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**Suriname**

**Support to Improve Sustainability of the Electricity Service**

**Investment Loan**

**(SU-L1009)**

**Monitoring and Evaluation Plan**

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**ABBREVIATIONS**

CBA Cost Benefit Analysis

EA Executing Agency

EBS Energiebedrijven Suriname

EE Energy Efficiency

GoS Government of the Republic of Suriname

IDB Inter-American Development Bank

MF Ministry of Finance

MNH Ministry of Natural Resources

MW MegaWatt

MWh MegaWatt hour

PCR Project Completion Report

PBP Policy-Based Programmatic

PBL Policy-Based Loan

RE Renewable Energy

1. **Introduction**

The objective of the Project is to support the implementation of IT business support tools for EBS, to provide financial support for upgrading critical infrastructure, and to contribute to expand electricity coverage by grid extension and renewable energy systems in the Hinterlands. The main components of this operation are: i) Improvement of EBS’ Operations; ii) Sustainable Rural Electrification; and iii) Critical Infrastructure.

The Project will contribute to the implementation of Sustainable Energy Framework for Suriname[[1]](#footnote-1) (SEFS) by strengthening EBS’ operational procedures and corporate performance, as well as by improving the sustainability of rural electricity supply. The specific objective is: to support the implementation of IT business support tools for EBS, to provide financial support for upgrading critical infrastructure, and to contribute to expand electricity coverage by grid extension and renewable energy systems in the Hinterlands. The main components of this operation are: i) Improvement of EBS’ Operations; ii) Sustainable Rural Electrification; and iii) Critical Infrastructure. Components description as follow:

* **Component I. Improvement of EBS’ Operations.** The specific objective of this component is to contribute to improve EBS’ performance by: (i) integrating Supervisory Control and Data Acquisition (SCADA) platforms for technical supervision and operation of the power system; and (ii) incorporating business information solutions by financing Information Technologies (IT) hardware and software, such as the Enterprise Resources Planning (ERP) and a Geographical Information System (GIS).
* **Component II. Sustainable Rural Electrification and Institutional Strengthening.** The specific objective of this component is: (i) the integration of Powakka village and surrounding communities into the EPAR grid by rehabilitating and upgrading the transmission and distribution system and securing the sustainability of the investment; and (ii) the installation of hybrid RE generation to local distribution systems to improve sustainability of electricity supply in Atjoni and nearby communities.
* **Component III. Critical Infrastructure.** The specific objective of this component is to finance the rehabilitation and upgrade of critical infrastructure of EBS including retrofitting of the two existing 33/12/6-kV substations (S/S C and S/S D) in the EPAR system, supplying energy to the northern load center of the Capital Paramaribo. Both substations were built in 1965.

This monitoring and evaluation (M&E) plan presents: (i) monitoring indicators (ii) main indicators to follow-up on outcome achievements (described in Table 1: Impact and Outcome Indicators), and (iii) the evaluation methodology chosen for assessing medium and long term impacts, an ex-post cost benefit analysis (CBA) for components I and III ? and, and Impact evaluation for Component II ?.

1. **Monitoring**

The purpose of this section is to describe the monitoring process.

## Indicators

Outputs, outcomes and impacts indicators, as well as their sources of verification are detailed in the following table:

**Table 1. Project Output and Outcome Indicators**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Outcomes** | **Indicators** | **Frequency** | **Baseline** | **End of project** | **Means of verification** | **Comments** |
| **Component 1 –**  **Improvement of EBS’ Operations** | | | | | | |
| Strengthening in EBS's operational procedures and corporate performance | Operational GIS and SCADA systems effectively in use by EBS’ business units | Yearly | 0 | 2 | field visits - EBS technical reports |  |
| **Component 2 –**  **Sustainable Rural Electrification** | | | | | | |
| Isolated communities with to secured and sustainable energy supply | Annual electricity sales by EBS in the targeted rural electrification areas (a) Powakka, and (b) Atjoni | Yearly | (a) 521 MWh/yr | (a) 4,852 MWh/yr; | aggregated metering data; project reports; final evaluation | Based on estimates provided by EBS |
| Yearly | (b) 750 MWh/yr | (b) 1,500 MWh/yr |
| **Component 3 –**  **Critical Infrastructure** | | | | | | |
| A more reliable energy supply system | System Average Interruption Frequency Index (SAIFI) | Yearly | 6.8 | 6.8 | EPAR operator (EBS) data and reports | EBS |
| System Average Interruption Duration Index (SAIDI) | Yearly | 17.5 | 16.2 | EPAR operator (EBS) data and reports | EBS |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Output Indicators** | | **Base line** | **Year** | | | | | | | | **End of project** |
| **1** | **2** | **3** | **4** | **5** | **6** | | **4** |
| **Component 1 –**  **Improvement of EBS’ Operations** | | | | | | | | | | | |
| 1.1 | Integrated SCADA system designed | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | | 1 |
| 1.2 | Integrated SCADA system procured and implemented | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | | 1 |
| 1.3 | Enterprise Resource Planning (ERP) system designed and specified | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | | 1 |
| 1.4 | Geographical Information System (GIS) designed | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | | 1 |
| 1.5 | Geographical Information System (GIS) procured and implemented | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | | 1 |
| **Component 2 –**  **Sustainable Rural Electrification** | | | | | | | | | | | |
| 2.1 | Substation Paranam (S/S P) upgraded | 0 | 0 | 0 | 0 | 1 | 0 | 0 | | 0 | 1 |
| 2.2 | Substation Powakka (S/S POW) procured and implemented | 0 | 0 | 0 | 0 | 1 | 0 | 0 | | 0 | 1 |
| 2.3 | Transmission and distribution systems in target area Powakka-Ayo-Redi Doti-Casipoera procured and installed | 0 | 0 | 0 | 0 | 0 | 1 | 0 | | 0 | 1 |
| 2.4 | Households in target area contracting 24/h electricity from EBS using prepaid meters | 0 | 0 | 0 | 0 | 0 | 300 | 1,000 | | 497 | 1,797 |
| 2.5 | Substation Atjoni (S/S Atjoni) habilitated for hybrid power supply by EBS | 0 | 0 | 0 | 0 | 1 | 0 | 0 | | 0 | 1 |
| 2.6 | RET-based generating capacity procured and installed in Atjoni (kW) | 0 | 0 | 0 | 0 | 0 | 0 | 200 | | 0 | 200 |
| 2.7 | Households in target area contracting electricity 24/h from EBS using prepaid meters | 0 | 0 | 0 | 0 | 0 | 0 | 494 | | 0 | 600 |
| **Component 3 –**  **Critical Infrastructure** | | | | | | | | | | | |
| 3.1 | Upgrade EBS Substation S/S C procured and commissioned | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | | 1 |
| 3.2 | Upgrade EBS Substation S/S D procured and commissioned | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | | 1 |

