N, T	D, N, T/P	D, P, M	D, P, M
Social				
Health and safety	D, N, T	D, N, M	D, P, M	D, P, M
Sanitation	I, P, M	D, N, T	D, P, M	D, P, M
Socio- economic	I, P, M	I, P, M	D, P, M	D, P, M
Road network	D, N, T	D, N, T	D, N, T	D, N, T
Visual amenity	D, N, T	D, P, M	D, N, M	D, N, M
Gender				
Job Training	D, N, T/M	D, P, M	D, P, M	D, P, M
Economic Empowerment	D, N, T	D, P, M	D, P, M	D, P, M

The majority of the risks are temporary, especially during construction phases.

G.2. Risk Factors and Mitigation Measures

Please describe financial, technical and operational, social and environmental and other risks that might prevent the project/programme objectives from being achieved. Also describe the proposed risk mitigation measures.

Financial Risk

Description	Risk category	Level of impact	Probability of risk occurring
Under-utilization of RAFF	Financial	Low (<5% of project value)	Low

Mitigation Measure(s)

To prevent the under-utilization of RAFF by the public for climate resilience implementation at their households or businesses, a widespread education and outreach campaign is included with demonstration sites and activities planned to engage with the public and with entrepreneurs. The entrepreneurial engagement is designed to encourage growth in the sector and assist with educational materials to convince potential customers of benefits of resilience implementation to them. These activities should reduce this risk to a percentage lower than 5%.

Operational Risk

Description	Risk category	Level of impact	Probability of risk occurring
Downtime/Malfunction of Systems	Technical and operational	Medium (5.1-20% of project value)	Low
Mitigation Measure(s)			
To avoid downtime due to malfunctioning systems included in this proposal (PV, natural gas turbine, water tankers, tank storage systems, RWH etc.), service contracts, leasing options with maintenance included, and capacity building components are included for monitoring, operations, and maintenance with problem solving integrated throughout. Technologies used will not be unique to BWA and parts and expertise to fix will be available in Barbados for jobs that do not require servicing by the seller. These measures will lower the level of this risk to low.			
Environmental Risk			
Description	Risk category	Level of impact	Probability of risk occurring
Extreme Climatic Conditions (Damages and Disruption)	Social and environmental	Low (<5% of project value)	Medium
Mitigation Measure(s)			
To alleviate potential damage to the infrastructure implemented under this project, the project is designed to be resilient to severe climatic conditions such as strong winds and flooding with early warning and emergency/backup systems in place to protect hardware and still provide service to population. The location of the PVs took this risk into consideration. Furthermore, the design of the system has taken into consideration potential rain days, which will disrupt PV energy production. Large tank systems will be strapped and when filled with water, will resist storm displacement. To mitigate the impacts of rain days and/or disruptions in energy production by the PV, other alternative sources of energy will be used as well as a MOU will be sought with the Barbados Light and Power Company Limited to get energy at a concessional rate or a net metering arrangement since the PV on non-rain days will produce more than enough energy to drive the operations at each pumping station.			
Social Risk			
Description	Risk category	Level of impact	Probability of risk occurring
Loss of jobs due to technology introduction/expansion	Social and environmental	Low (<5% of project value)	Low
Mitigation Measure(s)			
Technology introduction and expansion supported by this project has potential to eliminate jobs linked with fossil fuel power generation, and with the utility's water production. The risk of job loss is low, however, as the PV, water storage, and rainwater harvesting systems, should create more jobs for Barbadians linked not just to installation, but also operation and maintenance of these new technologies. As a result, a strong component is included in this grant for human workforce development to ensure workers have new skillsets to address new opportunities from the installed technologies. In addition to training and certification, the ongoing relationship with the academic and vocational institutions will ensure new needs are addressed. Also, this project will engage with private sector and the public to build entrepreneurial activities that broaden/mainstream the technologies being supported and this will help to realize even more job opportunities. These measures will ensure the low probably of this risk occurring.			
Social Risk			
Description	Risk category	Level of impact	Probability of risk occurring

Gender disparities in jobs as a result of project	Social and environmental	Medium (5.1-20% of project value)	Low
Mitigation Measure(s)			
Baseline gender analyses at the BWA show that more men are employed at the utility, especially in technical areas. PV installation, mains replacement, and water storage tank installation tend to be male dominated activities whereas water quality analyses and education and outreach show more female representation. This project's emphasis on capacity building as a part of project development, and implementation, and the allocation of funds for gender integration into all aspects of the project, will reduce gender disparities in jobs. This approach should also create new jobs as gender sensitive design opportunities emerge. Recommendations from baseline gender analysis will be used in the proposal. The BWA will develop a gender policy as a part of this project. Gender and stakeholder training will be developed and required for project partners and other stakeholders. TORs for contractors will also address gender barriers and opportunities for gender integration. These initiatives will ensure this risk remains low.			
Social Risk			
Description	Risk category	Level of impact	Probability of risk occurring
Weak institutions for meaningful policy dialogue	Social and environmental	Low (<5% of project value)	Low
Mitigation Measure(s)			
To eliminate the threat of institutions' lack of capacity for dialogue needed to develop policies on water sector resilience and PPPs, this project includes a capacity building component with facilitated stakeholder workshops and contractual budget for legal assistance in policy development. Maintaining dialogue, transparency and visibility is essential to generate support by decision makers for the project and educational budget is also included to share project information through guided tours, videos, social media etc.. If necessary because of its repository of research, projects and experts, CCCCC could aid with creating linkages and mediating to see the successful implementation and growth of this project. These interventions should reduce this risk even lower than it already is.			
Social Risk			
Description	Risk category	Level of impact	Probability of risk occurring
Low participation of vulnerable groups	Social and environmental	Low (<5% of project value)	Low
Mitigation Measure(s)			
To mitigate this risk, stakeholders' involvement is critical. In designing the project, gender and stakeholders analyses were conducted and the concerns of both men and women taken into consideration. Additionally, the project has identified how the water woes of Barbados affect children, women, men and the elderly; these were taken into consideration during the design process and the implementation of the project will be guided as such. The project also promotes equal employment opportunity to all.			
Other Potential Risks in the Horizon			
Please describe other potential issues which will be monitored as "emerging risks" during the life of the projects (i.e., issues that have not yet raised to the level of "risk factor" but which will need monitoring). This could include issues related to external stakeholders such as project beneficiaries or the pool of potential contractors.			

