DOCUMENT OF THE INTER-AMERICAN DEVELOPMENT BANK

**BARBADOS**

**Deployment of Cleaner Fuels and Renewable Energies in Barbados**

**(BA-L1012)**

**MONITORING AND EVALUATION PLAN**

This document was prepared by the project team consisting of: Christiaan Gischler (INE/ENE), Team Leader; Adriana Valencia (DSP/DCO), Co-Team Leader; Martin Duhart (INO/SMC); Camila González; Joel Hernández; Stephanie Suber and Carlos Sucre (INE/ENE); Vinicio Rodriguez; Denise Salabie and María Padilla (FMP/CBA); Camilo Gómez; Leanne Rapson and Rochelle Franklin (CCB/CBA); Raúl Muñóz (VPS/ESG); Escarlata Baza and Betina Hennig (LEG/SGO).

**CONTENT**

Table of Contents

[1 Introduction 5](#_Toc464207158)

[2 Monitoring 8](#_Toc464207159)

[2.1 Indicators 8](#_Toc464207160)

[2.2 Data Collection and Instruments to Monitor the Project Indicators 11](#_Toc464207161)

[2.3 Reporting 13](#_Toc464207162)

[2.4 Monitoring Coordination, Work Plan and Budget 14](#_Toc464207163)

[3 Evaluation 21](#_Toc464207164)

[3.1 Indicators 21](#_Toc464207165)

[3.2 Main Evaluation Questions 21](#_Toc464207166)

[3.3 Existing Knowledge 22](#_Toc464207167)

[3.3.1 Ex-Ante Cost-Benefit Analysis 23](#_Toc464207168)

[3.4 Key Impact Indicators and Methodology 24](#_Toc464207169)

[3.4.1 Impact Indicator Calculation Methodology 25](#_Toc464207170)

[3.5 Key Outcome Indicators 26](#_Toc464207171)

[3.5.1 Outcome Indicator Calculation Methodology 26](#_Toc464207172)

[3.6 Mid-project Evaluation 27](#_Toc464207173)

[3.7 Final Project Evaluation 28](#_Toc464207174)

[3.7.1 Ex-poste CBA methodology 29](#_Toc464207175)

[3.8 Evaluation Coordination, Work Plan and Budget 30](#_Toc464207176)

ABBREVIATIONS

AOP: Annual Operations Plan

BL&P: Barbados Light & Power

BNOCL: Barbados National Oil Company Limited

CBA: Cost-Benefit Analysis

CNG: compressed natural gas

CO2: carbon dioxide

EA: Executing Agency

EE: energy efficiency

ELPA: Electric Light and Power Act

ESA: Environmental and Social Assessment

ESMP: Environmental and Social Management Plan

GHG: greenhouse gas

GIS: geographic information system

GOB: Government of Barbados M&E: Monitoring and Evaluation

HFO: heavy fuel oil

IDB: Inter-American Development Bank

INDC: Intended Nationally Determined Contribution

LNG: liquefied natural gas

MMcfd: Million cubic feet per day

NG: natural gas

NPC: National Petroleum Company

OM: Operations Manual

PCR: Project Closure Report

PEP: Pluriannual Execution Plan

PMR: Progress Monitoring Report

PP: Procurement Plan

PPP: Public-Private Partnership

RE: renewable energy

SCADA: supervisory control and data acquisition

SEFB: Sustainable Energy Framework for Barbados

UNFCCC: UN Framework Convention on Climate Change

VS LNG terminal: very small LNG terminal

XPMR: Extended Progress Monitoring Report

# Introduction

The Inter-American Development Bank (IDB) is preparing a loan operation (Loan BA-L1012) for the Government of Barbados (GOB) to support the deployment of cleaner fuels and renewable energies in the country (the Project). Barbados has made significant progress in developing its renewable energy (RE) endowment, but the country is still dependent on costly imported liquid fossil fuels for power generation. The government’s priorities in the energy sector, according to the National Sustainable Energy Policy (NSEP), are to reduce electricity prices, increase energy security, increase the use of cleaner fuels and reduce negative environmental impacts.

As a result, and as mentioned in the Barbados Medium-Term Growth and Development Strategy (2013-2020), Barbados is seeking to promote energy efficiency (EE) and RE, and ensure a reliable source of cleaner fuels for power generation. The Barbados Intended Nationally Determined Contribution (INDC) submission to the UNFCCC (September 28, 2015) stated that Barbados aims to have RE provide 65% of peak electricity demand by 2030 and achieve a 22% reduction in electricity consumption by 2029 relative to business as usual scenario. In order to facilitate higher RE penetration, Barbados is looking to NG as a baseload energy source for the power sector that could further reduce carbon emissions, reduce electricity tariffs and provide an alternative to switch away from HFO in the short term.

The Barbados National Oil Company, Limited (BNOCL) has already installed an LNG facility at the Woodbourne Terminal (Micro LNG Plant) with capacity to handle iso-containers to supply a NG demand of around 0.5 mmcfpd. However, there is a need to expand its capacity in order to satisfy total demand of 2-3 mmcfpd and avoid costly NG shortages.

In addition to meeting current demand, the government is planning steps that could eventually enable the use of NG for power generation. BL&P has already shown interest in using NG in some of their facilities. To this end, the National Petroleum Company (NPC) is planning the process of establishing a Public-Private partnership (PPP) to import LNG for power generation. In order to support this process, the IDB will collaborate with its private sector arm, the Inter-American Investment Corporation (IIC).

The objective of this project is to enhance Barbados’ energy security and sustainability by diversifying its energy matrix through promoting the use of cleaner fuels for power generation, and increasing the use of RE sources. Specific objectives include: to (i) upgrade existing NG infrastructure to ensure NG service continuity; (ii) increase EE and RE applications within NPC’s and BNOCL’s operations to reduce GHG emissions; (iii) enable implementation of a PPP project to import and supply LNG for power generation; and (iv) provide technical support to NPC and BNOCL to foster organizational and operational efficiency. Each Component is described in greater detail below.

Component 1 of the Project, Natural Gas Infrastructure, will provide US$25.02 million to finance activities to upgrade Barbados’ existing NG infrastructure under two sub-components:

* **Sub-component 1.1 – NG Infrastructure upgrade**: Infrastructure upgrades may include:
  + developing a geographic information system (GIS) of the NPC-BNOCL network;
  + updating the Supervisory Control and Data Acquisition (SCADA) of NG processing and distribution;
  + replacing and upgrading meters, including automated meter infrastructure;
  + modernizing the NPC-BNOCL transportation fleet; and,
  + replacing, realigning and installing NG pipelines for transmission and distribution and upgrading distribution stations.
* **Sub-component 1.2 – Expansion of Micro LNG Plant at Woodbourne**, including:
  + An LNG unloading facility for iso-container reception (up to 2 MMcfd);
  + A cryogenic LNG storage tank and related equipment;
  + emergency equipment; and
  + a gas buffering system.