1. Data Collection and Instruments

EBS will be the Executing Agency (EA). EBS is the sole concessionary responsible for transmission and distribution of electric energy in Suriname under the supervision of MNH. The EA will be responsible of reporting the results of the Project, using information collected with the support of an external consultant. The sources of information will be mainly the MNH’s administrative records of the Project, EBS reports and field inspections.

The EA shall collect through the supervision consulting firm or an individual consultants, store and retain all necessary information, technical and social performance reviews, indicators and parameters, including the technical reports, the mid-term review, and final evaluation, in order to assist: i) the Bank in the monitoring of the Project performance; and ii) the Bank’s Oversight Evaluation Office (OVE), if it so wishes, to evaluate the impact of this operation.

1. Reporting Monitoring Results

The result matrix will be the basic instrument for monitoring the Program’s outputs and outcomes according to the established indicators. The Executing Agency will submit semi-annual reports following the requirements established in the Bank’s Progress Monitoring Report system (PMR)[[2]](#footnote-2). The semi-annual report will include (i) physical and financial progress of the Program; (ii) updated procurement; (iii) monitoring of Program indicators; (iv) disbursements progress and projections; and (v) lessons learned, and any other information required to ensure the successful implementation of the Program. The semi-annual reports will monitor risks identified, as well as proposed actions of mitigation measures (see Risk Matrix of the Program).

1. Monitoring Coordination Work Plan and Budget

EBS will be responsible for the fulfillment of technical, administrative and financial procedures related to the execution of the Program, as well as the planning, monitoring, supervision and evaluation. The EA will be responsible for, inter alia: (i) the technical execution of Program activities; (ii) selecting and contracting of consultancies, procurements, and services; (iii) reviewing and approving consulting products; (iv) registering accounting information of Program funds; (v) managing consulting contracts and processing payments for consulting services and procurement of goods; (vi) reporting periodically to the Bank on the technical and administrative activities of the Program; (vii) monitoring of Program progress towards the achievement of outcomes and goals, and the identification of needs for adaptive management; and (viii) the preparation of progress reports.

EBS will be responsible for implementing the Program Execution Unit (PEU), composed of specialists to execute the Program: (i) Project Manager (PM); (ii) Procurement specialist; (iii) Financial Specialist; (iv) Electrical engineer; and a (v) Social-environmental specialist. Having this team in place will be a condition prior to the first disbursement of the financing.

The Project Manager will be responsible, among others, for the preparation of the Terms of Reference (ToR) and support for the selection process of contracted consultancies, services and procured goods; review of products delivered by consultancy firms, budget administration, logistics, local support and coordination among the stakeholders. The PM will also prepare the Annual Operation Plans (AOP) to assist the EA in the execution and supervision of the Program. The PM will have responsibility for the delivery of the anticipated results outlined in the AOP. The PM will coordinate with the Steering Committee (SC) for the execution of Component II, and will report to the EA and the Bank for the entire Program. IDB will provide technical and fiduciary support through INE/ENE and the IDB Country Office in Suriname.

The IDB will be monitoring the Program both from INE/ENE and the IDB Country Office in Suriname, with ad-hoc visits to the EA and the Project sites. The EA will also be responsible for the preparation of financial documentation needed for the annual financial audits of Project statements.

The monitoring work plan and budget are described in Table 2.

**Table 2. Monitoring work plan and budget**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Key Monitoring Activities by outputs and outcomes** | **Year 1** | | | | **Year 2** | | | | **Year 3** | | | | **Year 4** | | | | **Year 5** | | | | **Year 6** | | | | **Responsible** | | **Costs** | | **Source** | |
| **Component 1 –**  **Improvement of EBS’ Operations** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | |  | |  | |
| *Data collecting and reporting (semiannual monitoring reports)* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | |  | |  | |
| Design of the Integrated SCADA system |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | EBS | | $20,000 | | Project | |
| Implementation of the Integrated SCADA system |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| Design Geographical Information System (GIS) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| Implementation of the Geographical Information System (GIS) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| **Component 2 – Sustainable Rural Electrification** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | |  | |  | |
| *Data collecting and reporting (semiannual monitoring reports)* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | |  | |  | |
| Upgrade of Substation Paranam (S/S P) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | EBS | | $20,000 | | Project | |
| Implementation of Powakka Substation (S/S POW) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| Installation of the Transmission and distribution systems in target area Powakka-Ayo-Redi Doti-Casipoera |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| Contracting 24/h electricity from EBS using prepaid meters by households in target area |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| Habilitation for hybrid power supply by EBS of the Atjoni Substation Atjoni (S/S Atjoni) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| Installation of RET-based generating capacity in Atjoni (kW) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| Contracting 24/h electricity from EBS using prepaid meters by households in target area |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| **Component 3 – Critical Infrastructure** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | |  | |  | |
| *Data collecting and reporting (semiannual monitoring reports)* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | |  | |  | |
| Upgrade EBS Substation S/S C procured and commissioned |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | EBS | | $20,000 | | Project | |
| Upgrade EBS Substation S/S D procured and commissioned |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| **Outcomes** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | |  | |  | |
| *Data collecting and reporting* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | |  | |  | |
| Upgrade EBS Substation S/S C procured and commissioned |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | EBS | | $20,000 | | Project | |
| Upgrade EBS Substation S/S D procured and commissioned |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| **Supervision visits** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | IDB | | $100,000 | | IDB | |
| Total | **$180,000** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

1. **Evaluation**

The purpose of this section is to detail the evaluation methodology, the result and impact indicators, the data collection process, the work plan and the budget and the implementation of the evaluation.