** Please expand this sub-section when needed to address all potential material and relevant risks.*

H.1. Logic Framework.

Please specify the logic framework in accordance with the GCF's Performance Measurement Framework under the Results Management Framework.

H.1.1. Paradigm Shift Objectives and Impacts at the Fund level[41]						
Paradigm shift objectives						
Shift to low-emission sustainable development pathways	This project builds greater climate resilience to climate change and variability including extreme weather and storm events whilst addresses issues related to supply, distribution, quality, availability, access, and utilization of water in Barbados as well as the greenhouse gas emissions intensity of water provision. It is an important increment in the suite of actions needed to safeguard and guarantee water security in Barbados and further bolster Barbados' resilience to climate change. The project will result in a paradigm shift that makes the Barbados society aware of the water cycle and climate change impacts threatening the island's drinking water supply, create resilience to severe weather impacts, reduce greenhouse gas emission, reduce consumption, promote appropriate uses of diverse water sources and legislations to support climate smart development and water sector resilience.					
Increased climate-resilient sustainable development						
Expected Result	Indicator	Means of Verification (MoV)	Baseline	Target		Assumptions
				Mid-term (if applicable)	Final	
Fund-level impacts						
M1.0 Reduced emissions through increased low-emission energy access and power generation	Tonnes of carbon dioxide equivalent (tCO_2eq) reduced or avoided as a result of Fund funded projects / programmes	Periodic Evaluations and Reports. Use internationally available PV software PV analysis to monitor and verify actual PV production and Co2 avoided. Example SMA Solar Technology and Solar Edge	0	Avoided emission 73,394 tCO_2eq by 2030	Avoided emission 220,184 tCO_2eq by 2048	• Medium term is up to 2030. • Useful life of the PV systems is 30 years • Displacement factor is 0.7906tCO_2eq/MWh

[41] Information on the Fund's expected results and indicators can be found in its Performance Measurement Frameworks available at the following link (Please note that some indicators are under refinement): http://www.gcfund.org/fileadmin/00_customer/documents/Operations/5.3_Initial_PMF.pdf

A1.0 Increased resilience and enhanced livelihoods of the most vulnerable people, communities and regions	Number of individuals/households (disaggregation by male and female) adopting climate-resilient livelihood options	Periodic reports on the progress of the project	50 vulnerable households with personal tanks	By 2020, 500 Vulnerable households with storage tanks By 2020, 2500 (50% male and 50% females) individuals, including women and children, benefit from Rainwater Harvesting Systems and Personal Tank Programme.	By 2023, 1,500 Vulnerable households with storage tanks By 2023, 5500 (50% male and 50% females) individuals, including women and children, benefit from Rainwater Harvesting Systems and Personal Tank Programme.	• Participation and implementation of programme of action or suggested improvements discussed at the workshop.
A2.0 Increased resilience of health and well-being, and food and water security	Number of health institutions (number patients-disaggregate by male and female and adult and children) benefiting from introduced climate resilience water supply to the health sector. Number of Individuals/Households/Entities (disaggregated by males and females) with year-round access to reliable and safe water supply despite climate shocks and stresses Number of farm/farmers made climate-resilient/food-secure	Periodic reports from BWA on energy savings, instances of water disruption and shortages and revenue generated. Annual report on RWH activities Annual report on probable recharge and demand	Hospital, and polyclinics have limited storage capacity 10,000 households somewhat resilient to climate shocks and stresses (estimated). Limited rainwater harvesting on farms serving multiple farmers	By 2020, 1 hospital and 9 polyclinics retrofitted with storage tanks or RWH By 2020, at least 120,000 individuals will be made resilience to climate shocks and stresses. 40 Farmers utilizing harvested rainwater for irrigation	By 2023, 1 hospital and 9 polyclinics retrofitted with storage tanks or RWH By 2023, at least 189,000 individuals will be made resilience to climate shocks and stresses. 120 Farmers utilizing harvested rainwater for irrigation	• Stable economic environment. • Cost per unit of electricity is US$0.38. • Rainwater Harvesting efforts do not compete with BWA but complements its operations. • Public education and capacity building spur job market for RWH