Component 2 of the Project, Smart Energy Solutions, will provide US$3.35 million to finance solutions to increase energy efficiency (EE) and the use of renewable energy (RE) in NPC-BNOCL facilities including:

* installing PV (300 kW) and smart systems in NPC-BNOCL facilities;
* converting compressors from NG to solar PV plus plant retrofits;
* installing a 850kW wind turbine, and
* installing EE and/or RE equipment in buildings.

Component 3 of the Project, Technical Advisory Services, will provide US$4.05 million to finance consultancy services through two sub-components:

* **Sub-component 3.1 – Institutional Strengthening**: consultancy services: (i) to provide training for NPC/BNOCL in areas including: (a) negotiating and entering into PPP contracts; (b) large infrastructure project design, execution, and management; and (c) quantification of gross and net GHG emissions of projects; and (ii) to develop studies for improving: (a) corporate governance, environmental, legal and regulatory functions; (b) quality management systems ; and (c) information technology applications to monitor and control the NG supply chain.
* **Sub-component 3.2 – Public-Private Partnership (PPP) for the construction of a Very Small (VS) LNG Plant**: Consultancy services will facilitate the establishment of a PPP for the construction of facilities to import LNG for power generation, with support from IIC, including:
  + support to procurement and negotiation processes for the selection of a private sector partner and the structuring of a PPP to build and operate the VS LNG Plant;
  + support to procurement and negotiation processes to secure at least 18 million cubic feet per day (MMcfd) supply of LNG under the PPP scheme; and,
  + capacity building for structuring and managing the PPP contract.

The cost of the program is estimated to be US$34 million, including the three Components noted above, resources to provide monitoring and evaluation for the program, and project management.

The Project will be evaluated based on whether the actions that are supported by the Project (i) ensure NG service continuity, (ii) increase the number of LNG suppliers to Barbados to enhance energy security, (iii) reduced CO2 emissions from NPC/BNOCL operational and administrative facilities, (iv) increase operational efficiency in NG transmission and distribution, and, (v) increase private sector participation to develop an LNG project. . The Project’s impact will also be evaluated based on its effect on Barbados’ total GHG emissions resulting from power generation and its effect on Barbados’ average national electricity tariff.

In order to monitor and evaluate the expected results of the Project, a before and after assessment methodology will be used, as well as an ex-post cost-benefit analysis. The key monitoring tools for the M&E plan include maintaining records during the implementation process, measuring electricity consumption at NPC-BNOCL facilities, and measuring NPC-BNOCL operational costs and NG sales to end users. The evaluation methodologies include before and after analysis of key outcome indicators and an ex-poste cost-benefit analysis. The ex-poste cost-benefit analysis of the investments funded by the Project will follow the same assumptions, methodology, and modeling parameters as the ex-ante cost-benefit analysis that was performed as part of the loan preparation process.

The Project will be executed by the National Petroleum Corporation (NPC) of Barbados, or the newly created NPC-BNOCL entity following the amalgamation of the two. Within the NPC, a Project Executing Unit (PEU) will be established and given primary responsibility for coordinating and executing the investments that will be financed by the Project. The PEU will have primary responsibility for all monitoring and evaluation activities related to the Project, including gathering the required data, analyzing progress toward the stated goals, and preparing the required progress and assessment reports such as the Annual Operating Plans (AOP), the Pluriannual Execution Plan (PEP), and the Procurement Plan (PP).

The PEU will also be responsible for gathering from other Barbados government bodies and private sector companies any needed data or input that may be required for Project monitoring and evaluation. For example, the Barbados government will provide data on Barbados’ future total GHG emissions resulting from power generation that it gathers in order to report its progress toward implementing and meeting its INDC obligations under the UNFCCC. In addition, Barbados Light and Power (BL&P), a privately held utility that provides Barbados’ electricity supply, will provide data on the future average national electricity tariffs.

The PEU will be supported by the Project Team at the IDB, including specialists from the Energy/Infrastructure Department and the Barbados country office. Specialist consultants are also expected to be contracted to support the ex-poste cost-benefit analysis.

# Monitoring

The purpose of this section is to describe the monitoring process for the three components of the Project: Natural Gas Infrastructure, Smart Energy Solutions, and Technical Advisory Services. For each component, the specific indicators, data collection methods, reporting, and monitoring coordination, work plan, and budget are provided.

## Indicators

Table 1 below lists the Indicators that have been defined for each Component’s outputs. The table also defines the frequency of measurement, and the source of verification for each Indicator.

Table 1: Project Output Indicators by Component

| Indicator | Formula | Frequency of Measurement | Source of Verification |
| --- | --- | --- | --- |
| **Output Indicators** | | | |
| Component 1: Natural Gas Infrastructure | | | |
| **Expected Result 1: Ensure NG service continuity** | | | |
| **Expected Results 2: Increase the number of LNG suppliers to Barbados to enhance energy security** | | | |
| Monitoring and control systems upgraded/replaced | # of systems upgraded or replaced | Semi-annually | Semi-annual reports from NPC/BNOCL |
| Pipelines for transmission and distribution replaced, realigned and/or installed | Km of pipeline installed, replaced, realigned and installed | Semi-annually | Semi-annual reports from NPC/BNOCL |
| NG distribution stations upgraded | # stations | Semi-annually | Semi-annual reports from NPC/BNOCL |
| On-road NG distribution fleet acquired or modernized | # vehicles | Semi-annually | Semi-annual reports from NPC/BNOCL |
| Micro LNG Plant at Woodbourne expanded | million cubic feet per day (mmcfpd) | Semi-annually | Semi-annual reports from NPC/BNOCL |
| Component 2: Smart Energy Solutions | | | |
| **Expected Result 3: Reduce CO2 emission reductions from NPC/BNOCL operational and administrative facilities** | | | |
| RE capacity installed in NPC/BNOCL/newly created entity facilities | kW | Annually | Semi-annual reports from NPC/BNOCL |
| Energy Efficiency and/or RE equipment installed in NPC/BNOCL/newly created entity’s operational and administrative facilities | Binary (no/yes) | End of project | Semi-annual reports from NPC/BNOCL. |
| Component 3: Technical Advisory Services | | | |
| **Expected Result 4: Increased operational efficiency in NG transmission and distribution** | | | |
| Studies developed to improve NPC/BNOCL/newly created entity’s corporate governance, environmental, legal and regulatory functions, quality management systems, and information technology | # studies | Semi-Annually | Semi-annual reports from NPC/BNOCL and final reports of the studies. |
| NPC/BNOCL/newly created entity personnel trained in technical and management areas to support NG expansion. | # of men | Semi-Annually | Semi-annual reports from NPC/BNOCL |
| # of women |
| **Expected Result 5: Increase private sector participation to develop an LNG project** | | | |
| Bidding documents developed to secure 18 mmcfd supply of LNG using a PPP scheme | Bidding documents package | Semi-Annually | Bidding documents which will be attached to the Semi-annual reports from NPC/BNOCL. |
| Bidding documents developed to select a private sector partner for a PPP LNG project | Bidding documents package | Semi-Annually | Bidding documents which will be attached to the Semi-annual reports from NPC/BNOCL. |

These indicators and their expected timing are defined in the Results Matrix. Baseline data for each of the indicators exists through NPC’s management and monitoring of its business operations, through BL&P’s management and monitoring of its business operations, or through Barbados’ monitoring and analysis as part of its commitments under the UNFCCC. The PEU will be responsible for gathering the required baseline data and monitoring the evolution of these indictors.