## Main Evaluation Questions

The evaluation purpose is to assess the outcomes of the Program. The main evaluation questions are as follows:

1. Has EBS strengthened its operational capacity procedures and corporate performance?
2. Is secured and sustainable energy been supplied to the targeted isolated communities?
3. Have electricity supply disruption from transmission system failures been maintained or reduced?

## Existing Knowledge (previous evaluations, ex ante economic analysis)

An ex ante Cost Benefit Analysis (CBA) was prepared for Components I and III and an ex ante Cost Effectiveness Analysis was carried out for Component II. The main conclusions of the economic analyses are described below:

**Ex ante Cost Benefit Analysis (CBA) - Components I Improvement of EBS’ Operations and Component III - Improvement of EBS’ Operations and Critical Infrastructure**

1. System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) historical indexes in EPAR[[3]](#footnote-3) system show the occurrence of significant service interruptions implying economic costs for the Surinamese economy. Total average annual interruptions per costumer were 81.4/year and 2.6 Hours/interruption during last three years and it is expected that with the new investments in a SCADA system total duration of the interruptions will be reduced in around 8%.
2. The SCADA extension project represent USD 6 million of investment costs, its expected economic rate of return is 15.8% and its net present value is USD 1.5 million of benefits related to reduction of energy shortages in Paramaribo. Other project benefits were not quantified, as increases in customer satisfaction by meeting the mandated power quality and cost reductions due to improvements in real time strategic decision making.
3. Several components of the EPAR power system are today insufficient to support a reliable power supply and it has been identified load increases in the Northern and Southern sectors of Paramaribo were current transmission and distribution capacities of Substations C and D are imposing limitations to the operations of the power grid. The upgrade of such substations will imply investments costs of USD 4.63 million and USD 2.26 million, respectively. The economic rate of returns estimated for the upgrade of substations C and D are 21.6% and 20.8%, respectively, and their net present values are USD 3.58 million and USD 3.03 million, respectively. Net benefits estimated for these projects were the consumers’ surplus associated to the additional electricity supplied and the reduction in O&M costs in those substations.
4. Total investment cost of the entire program is USD 12.89 million, its economic rate of return is 19.2% and the present value of its net benefits (at 12% discount rate) is USD 8.12 million. Results obtained indicates that + 15% and -15% variations in main parameters intervening in the economic evaluation imply always results higher than 12% for the economic rate of return for the entire program and for each project.

Next table summarizes annual benefits estimated for each project and for the Strategic Short Term Investment Program in EPAR Electricity System:

PROGRAM BENEFITS (US$ K)



**Ex-ante Cost-** Effectiveness **Analysis - Component II**.

1. It is estimated that the main benefits of the Program are derived from the substitution of the business-as-usual technology (stand-alone diesel) by more cost-effective alternatives: (i) integration of the Powakka area into the main EPAR grid; (ii) renewable energy-based electricity generation (PV panels with battery backup) in combination with diesel.
2. Powakka project. Quantified in the ERR for the Powakka project are the monetary savings resulting from the difference between the costs of electricity generation under the business-as-usual scenario (stand-alone diesel @ USD 0.50 /kWh) and the marginal cost level of energy generation-transmission in the EPAR grid (@ USD 0.156/kWh). The resulting revenues are USD 0.344 per kWh.
3. The ERR of the Powakka project is 35.7% (NPV@12% of USD 16,140,079); for the Atjoni project, the ERR is 15.3% (NPV@12% of USD 438,827). The ERR of the combined projects is 31.7% for a scope of 20 years with a NPV (@12%) of USD 16,578,906. Several sensitivity analyses were carried out all of them yielding a positive ERR.
4. Atjoni project. The evaluation of the hybrid (diesel-PV) electricity generation project in Atjoni is based on a comparison of the levelized electricity costs (LCE) of the business-as-usual option (full diesel) and the PV system. Based on this evaluation, the ERR for the investment in the PV system is calculated by considering the annual revenues obtained from: (a) the diesel fuel replaced by PV-based generation (@ USD 0.47/kWh of electricity); and (b) the economic value of the electricity generated by the PV-system (@ USD 0.56/kWh ).
5. Non-quantified benefits. The benefits from the investments go beyond the direct financial and economic benefits for the State of Suriname and EBS. A more reliable and sufficient supply in the Hinterlands will have substantial impact in terms of quality of life, economic development and quality of basic services (clean water, health, education). These benefits are expected to be equal or greater than the cost for unserved energy. Environmental benefits arise from the avoidance of CO2 emissions by thermal generators (diesel and heavy fuel oil). The value of carbon emission credits (VERs or CERs) may be used for rating these benefits. Indirect economic benefits occur by improving the financial position of EBS and the State, by reducing their costs of capital.

## Key Outcome Indicators

The key outcome indicators as well as their frequency of measurement and source are described in the table below. These key indicators will be assessed and presented to the IDB through annual monitoring reports.