H.1.2. Outcomes, Outputs, Activities and Inputs at Project/Programme level						
Expected Result	Indicator	Means of Verification (MoV)	Baseline	Target		Assumptions
				Mid-term (if applicable)	Final	
Project/programme Outcomes	Outcomes that contribute to Fund-level impacts					
M6.0 Increased number of small, medium and large low-emission power suppliers	6.3a Percentage of water systems equipped with climate resilient low emission energy systems. 6.3b MWs of low emission energy capacity installed.	Observed installed and operational PV systems and Project Reports.	0	By 2020, 25% of water systems equipped with climate resilient low emission energy systems. By 2020, 2 PV Systems with capacity of 4MW installed	By 2023, 54% of water systems equipped with climate resilient low emission energy systems. By 2023, 3 PV Systems with capacity of 4.5MW installed	
A5.0 Strengthened institutional and regulatory systems for climate-responsive planning and development	5.1. Institutions and regulatory systems that improve incentives for climate resilience and their effective implementation. 5.2 Number and level of effective coordination mechanisms	Project reports, Register of workshop attendees, policy produced RAFF reports and audits	0 0	By 2023, 0 Policy Papers produced By 2020, RAFF established	By 2023, 2 Policy Papers produced By 2023, RAFF fully operationalized.	• Engagement with stakeholders are properly planned and implemented
A6.0 Increased generation and use of climate information in decision-making	Number of effective climate information products /services for deciusion making in climate sensitive sectors developed, delivered and used.	Project reports, meeting notes, ground water model and research paper	0	By 2020, 1 Water Master Plan By 2020 1 Optiramp tool installed By 2020, BWA and other stakeholders trained to used CCORAL.	By 2023, 1 groundwater model By 2023, Water Master Plan, Optiramp tool, CCORAL and groundwater model used in the development of adaptation initiatives (Concept or Full Projects).	
A7.0 Strengthened adaptive capacity and reduced exposure to climate risks	7.1 Number of households, communities, businesses and public-sector services of Fund supported tools, instruments, strategies and activities to respond to climate change and variability vulnerable	BWA's metering, monitoring and reporting. Feedback from activities impact on participants # people trained on climate change adaptation via project activities	100% of water production and distribution is vulnerable to storms /hurricanes.	By 2020, 40% of water production and distribution will not be affected by a storm/hurricane	By 2023, 60% of water production and distribution will not be affected by a storm/hurricane	• Population growth, 0.37% • Rainwater Harvesting efforts do not compete with BWA but

	7.2: Number of individuals/household (disaggregated by males and females) reached by [or total geographic coverage of] climate related early warning systems and other risk reduction measures established/ strengthened		36% of NRW (30MGD) is leakage.	By 2020, reduce NRW by 0.15MGD By 2020, 5% increase in water available to the public including rainwater harvesting (water security) By 2020, 600 Personal Tanks and Rainwater Harvesting Systems installed	By 2023, reduce NRW by 0.48MGD By 2023, 15% increase in water available to the public including rainwater harvesting (water security) By 2023, 1,500 Personal Tanks and Rainwater Harvesting Systems installed	complement its operations • 0.03MGD is lost per km of distribution piping but conservative estimate of 0.02MGD per day is used to set target.
A8.0 Strengthened awareness of climate threats and risk-reduction processes	8.1: Number of males and females made aware of climate threats and related appropriate responses	# people reached through training and educational outreach via social media, radio, TV, in person meetings	0		By 2023, At least 200 persons trained in PV installation and maintenance, CCORAL, RWH system installation and maintenance or ENVISION By 2023, CCORAL is used to access climate risk for BWA project. By 2023, Annual World Water Day Event instituted By 2023, at least 2,000 persons (students and households) actively participated in community events, school outreach events, social media, consultations or public presentation(s). By 2023, A Case Study of lessons learnt.	
Project/programme outputs	Outputs that contribute to outcomes					

Output 1.1: Photovoltaic Renewable Energy Systems and Natural Gas Microturbines Installed and Integrated	Operational PV systems l and Backup Natural Gas Turbines	Procurement and Contractual agreement(s) with vendor(s). Periodic reports from BWA. Pictures and GPS mapping.	0	4.0 MW PV systems installed 2.7 MW Natural Microturbines installed	4.5 MW PV systems installed 3.5 MW Natural Microturbines installed	• System s will operate at their capacity and function al into the long-run (30 years) • Medium term is up to 2030. • 5.5 sunshin e hours per day • Energy to be displace d by solar 9,283.4 1MWh per year for 30 years.
Output 2.1: Revolving Adaptation Fund Facility (RAFF) Established	RAFF in place Number of people benefiting from the RAFF	Bank Account, Financial Records, MOUs, Project Document, Media Campaigns and Legal Documents	No micro-adapta tion and mitigati on fundin g	A Bank account opened and funded.	A Bank account opened and funded. 25 persons benefited from the fund.	• Terms and conditio ns will be agreeab le for all parties. • The Public will see the benefit of such and utilizatio n it. • Mid-term is 2 years into project impleme ntation.
Output 3.1: Climate Change Adaptation (CCA) Water Master Plan Completed	Climate Change Adaptation Water Master Plan available	Project report, Review and accepted document produced by the Consultant.	No Water Master Plan exists with CCA	0	1 Climate Change Adaptation Water Master Plan	• Favoura ble conditio ns for data gatherin g, researc h and knowled ge sharing and mains
O**utput 3.2:** 16 km of Mains Replaced	Km of Mains replaced	Pictures, Project Documents and Reports, Site Visits	0	5 km of main replaced	16 km of main replaced	

						replace ment
Output 3.3: Real time decision making tool Implemented	Optiramp software synced with BWA data available	Optiramp interface and project reports	0	1 Optiramp installed and linked with SCADA & other data	1 Optiramp installed and linked with SCADA & other data	• BWA data is readily accessi ble
Output 3.4: Potable Water Storage Systems Installed	One (1) Needs Assessment conducted Number of Personal tank systems installed at hospital, polyclinics, schools, vulnerable homes Storage capacity and emergency response supply systems increased by 250M^3	Pictures, Project Documents and Reports, Site Visits	50 vulner able house holds retrofitt ed with storag e tanks 100M^3	1 Needs assessment 1 hospital, 9 polyclinics, 16 schools, and 500 vulnerable residences retrofitted with storage tanks By 2020, Tanks and Tanker Capacity increased by 150M^3	1 Needs assessment 1 hospital, 9 polyclinics, 16 schools, and 1500 vulnerable residences retrofitted with storage tanks By 2023, Tanks and Tanker Capacity increased by 250M^3	• Medium term is up to 2020. • Full term is up 2023
Output 3.5: Rainwater Harvesting Programme Implemented	One (1) Needs Assessment conducted Number of Rainwater harvesting systems installed in homes, farms, schools and community centers. 22 Infiltration (suck) wells retrofitted Number of Groundwater model developed	Pictures, Project Documents and Reports, Site Visits	0	1 Needs Assessment 22 Schools, 20 community centers 2 Rainwater Harvesting Ponds for farms 0 infiltration (suck) wells retrofitted 0 groundwater model	1 Needs Assessment 800 homes, 22 schools, 20 community centers and 121 Farmers with Rainwater Harvesting Systems (ponds and rooftop) 22 infiltration (suck) wells retrofitted 1 groundwater model	• Medium term is up to 2020. • Full term is up 2023
Output 4.1: Personnel Trained and Certified	Disaggregate by Gender: Number of BWA staff trained on ISO 450001 Number of BWA partners ENVISION certified Number of BWA staff trained on gender mainstreaming	progress reports and	0 0 0	250 BWA staff trained with ISO 45001 25 BWA and partners ENVISION certified 250 BWA staff trained on gender	500 BWA staff trained with ISO 45001 25 BWA and partners ENVISION certified 500 BWA staff trained on gender	• Willingn ess and ability of people to participa te in events