The following table shows the Physical Progress as planned during project execution by Output and Component.

Table 2: Project Execution Timeline by Output and Milestone

| Indicator | Unit | Baseline (2015) | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Final Target (EOP) | Source of Verification |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Component 1: Natural Gas Infrastructure | | | | | | | | | | |
| **Component 1 Outputs** | | | | | | | | | | |
| Monitoring and control systems upgraded/replaced[[1]](#footnote-1) | # of systems upgraded or replaced | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 3 | Semi-annual reports from NPC/BNOCL |
| Pipelines for transmission and distribution replaced, realigned and/or installed | Km of pipeline installed, replaced, realigned and installed | 0 | 2 | 4 | 4 | 0 | 0 | 0 | 10 | Semi-annual reports from NPC/BNOCL |
| NG distribution stations upgraded | # stations | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | Semi-annual reports from NPC/BNOCL |
| On-road NG distribution fleet acquired or modernized[[2]](#footnote-2) | # vehicles | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 7 | Semi-annual reports from NPC/BNOCL |
| Micro LNG Plant at Woodbourne expanded[[3]](#footnote-3) | Binary (No/Yes) | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | Semi-annual reports from NPC/BNOCL |
| Component 2: Smart Energy Solutions | | | | | | | | | | |
| **Component 2 Outputs** | | | | | | | | | | |
| RE capacity installed in NPC/BNOCL/newly created entity facilities | kW | 0 | 0 | 0 | 0 | 300 | 0 | 850 | 1,150 | Semi-annual reports from NPC/BNOCL[[4]](#footnote-4) |
| Energy Efficiency and/or RE equipment installed in NPC/BNOCL/newly created entity’s operational and administrative facilities | Binary (no/yes) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | Semi-annual reports from NPC/BNOCL[[5]](#footnote-5) |
| Component 3: Technical Advisory Services | | | | | | | | | | |
| **Component 3 Outputs** | | | | | | | | | | |
| Studies developed to improve NPC/BNOCL/newly created entity’s corporate governance, environmental, legal and regulatory functions, quality management systems, and information technology | # studies | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 4 | Semi-annual reports from NPC/BNOCL and final reports of the studies. |
| NPC/BNOCL/newly created entity personnel trained in technical and management areas to support NG expansion. | # of men | 0 | 4 | 4 | 5 | 5 | 0 | 0 | 18 | Semi-annual reports from NPC/BNOCL (a minimum of 7 women will be trained in technical and managerial areas) |
| # of women | 0 | 2 | 2 | 2 | 1 | 0 | 0 | 7 |
| Bidding documents developed to secure 18 mmcfd supply of LNG using a PPP scheme | Bidding documents package | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | Bidding documents which will be attached to the Semi-annual reports from NPC/BNOCL. |
| Bidding documents developed to select a private sector partner for a PPP LNG project | Bidding documents package | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | Bidding documents which will be attached to the Semi-annual reports from NPC/BNOCL. |

## 

## Data Collection and Instruments to Monitor the Project Indicators

The National Petroleum Corporation (NPC) of Barbados, or the newly created NPC-BNOCL entity following the amalgamation of the two, will be the Project Executing Agency (EA). Within the NPC, a Project Executing Unit (PEU) will be established and given primary responsibility for coordinating and executing the investments that will be financed by the Project. The PEU will also have primary responsibility for all monitoring and evaluation activities related to the Project, including gathering the required data, analyzing progress toward the stated goals, and preparing the required progress and assessment reports.

The PEU will develop the following activities to support the planning and execution of the Project:

* **Project Operations Manual (OM).** The Project Operations Manual will detail all roles, responsibilities, specific individual members, and operational arrangements that may be required for the PEU to execute the Project. The OM must include the principles and requirements from the Environmental and Social Management Plan (ESMP) draft annexed to the Environmental and Social Assessment (ESA), as well as the terms of reference for each of the PEU’s members. The OM will also be used to revise and update existing planning instruments that will form the baseline for project monitoring and evaluation and as the initial entry for the project monitoring report (PMR). These instruments include the Results Matrix, the Risk Matrix, the initial Pluriannual Execution Plan (PEP), the initial 12-month Annual Operating Plan (AOP), and the initial Procurement Plan (PP) for the first 12 months of the Project. The OM must be completed and approved by the EA prior to the first disbursement of the loan.
* **Pluriannual Execution Plan (PEP) and Annual Operations Plan (AOP).** The PEP and AOP consolidate all activities that will be developed as part of the Project execution, including detail by project and a timeline of both physical and financial progress. In each semi-annual report (noted below), the PEU will present the PEP and AOP for the following 12 months. The AOP will include details on the Project’s progress and execution of activities including goals, results, budget, and implementation schedule. The PEP will detail the project’s progress and implementation schedule for the outstanding years of the loan.
* **Procurement Plan (PP).**  The PP includes details on all works, goods, and services that will be required to implement the Project during a determined period of time. The initial PP covers the expected procurement requirements for the first 12 months of the Project. It will be updated at least once every 12 months, and can be amended as often as necessary, by agreement between the EA and the IDB. The PP will include details on procurement of works, goods, and non-consulting services and their compliance with IDB policies (GN-2349-9), as well as the procurement of consulting services and their compliance with IDB policies for selecting and contracting consultants financed by the IDB (GN-2350-9) that exceed established thresholds.

The principle methods of verification for project monitoring will be administrative and contractual documents prepared and gathered by the EA. These documents will include: (i) NPC annual reports and audited financial statements; (ii) signed contracts for the purchase of goods and services; (iii) final reports from consulting services; (iv) evaluation reports; (v) tender process, bidding, and award documents; and (vi) technical data on system operations.

In addition, data from other government entities or private companies will also be required. This data includes total GHG emission data (from the Barbados government) and electricity tariff rates (from BL&P).