Table 2: Impact and Outcome Indicators

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Impacts** | **Impact Indicators** | **Frequency** | **Baseline** | **End of project** | **Means of verification** | **Comments** |
| Increased in Electrification Coverage | Percentage of the population with access to electricity. | Yearly | 85% | 90% | Sector statistics | Based on Country Strategy 2011-2015 |
| Improvements in the sustainability of rural electrification supply | Percentage of cost recovery for electricity supply in interior locations | Yearly | 0% | 30% | Sector statistics | Based on Country Strategy 2011-2015 |
| Decrease in EBS Operational costs (US$/kWh). | Yearly | 0.2 | 0.11 | Sector statistics | Based on Country Strategy 2011-2015 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Outcomes** | **Indicators** | **Frequency** | **Baseline** | **End of project** | **Means of verification** | **Comments** |
| **Component 1 –**  **Improvement of EBS’ Operations** | | | | | | |
| Strengthening in EBS's operational procedures and corporate performance | Operational GIS and SCADA systems effectively in use by EBS’ business units | Yearly | 0 | 2 | field visits EBS technical reports |  |
| **Component 2 –**  **Sustainable Rural Electrification** | | | | | | |
| Isolated communities with to secured and sustainable energy supply | Annual electricity sales by EBS in the targeted rural electrification areas (a) Powakka, and (b) Atjoni | Yearly | (a) 521 MWh/yr | (a) 4,852 MWh/yr; | aggregated metering data; project reports; final evaluation | Based on estimates provided by EBS |
| Yearly | (b) 750 MWh/yr | (b) 1,500 MWh/yr |
| **Component 3 –**  **Critical Infrastructure** | | | | | | |
| A more reliable energy supply system | System Average Interruption Frequency Index (SAIFI) | Yearly | 6.8 | 6.8 | EPAR operator (EBS) data and reports | EBS |
| System Average Interruption Duration Index (SAIDI) | Yearly | 17.5 | 16.2 | EPAR operator (EBS) data and reports | EBS |

## Evaluation Methodology

A Project Completion Report (PCR) funded by the IDB, will be prepared six months after the last phase of the Program has been fully disbursed and will be done through a before and after methodology. The PCR will evaluate results obtained by the Program and will include the results from an ex-post cost benefit analysis (CBA) for components I and III, as well as impact evaluation for Component II. This last one financed by the Program.

The PCR shall further assess the “likelihood of sustainability of outcomes at project termination”. The assessment will give special attention to the analysis of risks that are likely to affect the persistence of project outcomes. It will include both exogenous and endogenous risks. The following four dimensions or aspects of risks to sustainability will be addressed: (a) financial risks; (b) sociopolitical risks; (c) institutional framework and governance risks; and (d) environmental risks. The PCR shall further consider the following issues affecting program implementation and the attainment of program results: (a) program preparation, country readiness, local implementation capacities; (ii) country ownership and drivenness; (c) stakeholder involvement; (d) financial planning, including parallel financing commitments, due diligence and audits; (e) IDB supervision and backstopping; (f) program outcomes and sustainability; and (g) delays and effects thereof on project outcomes.

The results and reports form the Project Completion Report (PCR), CBA Impact Evaluation will be post on the IDB website, while progress reports will be post confidentially in IDBDOCSs.

1. Component I and II ex post Cost Benefit Analysis description.

The ex post cost benefit analysis for component I and II will be prepared considering the following benefits:

1. *Economic benefits associated to reduction of power service interruptions:*

A quality SCADA solution is central to effective operation of a utility's most critical and costly distribution, transmission, and generation assets. Modern SCADA systems are already contributing and playing a key role at many utilities towards achieving: i) New levels in electric grid reliability – increased revenue, ii) Proactive problem detection and resolution – higher reliability, iii) Meeting the mandated power quality requirements – increased customer satisfaction, iv) Real time strategic decision making – cost reductions and increased revenue. EBS already has part of the EPAR transmission grid connected to a SCADA system and with the SCADA extension project it is planning is to connect the entire EPAR grid to this system.

Economic benefits of this project will be estimated with the expected reduction of interrupted energy associated to this project. This will be estimated through an analysis of the System Average Interruption Frequency Index (SAIFI) and the System Average Interruption Duration Index (SAIDI), which are commonly used as reliability indicators by electric power utilities. SAIFI is measured in units of interruptions per customer and SAIDI is the average outage duration for each customer served, and is usually measured in hours. Both are measured over the course of a year. SAIDI and SAIFI indexes in EPAR system during 2010, 2011 and 2012 indicate that had occurred significant service interruptions of around 30-50 hours/month during three months of the year, implying economic costs for the Surinamese economy. Total average annual interruptions per costumer were 81.4/year and 2.57 Hours/interruption during last three years.

1. *Increases in transmission and distribution capacities*

Upgrade of substation C. Substation C receives power from substations T and A2 (which in turn are connected to the power plants). Basically it play a role of transmission and distribution of power to final users supplied from substations Q and C, through existing distribution transformers totaling an existing capacity of 28 MVA in such substations that will be expanded to 50 MVA with the project.

Currently, a fault in the 33 kV switchgear of substation C will imply a short circuit current of 14 kA, higher than its Short Circuit Rating (SRC) of 8.7 kA, implying out of regulations and non safe operations. To evaluate the upgrade of substation C it will be estimated, through short circuit analysis, the transmission and distribution capacity in substations C and Q that will not violate the SCR of substation C.

To evaluate this Project it will be estimated that its operative capacity under the situation “without” its upgrade is 28 MW and "with" its upgrade 50 MW. This analysis will consider the additional 33/12.6 kV distribution capacity to be installed in this substation. The basic information for the evaluation of this project will be: i) Maximum transfer and distribution of power in substations C (and Q) “with” and “without” the upgrade project (related to permitted SCR under these two situations), ii) Peak demand statistics in substations Q and C, iii) Characterization of the electricity demand supplied from substations Q and C (% residential, % industrial, % commercial and % others and average tariffs for each sector), iv) Characterization of electricity distribution losses in substations C and Q (% of technical losses and % of non technical losses), v) Investment costs related to the upgrade of substation C, and vi) Annual Operation and Maintenance costs (men-hours per year) of substation C “with” and “without” the upgrade

Upgrade of substation D. Substation D receives power from substations R and J (which in turn are connected to the power plants). Basically it plays a role of transmission and distribution of power to final users supplied from substations O, N, E and D through distribution transformers totaling an existing capacity of 74 MVA in such substations. Operating those substations at that capacity, a fault in the 33 kV switchgear of substation D will imply a short circuit current of 14 kV, higher than its SRC of 8.7 kV, implying out of regulations and non safe operations. According EBS analysis, to maintain safe operations power distributed in those substations should be limited to 40 MVA.