	Number of workshops organized public educated and engaged with the project,		0	11 Community workshops/training	33 Community Workshops/ training (3 per parish)	
	Number of UWI students with knowledge trained about climate change; climate change, water conservation, recycling, rainwater harvesting and renewable energy; (gender disaggregated data)		0	50 persons trained	100 persons trained	
	Number of CCORAL Workshop		0	1 CCORAL workshop (BWA & key stakeholders)	1 CCORAL workshop (BWA & key stakeholders)	
	Number of people trained on vocational training on Green Construction		0	25 BWA staff trained in Climate Change installation and maintenance of PV systems (CARIPITA).	25 BWA staff trained in Climate Change installation and maintenance of PV systems (CARIPITA).	
	Number of BWA staff with advanced PV international certification		0	5 BWA staff receive advanced PV international certification	5 BWA staff receive advanced PV international certification	
Output 4.2 Public Awareness Campaign Implemented	Number of school outreach events organized	Monitoring reports, project documentation, audiovisual records, community events, social media thread and newspaper articles.	0	11 school outreach events	22 school outreach events	• Willingness and ability of people to participate in events
	Number of public presentation on Climate Change Adaptation Water Master Plan undertaken		0	1 public presentation on Climate Change Adaptation Water Master Plan	5 World Water Day Celebrations/Events (annual)	
	Number of awareness campaigns (TV, Radio and Social Media) on water conservation, energy efficiency, rainwater harvesting and climate change undertaken		0	0 water conservation, energy efficiency, rainwater harvesting and climate change campaign (TV, Radio and Social Media)	1 water conservation, energy efficiency, rainwater harvesting and climate change campaign (TV, Radio and Social Media)	
Output 4.3: Policies for water sector resilience and PPPs created	Number of Legislative Desk Reviews undertaken	Policy papers and studies &	limited legislation exist	1 desk review 1 policy paper	1 desk review 2 policy papers	• Prudent and favourable

	Number of Policy papers with guidelines and recommendations prepared Number of Workshops/seminars held with key policy makers, businesses and community groups	Stakeholder Registry and # of workshops/seminars		5 workshops/seminars/working group meetings	10 workshops/seminars/working group meetings	government engagement and support. • Policy papers will contribute to developing legislative framework and law which we believe will be implemented
Activities	Description		Inputs		Description	
Activity 1.1.1: Design, Purchase and Installation of 2.0 MW Grid-tied PV (solar) plant, Switchgear (HT & LT), Transformer, and a 2.0 MW Microturbine (Natural Gas) at Belle Pumping Station	Installation of a 2.0MW PV system with a 2.0 MW backup natural gas Microturbine at the Belle Pumping Station; a 2.0MW PV system at the Hampton Pumping Station which already has a standby dual fuel (natural gas and bio-diesel) generator and a 0.5MW PV system with a 0.8 MW backup natural gas Microturbine at Bowmanston Pumping Station. Installing PV systems with their backup natural gas Microturbines at the selected pumping stations make those pumping stations independent of the power company (Barbados Light and Power Company).		Electrical Drawings of site, Designs, Site Preparation, Oversight, Contractor(s), PV panels and Balance of System and spares (Inverters, electrical materials, mounting structure, meters, etc.), Civil works (electrical switchgear, inverters, maintenance workshop, etc.), transformer(s), security, permits, GEED certification, Division of Energy licensing, Barbados Light and Power application		The PV systems will be ground-mounted on the adjoining land for the aforementioned pumping stations - see diagram. The installation of the PV systems will also include some civil and electrical works. Civil and electrical works involves the construction of an inverter room with appropriate switch gear and the installation of electricity metering and monitoring equipment. AC power from the inverter room will routed to the switch gear at the pumping station. This power will be coupled with the main bus bar system for the pumping station incorporating an automatic transfer switch (ATS), which will be coupled either with the GENSET or with the Power Utility System. Approvals are required from the Government Electrical Engineering Department (GEED), Barbados Light and Power (BL&P) and the Division of Energy. Further details on these approvals are given in Section C.6.	
Activity 1.1.2: Design, Purchase and Installation of 0.5 MW Grid-tied PV (solar) plant and a 0.8 MW Microturbine (Natural Gas) at Bowmanston Pumping Station.						
Activity 1.1.3: Design, Purchase and Installation of 2.0 MW Grid-tied PV (solar), Switchgear (HT & LT) and Transformer at Hampton Pumping Station .						
Activity 2.1.1: Establish fund administration. Activity 2.1.2: Open bank account(s) Activity 2.1.3: Establish MOUs, protocols and guidelines for the fund	*Mobilising funds for use in water sector adaptation and mitigation initiatives through the mechanism of a Revolving Adaptation Fund Facility (RAFF), which would enable all members of the population to have access to funding (credit facilities) for climate change adaptation and mitigation related to the water sector of Barbados.*		Finance Officer, legal advisor, bank account, protocols, MOU(s) and management guidelines.		MOUs are required between BWA and RAFF and between the City of Bridgetown Cooperative Credit Union (COB- CCU) and Fund Management and Administration. The MOU between the RAFF (management and administration) and COB-	