In each case, data recording, gathering, and reporting instruments, processes and forms are already in place or will be included as part of the Project investment, and do not require a special design. For example, information on the number of personnel that are trained will be captured during the training process. Progress toward developing the bidding documents and implementing the bidding process will also be gathered by the Executing Agency (EA) and recorded against the established work plan throughout the implementation process.

The EA will gather information on the progress toward implementing the monitoring and control systems upgrades; NG pipeline replacement, realignment, and installing; vehicle fleet upgrade, and mico-LNG facility expansion. This information will be recorded against the established work plan throughout the implementation process. The EA will also gather information on the number of customers added, NG distribution system downtime, NG volume sold, and the price at which it was sold through its ongoing operations and business management.

The natural gas pipeline system upgrades will include monitoring equipment that will gather the data required to measure the outcome indicators. These monitors will include the advanced meters installed at customer sites and improved monitoring to detect NG leaks.

Information on the progress toward implementing the renewable energy, smart energy, and energy efficiency systems will be gathered by the Executing Agency (EA) and recorded against the established work plan throughout the implementation process. The EA will also gather information on the electricity consumed in its facilities and the volume of natural gas sold to BL&P for electricity generation through its ongoing operations and business management.

BL&P will also monitor and record the total amount of electricity produced using natural gas each year as part of its ongoing operations and business management.

The required information will be recorded in the PMR and the results provided in the applicable report noted below.

## Reporting

The Executing Agency (EA) will submit semi-annual reports describing progress toward completing each of the Project Components throughout the duration of the loan program. These reports will be produced by the PEU and submitted to the IDB Energy/Infrastructure Department via the IDB team leader. Each report must be submitted no later than 60 days after the end of the reporting period.

The semi-annual report will present to the IDB the degree of fulfillment of the output indicators and progress toward the outcomes of the Results Matrix as recorded in the updated PEP, AOP, and PP. This will allow the Bank to monitor these indicators using the Bank’s PMR tool.

The semi-annual reports must include, at a minimum: (i) compliance with contractual obligations; (ii) description and general information on the completed activities; (iii) progress toward project execution indicators, the agreed disbursement calendar, and timelines for physical progress in implementing the program investments; iv) financial summary of the program; (v) description of any procurement tenders that have been carried out; (vi) evaluation of any contracting companies carrying out physical works; (vii) socio-environmental management of the project, including timelines, results, and measures implemented to ensure compliance with socio-environmental obligations; (viii) a detailed activities program and execution plan for the following 12 months; (ix) estimated cash for the following 12 months; (x) potential developments or events that could put the execution of the Project at risk; and, (xi) updates to the Project PEP, AOP, and PP.

The semi-annual reports must include all relevant information to understand the progress toward meeting the project output and outcome indicators and to identify any areas that require improvement in data collection, processing, analysis and reporting. In addition, the EA will present to the Bank a mid-project interim evaluation after the earliest of three years after the project initiation or once 50% of the Project resources have been disbursed. This mid-project evaluation will assess the level of completion of the project output indicators (see Table 1) in order to determine the project implementation status. This evaluation will be used to propose any changes in the project scope or process that may be required in order to reach the project’s targets. Finally, after completing 90% of the Project’s disbursements, the EA will present to the Bank the Final Project Evaluation Report which will include, among other requirements, the ex-poste cost-benefit evaluation of the Components financed under the Project. This report will serve as the basis for the Bank to prepare a Project Completion Report (PCR) once the project execution is completed (OP-1242-3).

The PCR is a record of an operation’s performance at the end of its execution phase, undertaken as a self-evaluation by the IDB’s unit responsible for the project. The PCR is the Bank’s Management main instrument for documenting concrete results to its shareholders and disseminating the lessons of a project’s experience. The PCR is also a tool for accountability and learning. The accountability objective addresses the need for the Bank to ensure that the proceeds of the project are used for the purposes for which the project was granted, with due attention to effectiveness and efficiency. The learning objective aims to replicate successes and avoid mistakes in the future by providing lessons to guide the execution of ongoing projects and the design of future ones.

## Monitoring Coordination, Work Plan and Budget

The PEU is responsible, among other outputs, for the following activities: (i) planning the execution of the loan; (ii) preparing and updating the semi-annual monitoring reports noted, which will include updates of the AOP, PEP, and PP; (iii) contracting and monitoring work progress for all contracted specialized services, consulting, and procured goods; (iv) collecting, maintaining, and making accessible the required data and updating progress toward the outcome and output indicators noted above; (v) collecting, maintaining, and making accessible the required project execution data; and, (vi) supervising the socio-environmental impacts of the project implementation. It is expected that the PEU team will spend the equivalent of roughly 70 man-days per year dedicated to M&E activities.

The IDB, through the Project Team Leaders, is responsible for coordinating and assuring that the monitoring plan complies with all technical and quality requirements and is completed on schedule. The IDB team will achieve this through semi-annual technical visits with the EA in order to review progress of works and make adjustments based on execution. Fiduciary oversight visits will be conducted once a year. External audits of accounting and operations are also planned to validate the use of the loan proceeds and the operational internal controls and processes to be implemented by the EA. This information will be analyzed every six months.

The Project indicators results at the end of the Project execution must be included in the PCR which will be completed by the IDB country office with the support of Energy Department specialists.

The following table shows the different Monitoring, Evaluation and Reporting activities including the timeline for data collection.

Table 3: Monitoring and Reporting Work Plan

| **BA-L1012 Monitoring and Reporting Work Plan** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Monitoring and Evaluation Plan** | Year 1 | | | | Year 2 | | | | | | | Year 3 | | | | | | | Year 4 | | | | | | | Year 5 | | | | | | | | Year 6 | | | | | | | | Lead | | | Cost  (US$ '000) | | | Financing | | |
|  | I | II | III | IV | I | II | | III | | IV | | I | | II | III | | IV | | I | II | | III | | IV | | I | | II | | III | | IV | | I | | II | | III | | IV | |  | | |  | | |  | | |
| Monitoring and Reporting Activities | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Operation Kickoff meeting |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | IDB | | | 30 | | | IDB | | |
| Project Monitoring Report Workshop (Initial Plan) |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | IDB | | |
| Fiduciary Workshop |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | IDB | | |
| Procurement training |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | IDB | | |
| Ongoing fiduciary monitoring |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | IDB | | |
| Semi-annual meetings and technical supervision visits |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | IDB | | |
| Environmental and social supervision visits |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | IDB | | |
| Operations Manual (OM) |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | PEU | | | 5 | | | Included in Project Management cost | | |
| Completion of monitoring and evaluation tools (PEP, AOP, PP) |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | PEU | | | 60 | | |
| Prepare semi-annual progress reports |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | PEU | | |
| Analyze and approve monitoring and evaluation tools (PEP, AOP, PP) |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | IDB | | | 6 | | | IDB | | |
| Analyze and approve semi-annual progress reports |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | IDB | | |
| Analyze and approve disbursement requests |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | IDB | | | - | | | IDB | | |
| Data Collection Activities | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Component 1: Natural Gas Infrastructure |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | PEU | | | 60 | | | Included in Project Management cost | | |
| Component 2: Smart Energy Solutions |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | PEU | | |
| Component 3: Technical Advisory Services |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | PEU | | |
| **Total Budget for Monitoring Activities** | | | | | | |  | |  | |  | |  | | |  |  |  | | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  |  | |  | **161** |

\*\*\* To be submitted to the Bank no later than 120 days after the final disbursement justification

These indicators and their expected timing are defined in the Results Matrix. Baseline data for each of the indicators exists through NPC’s management and monitoring of its business operations, through BL&P’s management and monitoring of its business operations, or through Barbados’ monitoring and analysis as part of its commitments under the UNFCCC. The PEU will be responsible for gathering the required baseline data and monitoring the evolution of these indictors.