To evaluate this Project it will be estimated that its operative capacity under the situation “without” its upgrade is 40 MW and "with" its upgrade 75 MW. The basic information to be used for the evaluation of this project is: i) maximum transfer and distribution of power in substations D, O, N and E “with” and “without” the upgrade project (related to permitted SCR under these two situations), ii) peak demand statistics in substations D, O, N and E, iii) characterization of the electricity demand supplied from substations D, O, N and E (% residential, % industrial, % commercial and % others and average tariffs for each sector), iv) characterization of electricity distribution losses in substations D, O, N, E and D (% of technical losses and % of non technical losses), v) investment costs related to the upgrade of substation D, and vi) Annual Operation and Maintenance costs (men-hours per year) of substations D “with” and “without” the upgrade.

1. *Economic benefits associated to electricity additional consumption*

The upgrade of substations C and D will permit an increment of electricity consumption in the Northern and Southern sectors of Paramaribo, given that without these projects EBS would have to restrict power supply up to the current transmission and distribution capacities determined for these two substations (to 28 MVA and 40 MVA, respectively). From the view point of the country, one of the economic benefits associated to these projects will consist in the increase of EBS power sales plus its associated consumer's surplus in the residential sector as permitted by the higher capacity of the upgraded substations (50 MVA and 75 MVA, respectively). Main assumption of the evaluation will be consideration of a referential "cost effective average tariff" of US$ 162/MWh to final consumers in its area of influence.

Next figure illustrates the demand curve in a future time (t=i). From a user´s perspective, benefits associated to the increase of electricity consumption are estimated as its value according to the willingness to pay by the consumers (area FACG which includes consumer´s surplus given by area BAC), plus the subsidy received by the users (area BDEC).

BENEFIT ESTIMATION OF ADDITIONAL RESIDENTIAL CONSUMPTION





Consumer's surplus will be estimated from the definition of Price – Elasticity ( ): it follows that the derivative of Price p with respect to the quantity q at the point Pi and quantity Qi is given by:

*dp/dq = Pi/Qi x 1/Ε*

The price that a consumer is willing to pay for a quantity *Qi - Δq* is given by:

*Pmi = P0 – dp/dq x Δqi*

And the consumer’s surplus is calculated as:

Consumer’s surplus = (*Pmi* – *P0*) x *Δqi / 2*

In the equation Δqi is the increase of electricity consumption in year i associated to the projects (Δqi = Qmi - Qi), Pmi is calculated with P0, E and the percentage Ri of additional electricity consumed attributable to the substations upgrade as Pmi = P0 x (1 - Ri/E). Pi corresponds to the “cost effective tariff” (US$ 162/MWh). It will ve applied a Price-Elasticity according typical estimations of similar electricity markets in Latin America, and Ri (Ri = Δqi/Qi) will be estimated from demand forecasts and distribution & transmission capacities.

Demand forecasts of power distributed in each substation will be from historical peak demand in 2012 (in MVA) and applying future demand increase estimated by EBS for each substation. Energy demand forecasts in MWh/year in each substation will be obtained from peak MVA forecasts by applying 0.9 as Power Factor, 0.71 as EPAR annual average Load Factor and 0.9 as Peak Load Diversity Factor. Electricity consumption of final users in MWh/per year will be obtained considering 8.2% as Loss Factor, as informed by EBS.

## Data Collection and Instruments

The analysis proposed in this section will replicate the ex-ante cost benefit analysis presented in Economic Analysis prepared for the Program. The information to be used for the CBA will be updated from the semiannual reports prepared by the prepared by EBS MF and the midterm evaluation. The IDB will prepare Terms of Reference (ToRS) for the development of the ex-post CBA and a check list with the basic information needed for the ex-post CBA to be included in the EBS and MNH reports.

And independent consultant will be hired by the IDB for the period from January 2019 to March 2019, who will prepare the ex-post CBA. ToRs for the ex-post CBA will be prepared at the end of the last year of the project. ToR reference for the ex post CBA will follow the requirements established for the ex ante CBA (see Annex I).

## Evaluation Coordination, Work Plan and Budget

The total cost of the evaluation plan is US$140.000. The IDB will hire an independent and experienced consultant or firm for preparing the Project Completion Report (PCR) (ex-post cost benefit analysis), which will be validated by the Executing Agency (EA).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Activity** | **2012** | | **2013** | | **2014** | | **2015** | | **2016** | | **Responsable** | **Costs** | **Funding** |
| **Jun** | **Dec** | **Jun** | **Dec** | **Jun** | **Dec** | **Jun** | **Dec** | **Jun** | **Dec** |
| Progress Reports |  |  |  |  |  |  |  |  |  |  | BID/EBS | $100,000.00 | EBS |
| Ex-post CBA |  |  |  |  |  |  |  |  |  |  | BID | $20,000.00 | BID |
| Project Completion Report (PCR) |  |  |  |  |  |  |  |  |  |  | BID | $20,000.00 | BID |
| **Total** |  | | | | | | | | | | | **$140,000.00** |  |

The borrower is responsible for supporting IDB team and consultant(s) in all the matters related with the Monitoring and Evaluation of this program.

The IDB Project Team will be based in IDB office located in Washington, DC (INE/ENE), Country Office Surianme (CCB/CSU), and the Country Office in Suriname (CCB/CSU), which will be responsible for the follow-up of the Program.

1. Component II Impact Evaluation description.

This section presents the basic aspects related to the methodology and implementation of the impact evaluation of the Component II – SU-L1009 (Program Support to Improve Sustainability of the Electricity Services). We present the main hypotheses to be tested through the impact evaluation, a brief review of relevant exiting knowledge, the evaluation design (a combination of experimental methods and quasi-experimental), the sample design, and a schedule evaluation[[4]](#footnote-4).