			CCU will identify: Access to the fund and identification of purposes; Fee structure; Parameters for the means test and applicable interest rates; Guidelines for final approval and disbursement; Guidelines for reporting and monitoring; and, A Portfolio Risk Management Plan.
Activity 3.1.1: Development of Climate Change Adaption Water Master Plan	The proposed assessment includes the preparation of a climate resilient investment plan and recommendations for policy and institutional strengthening to support the integration of climate resilience in the sector. The study will contribute to the preparation of a tool for building resilience in the water sector, which could be applied throughout the Caribbean.	TOR, Consultant	TORs will be drafted and a consultant hired to develop the Climate Change Adaptation Water Master Plan. It is expected that all major stakeholders will be consulted during this process.
Activity 3.2.1: 16 km Mains Replacement	This activity includes the execution of a leak detection survey, execution of a water audit and demand analysis, execution of a foresight and pressure management study, purchase and installation of pressure management equipment, implementation of design and oversight for mains replacement, the purchase of mains and fittings, the creation of a decision matrix that considers gender and stakeholder impact to determine prioritization of mains replacement, and the replacing of 16km of mains. Using information generated by mapping and leak detection activities, replace 16 km of leaky and aged transmission/distribution mains.	BWA's Hydraulic Model, GIS maps, meters, flow probes, pressure transducers, acoustic leak detectors, BWA's NRW Unit and Consultant(s) Output from leak detection with frequency of bursts, materials present, and source of water Congestion and access, types of users in community, mains to be replaced, technology to use Schedule for mains replacement, communities affected. Oversee contractor completing mains replacement activity Engage stakeholders on reconnection Monitor pressure, customer complaints	Create decision matrix for mains replacement Assess area for mains replacement & identify best technique Provide residents with a schedule and address any special needs. Approve replacement schedules, activity, pressure test meets requirements, pipes pass sanitary test, and removed pipes are properly disposed. Communicate with customers on reconnection flushing of lines. Reconnect replaced mains
Activity 3.3.1: Develop real time decision making tool	This activity involves installing OPTIRamp software, installing production meters and purchasing detection equipment will be used to improve the real-time management of water supply. This tool will be used to improved real-time management of water supply based on BWA collected SCADA data (e.g. reservoir levels, pumping rates), and non-telemetry data (e.g. water meter data).	SCADA Telemetry Equipment and Data, software license maintenance, training, BWA consultants, Production meter, leak detection equipment, engineers	This tool increases BWA's resilience by making it proactive to climate variability and change, reducing disruptions in supply based on real time data of reservoir levels, groundwater levels, and demand.
Activity 3.4.1: Execution of Needs Assessment and Installation of Personal Tank Systems	This activity includes expanding BWA's personal tanks programme, increasing storage at Barbados' only public hospital from 14 hours to between 72 to 96 hours, increasing the number of emergency response units from 13 to 18, and radically improving BWAs ability to model and prioritize/react to infrastructural needs.	Needs Assessment, Design, Tanks, pumps, pipes and fittings, plumbers, Contractors, emergency mobile units, BWA's Rapid Response Team, Flow Meters, Pressure Transducers, OPTIramp Software.	A needs assessment is needed to identify households that most in need and will benefit significant from this programme. It pulls on existing designs the BWA has, which were improved are the first round of implementation.

Activity 3.5.1: Installation of Rainwater Harvesting Systems at Farms and Public Facilities (Schools, Community Centers, Polyclinics)	Harvested rainwater to secure residential and community assets (schools, polyclinics, essential services) water supply and the potential of rainwater to recharge aquifers through the rehabilitation of drainage wells. This activity involves clearing clogged infiltration (suck) wells and creating natural filters using sand and gravel that will stop mud and debris from getting into infiltration channels.	Needs Assessment, Rainwater harvesting tanks, pipes and fittings, plumbers, BWA staff, USF and UWI researchers	Implement residential rainwater harvesting at key locations in DMAs, monitor for performance/usage. See 4.1 above as this forms part of that work , focusing specifically on the role of drainage wells, volumes collected, water quality and infiltration characteristics.
Activity 3.5.2: Retrofit of infiltration (suck) wells		BWA staff, USF and UWI, customer sites, PV powered pumps and clearing equipment. BWA's Engineers and equipment and sand and gravel	
Activity 3.5.3: Develop groundwater model for Barbados	This activity includes the installation of groundwater monitoring wells, especially around watersheds already experiencing saltwater intrusion during dry seasons, and completion of a groundwater model for Barbados. It builds on groundwater models developed by UWI CERMES researchers.	TOR, Consultant, UWI CERMES Researchers, Preliminary groundwater model	UWI CERMES Researcher in collaboration with an expert consultant will advance the modeling of groundwater resources.
Activity 4.1.1: Develop educational materials and a mechanism that builds BWA and local capacity for climate resilient decisions and climate proofing its existing infrastructures, sustainability, stakeholder and gender, and risk reduction and safety.	Establish a unit within BWA that fosters a robust gender and socially responsive workforce development program for the human-technology interface for climate adaptation that builds human capacity, university-utility Private Public Partnerships and encourages knowledge transfer at the BWA, in Barbados and the wider Caribbean.	Project partners, MOUs	Establish goals, protocols, and mechanisms for operating the PRU that will be responsible for project activities and the workforce development needs.
Activity 4.1.2: Provide theoretical and practical training related to the installation, operation, maintenance and monitoring of photovoltaic systems, leak detection technology and techniques, water storage systems, and rainwater harvesting.	Partner with the University of the West Indies and University of South Florida to establish a sustainable infrastructure team within the BWA with trained personnel for energy efficiency, Water Loss Reduction, resilience programme, and rainwater harvesting that improves adaptation to Climate Change and delivers knowledge products from lessons learned. Institute research for tertiary level students based on the various demonstration projects with co-advising by various partners (University of West Indies, University of South Florida), including BWA employees CCCCC will conduct CCORAL training with BWA staff and other to mainstream climate change into infrastructure development and upgrades.	Project partners, BWA staff, curriculum	Establish/identify workforce development program
		CCORAL training, CCCCC	CCCCC will conduct CCORAL training will BWA Project Team.
		ISO45001 training, BWA staff, contractors	BWA employees will obtain ISO45001 certification, with health and safety manager obtaining highest level of certification.
		ENVISION^{TM} certification course offering (includes climate impacts/adaptation), BWA staff, USF, contractors, key stakeholders	USF will lead training of 50 BWA employees and contractors and key stakeholders in Barbados on ENVISION^{TM} certification and apply this tool to projects.
		PV training course offerings from CVQ & NVQ (Caribbean and National Vocational Qualification), BWA Renewable Energy Unit	BWA employees in the Renewable Energy Unit will obtain NABCEP PV Installation Professional certification and manage and maintain the PV installations.
		Monitoring & evaluation software for PV systems, BWA staff, consultant	BWA employees in the Renewable Energy Unit will be trained on monitoring and evaluation of PV operating systems
		Gender materials, Gender policy, BWA staff	USF and UWI develop a gender certification through Institute of Gender and Development Studies (IGDS)
		Knowledge management to oversee research opportunities for academic partnership and development of lessons learnt from various aspects of the project	Master's & Doctoral research with UWI CERMES & USF students based on project components to contribute knowledge on lessons learnt on climate resilient smart utilities.