The following table shows the total Project Costs by component.

Table 4: Project Costs by Component

|  |  |
| --- | --- |
| **Component** | **IDB (OC loan)** |
| Component 1. NG Infrastructure | 25,025,000 |
| Component 2. Smart Energy Solutions | 3,350,000 |
| Component 3. Technical Advisory Services | 4,050,000 |
| Program evaluation | 75,000 |
| Project Management and Monitoring [[6]](#footnote-6) | 1,500,000 |
| **Total** | **34,000,000** |

The following table shows the financial plan for the operation. It details the total annual expected costs associated to each of the project’s outputs organized by component.

Table 5: Financial Timeline by Output

| Indicator | Unit | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Final Target (EOP) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Component 1: Natural Gas Infrastructure | | | | | | | | |
| **Outputs (Expected Result 1: Ensure NG service continuity)** | | | | | | | | |
| Monitoring and control systems upgraded/replaced | US$ | - | 2,295,000 | - | 2,295,000 | - | 3,060,000 | 7,650,000 |
| Pipelines for transmission and distribution replaced, realigned and/or installed | US$ | 1,660,000 | 3,320,000 | 3,320,000 | - | - | - | 8,300,000 |
| NG distribution stations upgraded | US$ | 1,124,000 | - | - | - | - | - | 1,124,000 |
| On-road NG distribution fleet acquired or modernized | US$ | 1,530,000 | - | - | - | - | - | 1,530,000 |
| Micro LNG Plant at Woodbourne expanded | US$ | 642,100 | 1,284,200 | 1,926,300 | 2,568,400 |  |  | 6,421,000 |
| Component 2: Smart Energy Solutions | | | | | | | | |
| **Outputs (Expected Result 3: Reduce CO2 emission reductions from NPC/BNOCL operational and administrative facilities)** | | | | | | | | |
| RE capacity installed in NPC/BNOCL/newly created entity facilities | US$ | - | - | - | 504,828 | 967,586 | 967,586 | 2,440,000 |
| Energy Efficiency and/or RE equipment installed in NPC/BNOCL/newly created entity’s operational and administrative facilities | US$ | - | 91,000 | 182,000 | 637,000 | - | - | 910,000 |
| Component 3: Technical Advisory Services | | | | | | | | |
| **Outputs (Expected Result 4: Increased operational efficiency in NG transmission and distribution)** | | | | | | | | |
| Studies developed to improve NPC/BNOCL/newly created entity’s corporate governance, environmental, legal and regulatory functions, quality management systems, and information technology | US$ | 180,000 | 540,000 | 540,000 | 540,000 | - | - | 1,800,000 |
| NPC/BNOCL/newly created entity personnel trained in technical and management areas to support NG expansion. | US$ | 40,000 | 60,000 | 70,000 | 70,000 | 10,000 | - | 250,000 |
| Bidding documents developed to secure 18 mmcfd supply of LNG using a PPP scheme | US$ | - | - | 300,000 | 700,000 | - | - | 1,000,000 |
| Bidding documents developed to select a private sector partner for a PPP LNG project | US$ | 300,000 | 300,000 | 300,000 | 100,000 | - | - | 1,000,000 |
| Evaluation | | | | | | | | |
| Mid-term evaluation | US$ | - | - | - | 30,000 | - | - | 30,000 |
| Final Evaluation | US$ | - | - | - | - | - | 45,000 | 45,000 |
| Project management | | | | | | | | |
| Consultants to support PEU | US$ | 224,167 | 224,167 | 224,167 | 224,167 | 224,167 | 224,167 | 1,345,000 |
| Monitoring and reporting | US$ | 25,833 | 25,833 | 25,833 | 25,833 | 25,833 | 25,833 | 155,000 |
| Total Project | | | | | | | | |
| Component 1: Natural Gas Infrastructure | US$ | 4,956,100 | 6,899,200 | 5,246,300 | 4,863,400 | - | 3,060,000 | 25,025,000 |
| Component 2: Smart Energy Solutions | US$ | - | 91,000 | 182,000 | 1,141,828 | 967,586 | 967,586 | 3,350,000 |
| Component 3: Technical Advisory Services | US$ | 520,000 | 900,000 | 1,210,000 | 1,410,000 | 10,000 | - | 4,050,000 |
| Program evaluation | US$ | - | - | - | 30,000 | - | 45,000 | 75,000 |
| Project management and monitoring | US$ | 250,000 | 250,000 | 250,000 | 250,000 | 250,000 | 250,000 | 1,500,000 |
| **Total Project** | **US$** | **5,726,100** | **8,140,200** | **6,888,300** | **7,695,228** | **1,227,586** | **4,322,586** | **34,000,000** |

# Evaluation

The purpose of this section is to detail the evaluation methodology that will be used for the Project and the implementation of the Project evaluation. The evaluation will be based on the information gathered through the project monitoring and will consist of a mid-project interim evaluation and a final evaluation no later than 120 days after the final disbursement justification.

## Main Evaluation Questions

The evaluation will seek to answer questions regarding the project’s results and impacts. Two specific questions regarding the impact of the Project: (i) did the various investments that were financed by the Project reduce Barbados’ total greenhouse gas (GHG) emissions resulting from power generation; and, (ii) did they result in a reduction in Barbados’ average national electricity tariff. The following are the questions regarding the project’s results: (i) did the various investments that were financed by the Project ensure NG service continuity; (ii) did they increase the number of LNG suppliers to Barbados to enhance energy security; (iii) did they reduce CO2 emissions from NPC/BNOCL operational and administrative facilities; (iv) did they increase operational efficiency in NG transmission and distribution; and, (v) did they increase private sector participation to develop an LNG project.

## Existing Knowledge

Several recent IDB supported studies and investment programs have demonstrated the potential for investments in renewable energy, energy efficiency, and natural gas imports to reduce GHG emissions from electricity generation and reduce the cost of electricity in Barbados.