1. Evaluation Questions

Component II will improve the quality of access to electricity supply in rural areas of the districts of Para and Sipaliwini, Suriname. Specifically, Component II will rehabilitate and upgrade the transmission and distribution system, as well as provide new infrastructure for hybrid Renewable Energy (RE) generation. Component II will also connect two villages, Atjoni to a local grid and Powakka to the National System, providing 24hr electricity service. Around other 130 villages will benefit from the outputs of Component II.

Presently targeted villages in the Hinterland (rural areas) receive energy through subsidized and costly thermal power, during 5-6 hours a day through off-grid diesel generator. The intervention is expected to provide better quality access to about 30 thousand people during 24 hours per day. In some cases the improvement will come from connecting the village to the national grid. In other cases, it will come from infrastructure improvements in the isolate electricity systems. All the households have already connection of an internal grid (within each village). The intervention will provide a better quality electricity 24/7 supply to each village. The evaluation will measure the impacts of having improved access to modern sources of electricity.

The causal chain of the intervention is the following. Having access to better quality of electricity services may induce change in the behaviour within the household and at the village level. As an input for economic activities and as infrastructure for leisure and better quality of life, access to electricity could increasing income, contribute to better health, support education, improve women’s quality of life and reduce environmental harm. Besides, as part of the program the beneficiary communities will be invited to implement a Business Model (BM) for the sustainability of the service. Based on the current cost of the energy and the economic capacity of the population, the BM will propose a tariff structure previously approved by Hinterland and sector authorities. Then, beneficiaries will face a new tariff structure that could change the pattern of energy consumption and expenditure in the household, which is an issue of greater interest in the literature for their public policy implications.

In the next paragraphs we explore some channels.

The access to better-quality electricity could trigger new economic activities or increase the potential of existing firms. Electricity also induces changes in labour market supply by increasing labour market participation of women via the development of small home businesses or more time devoted to income generating activities due to the increase in work hours (Dinkelman, 2011). Access to electricity allows female household members to allocate less time to cooking and other time-consuming activities such as laundry and cleaning, which in turn can be re-assigned to more productive uses.

The benefits of access to modern source of energy on health derive from the fact that it directly contributes to a reduction of respiratory illness among the rural population, reducing both public and private healthcare costs. The avoidance of children’s burn injuries from kerosene lamps is an additional benefit of rural electrification (ADB, 2010). Presumably, better health practices are also fostered via access to television and children’s nutritional outcomes can be improved through improved knowledge and access to refrigeration. Also, a reduction in fertility is expected due to the access to better knowledge and changes in customs and practices regarding sexual behaviour (La Ferrara, Chong and Duryea, 2012).[[5]](#footnote-5)

Electricity extends evening lighting hours, making it easier for children to study, do homework, or read. It is reasonable to assume that electrification gives children more flexibility in choosing when to do schoolwork. Similarly, it enables schools to be equipped with modern teaching equipment and information and communication technologies, especially access to the internet (Meier et al. 2010; ADB, 2010), which in turn may improve education.

It is important to note that all the impacts are not necessarily positive. Access to electricity may also have some harmful effects. For instance, in the case of education, it is possible that access to electricity may induce a time allocation that favours substitution towards leisure. New access to household electrification may change the nature of work in the home as well as the amount and type of work that can be done in the market. Providing new public infrastructure to a location may a enact migration of employed and unemployed individuals. Outlining the form each of these changes may take is important for interpreting the empirical results in the paper. In many cases, the net effect of rural electrification is an empirical issue.

As it is designed, the program leaves the household with the decision of connecting themselves to the grid. Besides, the program also implies that the households actually connected will be subject to a new tariff scheme for the electricity they consume. In this context, it will be interesting to look at how the households respond in terms of connections (non-connection, illegal connection or formal connection), consumption and expenditure in electricity.

Therefore, the two main general hypotheses to be tested through the impact evaluation are:

1. What are the social benefits of having access to reliable modern energy?
2. How does the program affect energy consumption and expenditure?

In particular, the evaluation will address:

* Improvements in health indicators related to electricity access, for example: diarrheal and respiratory illnesses
* Changes in household incomes that could be attributed to the program. For example, when it is related to self-employment, crime reduction or better time allocation.
* Changes in schooling rates and increase in hours dedicated to studying among children bellow 16 years old.
* Changes in self-reported life satisfaction indicators
* Changes in self-reported crime rates.
* Changes in energy consumption (MW) and expenditure (US$ and percentage of total income) over time.

Since it is expected that the impact of the program could be different by gender, we will evaluate these questions differentiating by the gender of the household’s head.

Another relevant aspect in the energy field is related to the behaviour of the household in presence of the new infrastructure (transmission and distribution lines). To date, the government does not have plans to connect around 130 villages surrounding the new infrastructure. This context could be used to observe the response of these villages. A priori, each village could take three decisions: (a) not connect to the grid; (b) connect illegally to the grid; or (c) connect formally to the grid. The baseline and follow-ups will provide a characterization of the households by type of decision. This information could be used to design the program, encouraging formal connections.

It is important to emphasize that the setting of the program presents a valuable opportunity to analyse the dynamic of expenditure and consumption of energy in poor rural villages. Empirical evidence on this regard will inform public policy, for example, in the following areas: (i) policies related to the pricing of electricity;(ii) willingness of the household living in highly subsidized areas to pay; (iii) direct economic benefits obtained by the reduction or phase-out of fossil fuel in electricity supply. For these reasons, it is important to design a survey that captures energy consumption patterns of the 130 villages.