Activity 4.2.1: Share lessons learnt to spur greater public and entrepreneurial involvement	This involves sharing lessons learnt, via documents and tours of demonstration sites, with the general public, especially entrepreneurs, to encourage growth of businesses that build water sector resilience. Create videos/documentary, organize event(s) within communities to raise awareness, Produce multi-media (social, newspaper, Radio and TV) outputs	Demonstration sites, learning materials, case studies, entrepreneurs, BWA/project staff, speakers, educational materials, website, project partners	Develop and deliver educational materials that gain public acceptance of climate adaptation projects and how their actions can make Barbados more resilient. Link these strategies with entrepreneurial activities (e.g. rainwater harvesting implementation). Project staff will use demonstration sites of water sector resilience to engage with entrepreneurs on opportunities for job growth in their businesses.
Activity 4.2.2: Promote and encourage the public to utilise RAFF and take action to mitigate, and adapt to climate variability and change.	Create videos/documentary, organize event(s) within communities to raise awareness, Produce multi-media (social, newspaper, Radio and TV) outputs	Social media, BWA website, Demonstration site, City of Bridgetown Credit Union, speakers, educational materials, website, articles, Radio and TV interviews and Ads.	Develop the BWA website to be more interactive and an educational tool that integrates with social media to engage customers with climate resilient solutions for Barbados.
Activity 4.3.1: Develop a policy for water sector resilience in Barbados to combat climate change.	Use the project components to engage with relevant stakeholders to solidify policies and laws pertaining to water sector resilience.	Government entities, BWA legal and compliance department, Outputs from various project components, educational materials, workshops.	Critical to completing this activity is engaging with government via various medium to mainstream climate change risk into the development and more specifically the water sector. It is also important to bring together both the public and private sectors to dialogue and develop effective avenues and instruments to spearhead climate resilience development.
Activity 4.3.2: Develop a policy for Public Private Partnership (PPP) to combat climate change.	The activity will review existing legislations with aim of creating a baseline on which a PPP framework can be developed using some information gathered in activity 4.3.1.		

H.2. Arrangements for Monitoring, Reporting and Evaluation

BESIDES THE ARRANGEMENTS (E.G. SEMI-ANNUAL PERFORMANCE REPORTS) LAID OUT IN AMA, PLEASE PROVIDE PROJECT/PROGRAMME SPECIFIC INSTITUTIONAL SETTING AND IMPLEMENTATION ARRANGEMENTS FOR MONITORING AND REPORTING AND EVALUATION. PLEASE INDICATE HOW THE INTERIM/MID-TERM AND FINAL EVALUATIONS WILL BE ORGANIZED, INCLUDING THE TIMING.

PLEASE PROVIDE METHODOLOGIES FOR MONITORING AND REPORTING OF THE KEY OUTCOMES OF THE PROJECT/PROGRAMME.

CCCCC-GCF Reporting and Monitoring

CCCCC reporting to the GCF fund will be guided by GCF Monitoring and Accountability Framework for Accredited Entities, its Accreditation Master Agreement and terms to be agreed in the funding agreement. Aligned with GCF's Monitoring and Accountability Framework for Accredited Entities, CCCCC will undertake continuous monitoring of the project through site visits and quarterly reports, which will feed into semi-annual reports and an annual report.

The Annual Performance Reports (APRs) will include the financial management reports and progress report on all activities. It will identify potential risk to project activities and remedial action to mitigate these risk. These reports will also evaluate the activities against the targets set out in the logical framework, which are in accordance with the GCF investment framework criteria. CCCCC monitoring and reporting will consider feedback from communities and local stakeholders, including civil society organizations and direct project beneficiaries, at all stages of the project cycle. This approach allows for a bi-directional flow of information (feedback) from the communities and local stakeholders to BWA and CCCCC and vice-versa.

There will be a final report at the end of the period of implementation, which will provide a holistic view of the achievements of the project, impact, effectiveness and efficiency (financial and economic), financial records, stakeholder feedback and lessons learnt. This report will also be accompanied by the final project financial audit to be completed by an independent and accredited auditor. All records on this project will be kept for at least five years for review by the GCF or its authorized bodies after project completion. The CCCCC will submit in English the final project report to the GCF within 6 months of the completion of the project.