The IDB has played an active role in supporting the energy sector transformation in Barbados since 2009. Through two Policy Based Loans (BA-L1022/2410/OC-BA and BA-L1021/2609/OC/BA) the Bank assisted the process of drafting and enacting policy and regulation to promote RE and EE. The Electric Light and Power Act, 2013 (ELPA), which defines the government of Barbados’ priorities to reduce electricity prices, increase energy security, increase the use of cleaner fuels and reduce negative environmental impacts, is to a large extent a result of this work.

The IDB also supported the identification of viable investments in RE and EE under an IDB-financed study titled ‘Sustainable Energy Framework for Barbados’ (SEFB). This report, completed in June, 2010, concluded that a 20-year program of investment in renewable energy (adding 40 MW of utility scale wind capacity, 20 MW of biomass cogeneration, 13.5 MW of solid-to-waste energy, and 20 MW of solar PV), and energy efficiency measures (including efficient lighting, air conditioners, premium electric motors, chillers, variable frequency drives, and power monitors) would result in a reduction in total electricity costs of US$283.5 million ( in net present value terms) relative to a “business as usual” base case, cut CO2 emissions by 4.5 million tons over the life of the project, and reduce reliance on fossil fuels to about 71 percent.[[7]](#footnote-7)

As a result of this effort, the Bank subsequently approved two investment loans, the Energy Smart Fund (2485/OC-BA) and the Public Sector Smart Energy Project (2748/OC-BA). The former developed financial instruments to support Small and Medium Enterprises adoption of RE and the latter allows for the retrofitting with EE and RE technologies of public buildings and street lights.

A 2014 Action Plan to Import Natural Gas to Barbados by Castalia Advisors examined the comparative costs to import natural gas using different technologies (such as CNG, LNG and pipelines) and determined that the most cost effective option to deliver natural gas in the volumes proposed by NPC was likely LNG through ISO containers or a very small LNG terminal. The study estimated that direct costs to deliver LNG to Barbados could be as low as US$11-12 per MMBtu. The Action Plan then proposed a development program to prepare and issue a competitive tender for natural gas supply.

The revised final report of the Natural Gas in the Caribbean – Feasibility Studies was completed in June, 2015. This report determined the feasibility of importing natural gas in Barbados, among other Caribbean countries, and estimated the likely cost and benefit to do so under various natural gas price regimes and technology options. The study concluded that importing LNG to Barbados could reduce the cost of electricity generation in 2023 by as much as one-third from the business as usual case. The study found importing LNG to Barbados would generate a net economic benefit of between US$321 million and US$462 million, and net financial savings of between US$217 million and US$357 million.

### Ex-Ante Cost-Benefit Analysis

In addition to the previous studies noted above, an ex-ante economic analysis was performed in preparation for the Project. This cost-benefit analysis (CBA) included four sub-projects that the loan operation will finance: expansion of the micro-LNG facility at Woodbourne, replacement of natural gas fired compressors with high efficiency electric compressors, installation of an 850 kW wind turbine, and installation of a 300 kW PV and smart energy system. The CBA also examined the possible very small (VS) LNG terminal that may be supported through a Public-Private Partnership, although the loan operation will not fund the construction of the terminal itself.

The economic NPV was calculated from the present value of the sub-projects’ estimated benefits and costs. For example, the benefit of expanding the micro LNG facility was calculated from the savings in fuel expenditures and the monetary value of the reduction in greenhouse gas emissions that result from consuming natural gas instead of liquid fuels. The cost of expanding the micro LNG facility was estimated from the full economic costs of implementing the project, including the costs not financed by the IDB. The difference between these two values for each year of the project period was then calculated, and then the present value of that difference was calculated using a 12 percent discount rate.

The CBA concluded that the sub-projects noted above generate an aggregate Net Present Value of US$6.9 million[[8]](#footnote-8) and an internal rate of return of 21 percent over a 25 year period. If the VS LNG terminal is included in the analysis, the aggregate Net Present Value is US$39 million and the economic internal rate of return is 18 percent. Both figures represent the NPV of the project sub-projects compared to a business-as-usual (BAU) scenario without the planned investments. The benefits of the sub-projects will stem from avoided economic losses from natural gas shortages, savings on liquid fuel expenditures, and the monetary value of avoided greenhouse gas emissions related to the displaced consumption of liquid fuels for electricity generation and commercial/industrial uses. Figure 3.1 shows the aggregate present value benefits, costs and net present value of the sub-projects financed by the Project.

Figure 3.1: Net Economic Benefits of the Sub-Projects (not including the VS LNG terminal) (US$ ‘000)

Figure 3.2 shows the aggregate present value benefits, costs, and net present value for the aggregate sub-projects including the VS LNG terminal.

**Figure 3.2: Net Economic Benefits of the Sub-Projects (including the VS LNG terminal) (US$ ‘000)**

The robustness of the estimated economic benefit was tested under unfavorable conditions through a sensitivity analysis of key input variables, including: (i) a 10% decrease in the projected oil price; (ii) a 10% increase in the projected price of natural gas at the source; (iii) a 40% decrease in the price of CO2; and, (iv) a 10% reduction in the capacity factor of the renewable energy components (wind turbine and solar panels). The analysis found that the Project remained viable even when subjected to all four unfavorable adjustments simultaneously.

## Key Impact Indicators and Methodology

This section describes the Project’s key impact indicators, including the related formulas, frequency of measurement, and data source. Table 7 below shows the two impact indicators that were identified for the Project: total GHG emissions resulting from power generation in Barbados, and the average national electricity tariff.

Table 7: Project Impact Indicators



### Impact Indicator Calculation Methodology

The reduction in total GHG emissions resulting from power generation in Barbados succinctly captures the broad environmental benefits that are expected to come from increasing RE capacity, improving EE, and replacing liquid fuels with natural gas. This impact indicator is measured and reported through a separate government entity that is not involved in the Project implementation.

Total GHG emissions from power generation are affected by the total amount of electricity that is consumed (EE measures help reduce or slow the growth in electricity consumption), the mix of technologies that are used to generate electricity (RE investments increase the share of carbon-free technologies in the mix), the efficiency at which fuels are converted to electricity (converting generators from liquid fuels to NG can slightly improve unit efficiency), and the carbon content of the fuels that are consumed (NG has less carbon per unit than HFO or diesel).

GHG emissions from power generation are calculated by multiplying the volume of carbon-based fuels (including NG, HFO, and diesel) that is consumed for electricity generation by the carbon content per unit of each fuel. The calculation relies on fuel consumption data that is gathered and maintained by BL&P and standardized values for fuel carbon content.