1. Literature Review

The empirical literature on impact evaluation of electrification programs is relatively recent. Some relevant papers include Lipscomb et al. (2011), Dinkelman (2011), Barnes and Sen (2004), Gonzalez‐Eiras and Rossi (2007), Torero (2009), Khandker et al. (2009), Khandker et al. (2012) and Rud (2010). They perform quasi-experimental evaluations at the household level in order to analyse the benefits of access to modern energy sources on the variables such as income, employment rates, better savings, participation of women in labour markets, education, health, and time used, among others[[6]](#footnote-6). The last four are considered more indirect impacts of access to electricity and it is increasingly recognized that these direct and indirect benefits produce synergy in economic growth, poverty reduction, and human development (Barkat et al. 2002; Shamannay, 1996; Barnes, 2005).

More recently, on-going evaluations incorporate randomized designs in order to avoid the potential of a selection problem. These efforts include those of Torero (2009) in Ethiopia, and Barron & Torero (2012) in El Salvador. To figure out the best policy instrument, the authors are assessing what drives the incentive to connect from the mainline of the town of each of the households and business. Their randomization instrument is a discount voucher to pay the last mile connection. This could be a useful proxy to get a sense of how much prices influence the decision to connect.

In this context, the empirical evidence in Latin American and Caribbean Region is limited to few countries and it is mainly oriented to the case of new connections. To the best of our knowledge, there is no evidence on the impacts of an improvement in the quality of electricity service. This represents a contribution of the present evaluation, as it aims to evaluate the effect on the subject of reciving improved quality of the electricity service. That is passing from having 6 hour per day to have 24 hour of electricity services.[[7]](#footnote-7)

1. Main indicators

The main indicator will be constructed on the basis of the double-differences approach, as follows:

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Where Y represents the average indicator of interest (income, schooling, etc.) and the sub-indices t: treatment, c: control, A: after, B: before, *fl*: follow-up, and *bl*: baseline. The source of the information will be the database constructed by the Monitoring and Evaluation (M&E) component that includes a baseline and follow-ups over the periods 2015 through 2020. The follow-up will be measured assuring that the treated villages will be exposed to the improvement in the electricity service at least for one year. The construction of the control group will be explained below.

1. Methodology

The nature and context of the program and its execution limit the intervention to two villages out of around 130 potential villages’ beneficiaries. However, in the medium to long term, it is probable that those 130[[8]](#footnote-8) villages will receive similar treatments[[9]](#footnote-9). Suriname has no statistical information that would help improve public policy in infrastructure, particularly in energy. This set-up represents an opportunity to generate a baseline that allows not only to evaluate the present intervention but also to inform public policy makers (infrastructure) in the future.

In general, the following methodologies rely on the analysis of a panel data at the household level over six years.

* Double Differences + Two Stage Matching (Powakka & Atjoni)

This strategy faces the limitation that the two villages were already selected by the Government of Suriname (GOS) in order to be connected to the grid. Besides observable characteristics for which we can control, there are probably potential non-observable factors that should be addressed in a qualitative analysis. This qualitative analysis would help to understand the direction of the bias, if any. Another limitation of the evaluation is that we only have two villages in a cluster-treatment.[[10]](#footnote-10)

In this context, the identification strategy relies on constructing a control group in two stages. First, based on information from the Census 2012, we match villages for Powakka and for Atjoni. It is expected that this stage helps to clean the selection bias of the two villages (based on observables). Second, in each matched village, we find match households for Powakka and for Atjoni. The peer villages come from the 130 remaining, non-treated, villages. The second stage will be performed based on information from the baseline. The control group will be constructed based on a matching that will take into account variables such as education, income, type of electricity connection, age and gender of the household head, ethnicity, and number of people in each household, among others.

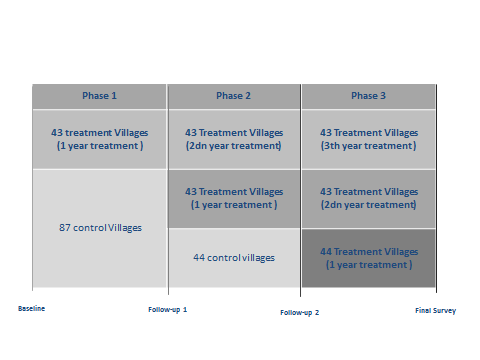
As a robustness check, complementary exercises to be performed are:

1. Before and after:The estimation of this exercise could be compared with those of the double difference, taking into account the potential bias of confounding trends. However, this exercise will be informative about the methodological limitations of the different techniques without representing additional costs.
2. Synthetic control:Given that the proposed evaluation aims to raise a baseline over the 130 villages in the same geographic area, it is possible to construct both; a synthetic Powakka and a synthetic Atjoni with the non-treated villages. Under this methodology, it is not necessary to perform matching at household level. It is enough to obtain data representative at the village level. The villages to construct the synthetics will be those without connection to the grid after at least three years. This is in order to have enough elapse time to evaluate the impacts of access to electricity services.

* Randomizing Phase-in order (130 villages)

The second component of the evaluation consists of randomizing the order of connection of the villages. Given financial restrictions, the GOS will not be able to connect the remaining 130 villages at once. In this context, the phase-in takes advantage of this limitation and is often perceived as the fairest way of determining the order of receiving the program. One drawback of this design is the difficulty to estimate long run effects. This limitation could be sorted out by identifying well balance village-cohorts along the evaluation period. That is, identity groups of similar villages to receive the treatment in each phase.

The design will take advantage of the baseline in order to select well-balanced cohorts of villages for each phase of the program. We expect to measure effects after at least 3 years of access to electricity services. In the phase 3, this design will allow us to perform an intensity analysis, comparing those villages exposed to 3 years of treatment with those exposed for 2 (phase 2) and 1 year (phase 3).



Given that the implementation of Plan for rural electrification using Bank’s policies is a new experience in the GOS, a slow implementation of the program is expected. This represents an advantage for the design, since it could take some time for the effect of the program to materialize. For example, if having access to modern sources of reliable electricity services allows a household to start a micro-enterprise, the expected impact on income could take at least a year to materialize.