BWA-CCCCC Reporting and Monitoring

To ensure the project continue to be both viable and sustainable, detailed timely reporting, monitoring and evaluation will be carried out. The BWA will provide CCCCC with (i) quarterly progress reports in a format consistent with CCCCC project management and performance reporting system; (ii) consolidated annual reports including (a) progress achieved by output as measured through the indicator's performance targets, (b) key implementation issues and solutions; (c) updated procurement plan and (d) updated implementation plan for next 12 months; and (iii) a project completion report within 6 months of physical completion of the Project. Financial audits of all accounts will also be conducted on a yearly basis.

CCCCC will also undertake a mid-term review within 2 years of project being effective or at any time that CCCCC, BWA and Government the of Barbados consider it necessary. The midterm review mission will:

1. review institutional, administrative, organizational, technical, environmental, social, economic, and financial aspects of the project and identify potential risks and corresponding mitigate actions.
2. review contracts to assess whether they are still relevant or need to be changed, or waived due to changing circumstances;
3. assess the need to restructure or reformulate the project and the effects of this on the immediate objectives (purpose) and long-term goals of the project; and,
4. update the project's design and monitoring framework if restructuring or reformulation is necessary or its immediate objectives will change.

Within 3 months of physical completion of the Project the BWA will submit a project completion report to Government of Barbados and CCCCC.

I. SUPPORTING DOCUMENTS FOR FUNDING PROPOSAL

X	NDA No-objection Letter
X	Feasibility Study
X	Integrated Financial Model that provides sensitivity analysis of critical elements (xls format, if applicable)
X	Confirmation letter or letter of commitment for co-financing commitment (If applicable)
X	Project/Programme Confirmation/Term Sheet (including cost/budget breakdown, disbursement schedule, etc.) – *see the Accreditation Master Agreement, Annex I*
☐	Environmental and Social Impact Assessment (ESIA) or Environmental and Social Management Plan (If applicable)
☐	Appraisal Report or Due Diligence Report with recommendations (If applicable)
☐	Evaluation Report of the baseline project (If applicable)
X	Map indicating the location of the project/programme
X	Timetable of project/programme

** Please note that a funding proposal will be considered complete only upon receipt of all the applicable supporting documents.*

References

Barbados Statistical Service (2014) Tourist arrivals monthly statistical bulletin December 2014. http://www.bhta.org/images/Stats/2014/Dec2014.pdf accessed April 14, 2016.

Barnett, M. 2011. The impact of the recent drought on the National Water Commission water supply services to Kingston and St Andrew. 5th Caribbean Environmental Forum, 21– 25 June 2010, Montego Bay, Jamaica

Campbell, J., M. Taylor, T. Stephenson, R. Watson, and F. Whyte. 2010. Future climate of the Caribbean from a regional climate model. International Journal of Climatology 31(12): 1866–78.

Cashman, A., Nurse, L., Charlery, J. (2010). Climate Change in the Caribbean: The Water Management Implications, The Journal of Environment & Development, 19(1) 42–67.

Charara, N., Cashman, A., Bonnell, R. and Gehr, R. (2011). Water use efficiency in the hotel sector of Barbados. Journal of Sustainable Tourism 19(2) pp: 231-245.

Cornejo, P.K., Santana, M.V.E., Hokanson, D.R., Mihelcic, J.R., Zhang, Q. (2014) Estimating greenhouse gas emissions for water reuse and desalination facilities. Journal of Water Reuse and Desalination, 4(4):238-252, 2014.

FAO (2015) http://faostat3.fao.org/browse/area/14/E

Food and Agriculture Organization (FAO). (2013a). FAOSTAT Database. Available at: http://faostat.fao.org/. (Accessed June 2, 2013).

Food and Agriculture Organization (FAO). (2013b). AQUASTAT Database. Available at: http://www.fao.org/nr/water/aquastat/ main/index.stm. (Accessed June 2, 2013).

Gohar, A. and Cashman, A. (2015). Modelling the impact of Climate Change and variability on water availability and economic livelihood: An example from the Caribbean. WIT Transactions on the Built Environment 12 pp: 1061-1072.

Government of Barbados (2009) National Profile of Chemicals Management in Barbados. Accessed 10/5/15. http://www2.unitar.org/cwm/publications/cw/np/np_pdf/Barbados_National_Profile_2009.pdf

Green Climate Fund (GCF) (2016). Consideration of funding proposals – Addendum VI Funding proposal package for FP033. Funding Proposal Version 1.0. GCF/B.15/13/Add.06, 24 November 2016. Retrieve on January 12, 2016 from: https://www.greenclimate.fund/documents/20182/490910/GCF_B.15_13_Add.06_-_Funding_proposal_package_for_FP033.pdf/29ba4b4b-c46b-49c0-86f8-73d538efd43d

Government of Barbados (2015) Barbados Intended Nationally Determined Contribution Communicated to the United Nations Framework Convention on Climate Change on September 28, 2015. Accessed 10/5/15 http://www4.unfccc.int/submissions/INDC/Published%20Documents/Barbados/1/Barbados%20INDC%20FINAL%20September%20%2028,%202015.pdf

Hall T., A. Sealy, T. Stephenson, S. Kusunoki, M. Taylor, A. Chen, and A. Kitoh. 2012. Future climate of the Caribbean from super-high-resolution atmospheric general circulation model. Theoretical Applied Climatology.

Hart, N., (2015) Industrial application of Renewable Energy (Photovoltaic & Wind turbine) within the frame work of Water and Wastewater as it relates to the Barbados Water Authority. Proceedings of 22nd Annual CWWA conference, 63, Miami, FL.

Hart, N., (2015) Real world Application of Photovoltaic –(PV) to Water and Wastewater Companies: Case Study Barbados Water Authority. Proceedings of 24th Annual CWWA conference, Miami, FL.