National average electricity tariffs reflect the cost providing electricity, including the cost of electricity generation. Under the current scheme, Barbados electricity tariffs are calculated based on the non-fuel costs incurred by BL&P to provide electricity (including generation, transmission, distribution, and administrative expenses), a regulated rate of return on the company’s asset base, and a separate fuel charge that reflects the current costs to purchase fuels for electricity generation. Electricity tariffs are differentiated across consumer classes, but at the national average level must reflect the total cost to provide electricity service.

Evaluating the reduction in average national tariffs captures the economic impacts of switching from HFO to lower cost NG. This impact indicator is also easy to measure and compare across multiple years, and is gathered and maintained by BL&P, a separate private company with no direct involvement in the Project implementation.

Average national electricity tariffs are calculated by dividing BL&P’s total income from electricity sales (in US$) by the total volume of electricity that it sold (in kWh). This country-wide total provides the annual average tariff level across all customer classes and tariff schedules and across any monthly variations in the fuel surcharge. The calculation relies on BL&Ps data on income and sales that is contained in its annual report to shareholders.

## Key Outcome Indicators

This section describes the Project’s key outcome indicators, including the related formulas, frequency of measurement, and data source. Table 8 below shows the six outcome indicators that were identified for the Project.

Table 8: Project Result/Outcome Indicators

| Indicator | Formula | Frequency of Measurement | Source of Verification |
| --- | --- | --- | --- |
| **Results Indicators** | | | |
| Component 1: Natural Gas Infrastructure | | | |
| **Expected Result 1: Ensure NG service continuity** | | | |
| Annual NG sales by NPC to residential, commercial and industrial clients | Million cubic feet (mmcf) | Annually | Semi-annual reports from NPC/BNOCL |
| **Expected Results 2: Increase the number of LNG suppliers to Barbados to enhance energy security** | | | |
| Number of international/regional LNG suppliers to Barbados | # of LNG suppliers | Annually | Semi-annual reports from NPC/BNOCL |
| Component 2: Smart Energy Solutions | | | |
| **Expected Result 3: Reduce CO2 emission reductions from NPC/BNOCL operational and administrative facilities** | | | |
| Annual CO2 emission reductions from implementing smart energy solutions in NPC/BNOCL operational and administrative facilities | Tons CO2 equivalent/year | Annually | Semi-annual reports from NPC/BNOCL [CO2 eq. reduction = kWh generated with natural gas \* CO2 emissions ratio1 (NG/HFO) (Tons CO2 eq. per year)] |
| Component 3: Technical Advisory Services | | | |
| **Expected Result 4: Increased operational efficiency in NG transmission and distribution** | | | |
| NPC’s Annual Operational cost per customer | US$/ customer | Annually | Semi-annual reports from NPC/BNOCL |
| **Expected Result 5: Increase private sector participation to develop an LNG project** | | | |
| Number of private sector partners with a contract awarded to implement the VS G Plant under a PPP scheme | # of private sector partners | End of project | Contract with winning proponent which will be attached to the Semi-annual reports from NPC/BNOCL. |

### Outcome Indicator Calculation Methodology

The methodology used to calculate each outcome indicator is described below.

**Annual NG sales by NPC to residential, commercial, and industrial customers.**  NG sales for each major customer and each customer class is recorded by NPC through the normal course of managing its business.

**Number of international or regional LNG suppliers to Barbados.** NPC records its LNG purchase agreements, including information on the LNG supplier, through the normal course of managing its business.

**Annual CO2 emission reductions from implementing smart energy solutions for electricity generation for own-consumption.**  The annual reduction in CO2 emissions is calculated as the amount of CO2 emissions that are avoided through RE and EE investments. For RE investments, the CO2 emissions reduction is calculated by multiplying the volume of electricity generated by the RE investments (wind turbine and solar panels) by efficiency of Barbados’ HFO generators (that is, the volume of fuel consumed per unit of electricity generated) and by the carbon content per unit of HFO. This calculation results the volume of CO2 that would have been emitted if the same amount of electricity had been generated with HFO instead of with RE technologies.

For EE investments, the reduction in CO2 emissions is calculated by first determining the amount of electricity consumption that was reduced as a result of the EE investment. This reduction is calculated by subtracting the current annual electricity consumption for the relevant building, equipment, or process, from the annual electricity consumed by the same unit prior to the EE investment. This reduction (in MWh) is then applied to the same methodology noted above for RE to calculate the volume of CO2 emissions that were avoided relative to a base case where the same volume of electricity would have been generated from HFO.

**Average NG operational cost per customer.** The average operational cost per NG customer is calculated from NPCs annual financial statements taking into consideration only the operational costs associated to the activities of transmission and distribution of NG (not including the cost to purchase NG). NPC’s total operational costs are divided by the total number of customers to obtain the average operational cost per customer. **Bidding process completed to select a private sector partner for a PPP LNG project.** NPC will prepare a bidding process for a PPP to support the construction of a VS LNG terminal. NPC internal documents and annual report will be used to verify the status and completion of the bidding process.

## Mid-project Evaluation

The mid-project evaluation will be initiated after the earliest of three years after the project initiation or once 50% of the Project resources have been disbursed. This mid-project evaluation will assess the level of completion of the project output indicators (see Table 1) in order to determine the project implementation status. This evaluation will be used to propose any changes in the project scope or process that may be required in order to reach the project’s targets.

The mid-project evaluation will use a before and after methodology to evaluate the annual results of the six outcome indicators noted above. The before and after methodology is the most appropriate methodology to assess the change in the identified key outcome indicators after the investments that are funded by the Project are implemented.

This evaluation will also examine aspects of coordination and execution, and recommend any needed adjustments that may be required to improve progress toward the proposed targets and increase coordination and execution efficiency.

This analysis will be based on the reports and data gathered through the project monitoring as noted above, in particular the semi-annual progress reports, the AOPs for each prior year, and the PP.

## Final Project Evaluation

The final evaluation will be completed by the PEU no later than 120 days after the final disbursement justification. The final evaluation include: (a) the degree of fulfillment of the targets specified in the Results Matrix; (b) an ex-post CBA; (c) an assessment of the performance of the EA; (d) factors affecting implementation; and (e) lessons learned and recommendations for the design of future operations. The Final Evaluation will allow the Bank to finalize the Project Completion report (PCR).

The final evaluation will evaluate the two impact indicators described in Section 3.3, the six outcome indicators described in Section 3.4, and the eight output indicators noted in Table 1. It will be based upon the reports and data gathered through the project monitoring as noted above, in particular the semi-annual progress reports, the AOPs for each prior year, and the PP.

Performing an ex-poste CBA will determine the accuracy of the ex-ante CBA and the root cause of any differences between the two. This comparison will identify specific factors in the project implementation that resulted in higher or lower costs and benefits than were anticipated, helping to improve the design and implementation of similar projects in the future.