International Monetary Fund (IMF), (2016). Press Release: IMF Staff Completes 2016 Article IV Mission to Barbados. Retrieved on January 26, 2017 from: https://www.imf.org/en/News/Articles/2015/09/14/01/49/pr16232

ISO. (2006). ISO 14040: 2006 environmental management: Life cycle assessment principles and framework (2 ed.). Geneva, Switzerland: International Organization for Standardization.

Kleypas, J.A., Buddemeier, R.W., Archer, D., Gattuso, J.P., Langdon, C., Opdyk, B.N. (1999). Geochemical Consequences of Increased Atmospheric Carbon Dioxide on Coral Reefs, Science 284(5411):118-120.

Mackey, T., A. Cashman and R. Cumberbatch. 2014. Identification of factors contributing to the deterioration and losses in the water distribution system in Barbados. Centre for Resource Management and Environmental Studies, The University of the West Indies, Cave Hill Campus, Barbados. CERMES Technical Report No. 68. 73pp.

Mo, W., Zhang, Q. (2012). Can Municipal Wastewater Treatment Systems be Carbon Neutral?, Journal of Environmental Management, 112, 360-367.

Mo, W., Zhang, Q., Mihelcic, J.R., Hokanson, D. (2011) Embodied Energy Comparison of Surface Water and Groundwater Supply Options, Water Research, 45:17, 5577-5586.

National Renewable Energy Laboratory (NREL) (2015) Energy Snapshot Barbados. DOE/GO-102015-4654. Accessed 9/20/15 http://www.nrel.gov/docs/fy15osti/64118.pdf.

Nurse, L., Cashman, A., Mwansa, J. (2012). Confronting the Challenges of Sewerage Management in the Caribbean: A Case Study from the Island of Barbados, Environment: Science and Policy for Sustainable Development, 54:2, 30-43, DOI: 10.1080/00139157.2012.657910

Pan American Health Organisation (PAHO), Health in the Americas, 2012 edition: Country Volume.

Pulwarty , R.S., Nurse, L.A., Trotz, U.O. (2010). Caribbean Islands in a Changing Climate, Environment: Science and Policy for Sustainable Development, 52:6, 16-27, DOI: 10.1080/00139157.2010.522460

Shirley, R., Kammen, D. (2013). Renewable energy sector development in the Caribbean: Current trends and lessons from history. *Energy Policy*, *57*, 244-252.

Simpson, M. C., Clarke, J. F., Scott, D. J., New, M., Karmalkar, A., Day, O. J., Taylor, M., Gossling, S., Wilson, M., Chadee, D., Stager, H., Waithe, R., Stewart, A., Georges, J., Hutchinson, N., Fields, N., Sim, R., Rutty, M., Matthews, L., and Charles, S. (2012). CARIBSAVE Climate Change Risk Atlas (CCCRA) - Barbados. DFID, AusAID and The CARIBSAVE Partnership, Barbados, West Indies.

Simpson, M. C., Clarke, J. F., Scott, D. J., New, M., Karmalkar, A., Day, O. J., Taylor, M., Gossling, S., Wilson, M., Chadee, D., Stager, H., Waithe, R., Stewart, A., Georges, J., Hutchinson, N., Fields, N., Sim, R., Rutty, M., Matthews, L., and Charles, S. (2012). CARIBSAVE Climate Change Risk Atlas (CCCRA) - Barbados. DFID, AusAID and The CARIBSAVE Partnership, Barbados, West Indies.

Slijkerman, D. M., de León, R., de Vries, P. (2014). A baseline water quality assessment of the coastal reefs of Bonaire, Southern Caribbean.*Marine pollution bulletin*, *86*(1), 523-529.

UNData (2016). Barbados World Statistics Pocketbook, United Nations Statistics Division. Retrieved on January 26, 2017 from: http://data.un.org/CountryProfile.aspx?crName=barbados

United Nations Environment Programme (UNEP) (2010). Latin America and the Caribbean: Environmental Outlook.

US Environmental Protection Agency (US-EPA), 2016. Social Cost of Carbon. Retrieved on October 1, 2016 from: https://www.epa.gov/climatechange/social-cost-carbon

Verbyla, M.E., Oakley, S.M., Mihelcic, J.R. (2013). Wastewater infrastructure for small cities in an urbanizing world: Integrating the protection of human health and the environment with resource recovery and food security, Environmental Science & Technology, 47(8):3598–3605.

World Bank Development Indicator (WDI) (2016) Country data: Barbados. http://data.worldbank.org/country/barbados. Accessed April 14, 2016.

World Weather and Climate Information (WWCI) (2016). Average monthly hours of sunshine over the year. Retrieved on January 15, 2016 from: https://weather-and-climate.com/average-monthly-Rainfall-Temperature-Sunshine,Bridgetown,Barbados

World Economic Forum. (2011). Water security: the water-food-energy-climate nexus. Washington, D.C.: Island Press. Available at: http://www.weforum.org/reports/water-security-water-energy-food-climate-nexus <accessed September 14, 2015.

World Resources Institute (WRI) (2015). Aqueduct Projected Water Stress Country Rankings, , Washington, D.C. http://www.wri.org/applications/maps/aqueduct-atlas/ accessed September 14, 2015.Yoshioka, R. M., Kim, C. J., Tracy, A. M., Most, R., Harvell, C. D. (2016). Linking sewage pollution and water quality to spatial patterns of *Porites lobata* growth anomalies in Puako, Hawaii. Marine Pollution Bulletin, 104, 313-321.

World Travel and Tourism Council, 2015. Travel & Tourism Economic Impact 2015 Barbados. Retrieved on January 23, 2017, from: http://www.caribbeanhotelandtourism.com/wp-content/uploads/data_center/destinations/Barbados-WTTC-EconomicImpact2015.pdf