The analysis will compare assumed and actual costs for procurement, operations and maintenance of new infrastructure, as well as key outcome indicators, such as the number of new customers and the volume of NG sold.

The ex-poste CBA will use the same methodology as the ex-ante CBA. It will be performed using three separate price inputs: (i) the original assumed price for NG and HFO; (ii) the actual observed NG and HFO prices; and, (iii) the estimated shadow prices for NG and HFO. Applying all three price inputs will allow the analysis to distinguish between the impact on the cost-benefit results from changes in natural gas volumes or the timing of project implementation, from the changes in external factors such as commodity prices, or from any changes in government subsidies that may distort the actual observed price.

At the end of the Project, the IDB Barbados country office, with support from ENE/INE specialists, will prepare the PCR, using input from the Final Project Evaluation provided by the PEU.

### Ex-poste CBA methodology

The ex-poste cost-benefit analysis (CBA) will mirror the methodology used in the ex-ante CBA in order to produce results that can be directly compared with the outcomes that were predicted in the ex-ante CBA. The ex-poste CBA will include four sub-projects that the loan operation will finance: expansion of the micro-LNG facility at Woodbourne, replacement of natural gas fired compressors with high efficiency electric compressors, installation of an 850 kW wind turbine, and installation of a 300 kW PV and smart energy system. The ex-poste CBA will also examine the very small (VS) LNG terminal if that project moves forward under subsequent loan operations.

The ex-poste CBA will calculate the economic NPV of each sub-project based on the present value of the sub-projects’ actual benefits and costs to date and the projected costs and benefits at the time of the ex-poste analysis. Historical data for the ex-poste CBA will come from the project reporting documents, including the semi-annual progress reports, the AOPs for each prior year, and the PP.

For example, the benefit of expanding the micro LNG facility will be calculated from the savings in fuel expenditures and the monetary value of the reduction in greenhouse gas emissions that result from consuming natural gas instead of liquid fuels. The cost of expanding the micro LNG facility will be based on the actual economic costs of implementing the project, including the costs not financed by the IDB, and the actual historical and projected future costs of operating the expanded micro LNG facility. The difference between these two values for each year of the project period (both historical and projected) will then be calculated, and the present value of that difference will be calculated using a 12 percent discount rate.

The ex-poste CBA will compare the aggregate economic Net Present Value and economic internal rate of return of the four sub-projects and compare them with the ex-ante results as well as a business-as-usual (BAU) scenario without the actual investments. The benefits of the sub-projects, including estimated avoided economic losses from natural gas shortages, savings on liquid fuel expenditures, and the monetary value of avoided greenhouse gas emissions related to the displaced consumption of liquid fuels for electricity generation and commercial/industrial uses, will be compared with both the anticipated benefits as calculated in the ex-ante CBA and the actual benefits against the BAU scenario without the investments.

The ex-poste CBA will highlight differences in the actual investment program, including scale, timing, and cost; differences in external factors, such as natural gas and oil prices and Barbados’ energy demand growth; and, any challenges or lessons learned from the project implementation. This assessment will help to identify root causes of any variation in the results of the ex-poste CBA and the ex-ante CBA analysis.

## Evaluation Coordination, Work Plan and Budget

The PEU will be responsible for coordinating and carrying out the mid-project and final project evaluations, including: (i) gathering the necessary data and prior reports; (ii) hiring an independent consultant to process and analyze the data and prepare the evaluations reports; and, (iii) overseeing the consultant’s work. The consultant will rely upon information from the monitoring program and related reports, and will also require active cooperation and input from the EA, BL&P, and the IDB project team.

The IDB, through the Project Team Leaders, is responsible for coordinating and assuring that the mid-project and final evaluations comply with all technical and quality requirements and are completed on schedule. The IDB team will achieve this through periodic meetings with the EA and the consultants responsible for conducting the evaluations in order to review progress of works and, if required, request progress reports or additional presentations of the results

The mid-project project evaluation is estimated to cost US$30,000 while the more extensive final evaluation report is estimated to cost US45,000. Both reports will be financed through the proceeds of the loan. Table 9 below shows the Evaluation work plan and budget.

Table 9: Evaluation Work Plan

| **BA-L1012 Evaluation Work Plan** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Monitoring and Evaluation Plan** | Year 1 | | | | Year 2 | | | | | | | Year 3 | | | | | | | Year 4 | | | | | | | Year 5 | | | | | | | | Year 6 | | | | | | | | Lead | | | Cost  (US$ '000) | | | Financing | | | |
|  | I | II | III | IV | I | II | | III | | IV | | I | | II | III | | IV | | I | II | | III | | IV | | I | | II | | III | | IV | | I | | II | | III | | IV | |  | | |  | | |  | | | |
| Evaluation Activities | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mid-term evaluation |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | PEU | | | 75 | | | Included in Evaluation Project cost | | | |
| Final Evaluation (\*\*\* to be submitted to the Bank no later than 120 days after the final disbursement justification) |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | \*\*\* | | PEU | | |
| Data Collection Activities | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Expected Result 1: Ensure NG service continuity |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | PEU | | | 30 | | | Included in Project Management cost | | | |
| Expected Results 2: Increase the number of LNG suppliers to Barbados to enhance energy security |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | PEU | | |
| Expected Result 3: Reduce CO2 emission reductions from NPC/BNOCL operational and administrative facilities |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | PEU | | |
| Expected Result 4: Increased operational efficiency in NG transmission and distribution |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | PEU | | |
| Expected Result 5: Increase private sector participation to develop an LNG project |  |  |  |  |  |  | |  | |  | |  | |  |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | PEU | | |
| **Total Budget for Evaluation Activities** | | | | | | |  | |  | |  | |  | |  |  | |  | | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  |  | |  |  | **105** |

1. Systems may include upgraded mapping (Geographic Information System), automated data gathering systems, and improved meters for commercial / industrial customers. [↑](#footnote-ref-1)
2. Can include conversion of existing vehicles to use compressed NG as fuel. [↑](#footnote-ref-2)
3. Capacity added should be at least 0.3 mmcfpd. [↑](#footnote-ref-3)
4. Indicating RE capacity installed which may include RE sources in NPC-BNOCL facilities: solar photovoltaic or wind turbine. [↑](#footnote-ref-4)
5. Indicating the EE measures implemented in NPC-BNOCL facilities. [↑](#footnote-ref-5)
6. Project management costs include the cost of individual consultants to set up and bolster capacity of the Project Management Unit during project implementation as well as the cost of monitoring and reporting activities including data collection [↑](#footnote-ref-6)
7. IDB report ATN/OC-11473-BA, prepared by Castalia, June 2010. [↑](#footnote-ref-7)
8. Assuming a real discount rate of 12 percent. [↑](#footnote-ref-8)