A risk for the impact evaluation in the present design is the potential contamination of the cohorts. The program could be implemented in different villages from the randomly selected or the electricity utility could find it profitable to connect some villages (unbalancing the cohorts). We expect that the dialogue with the GOS reduces this risk. Note that it has been assumed that it is not possible for the villages to connect with their resources to the grid.

1. Sample Size & Power Calculation

In the present case, the sample size estimation is restricted for the following reasons: (i) Two villages have already been selected for treatment. In order to evaluate the impacts on these villages, we should extract a representative sample of each village; (ii) there is a maximum of 130 villages that can be potential beneficiaries of the grid infrastructure.

Other general considerations to take into account for the sample size estimation are: (a) it is an ex-ante quasi-experimental study with repeat measures (baseline and follow-ups); (b) The surveys intent to capture control variables; (c) there exists potential imperfect compliance; and (d) It is a two-level design, with treatment applied to villages (clusters) and outcomes measured at the household level (primary unit of observation/sample). Besides, the sample size estimation should be useful to perform the evaluation of the impacts on the two villages attended for the component II of the Program.

In order to estimate the sample size required to detect a minimum effect (in our response variables) we will perform a statistical power exercise. The Minimum Detectable Effect (MDE) refers to the smallest effect that can be detected when testing the statistical significance of our indicators. In terms of standard deviation (SD), the MDE standard in the literature goes from 20% SD to 40% SD[[11]](#footnote-11). However the risk is that if the true effect would be 15%; then the analysis will not find any statistically significant effects, even when such effect exist.

It is also relevant to mention that the variables of interest (such as income, frequency of respiratory illnesses, employment/self-employment rate, among others) were not available for the country. For this reason, we proceeded to estimate the sample size based on the assumed minimum effects measured as standard deviations. For the case of income, Dinkelman (2010) found an effect of 20% for men and 16% for women. We will use this as reference when choosing the more appropriate sample size[[12]](#footnote-12).

Another relevant input is the intra-cluster correlation (ICC). Without available information for the country, we must rely on parameters from other studies. For example, Duflo et al (2006) has shown that the ICC could be high (around 0.4) for test performance in primary schools. Other variables, such as income, are also expected to be highly correlated between households within a village (around 0.2). The ICC tends to be lower (between 0.037-0.08) for the case of health variables, as reported by Torero (2009). Taking this into account, we set the ICC in the range between [0.037-0.2]

Given these restrictions, characteristics and parameters we proceeded to estimate the sample size, following Bloom et al. 2011, under the expression:

Note that the power () is now a function of the number of clusters (J), the cluster size (n), the standardized effect size (), the intra-class correlation (), the reliability ()[[13]](#footnote-13). The presence of covariates to increase power is entered as a factor, with representing the estimated percent of variance explained by the covariates at the cluster-level.

In order to correct for imperfect compliance we adjusted our estimated by the factor (Duflo et al, 2006). Where c represents the percentage of households assigned to a treatment who actually receive the treatment and s represent the share of households assigned to control group who receive the treatment. We assume the imperfect compliance could occur only at cluster level; however it could also be the case that control villages receive the treatment, or treatment villages did not receive the treatment. It is expected that these issues could be controlled at implementation level.

The next table and figure present the main results. The range in the MDE states different levels of ICC (0.037 and 0.2, respectively). The number of households per cluster is already adjusted to imperfect compliance. As the figure shows, around 28 households per village return the required MDE (13%-20%). Accounting for a total of 130 villages the total number of household to survey will be around 3600.

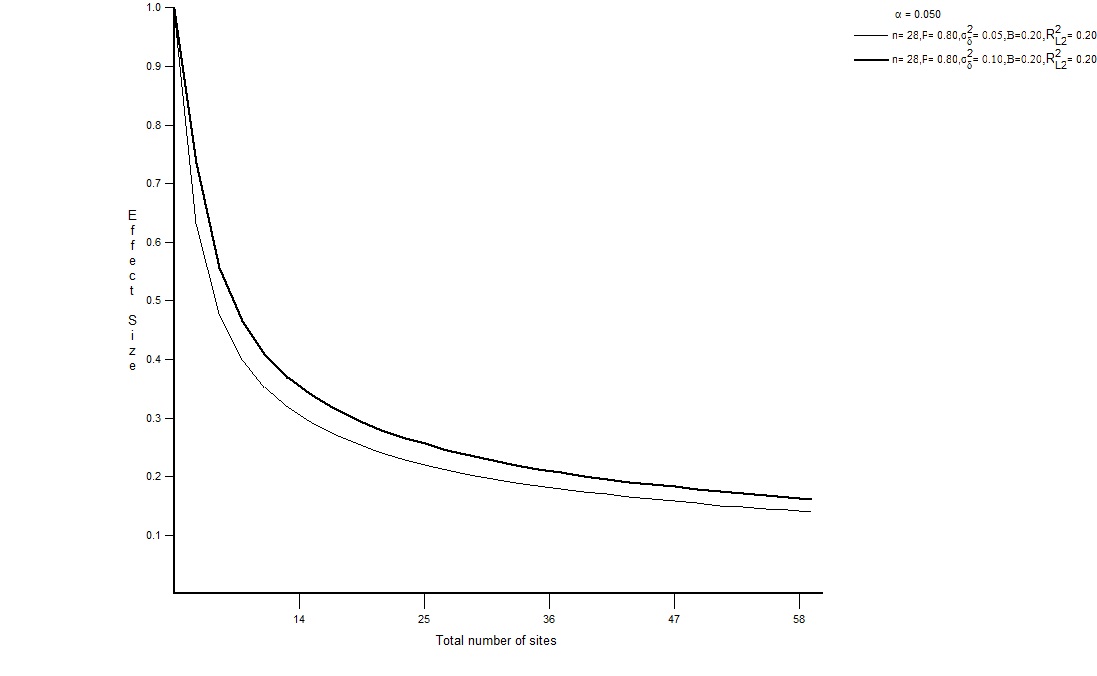
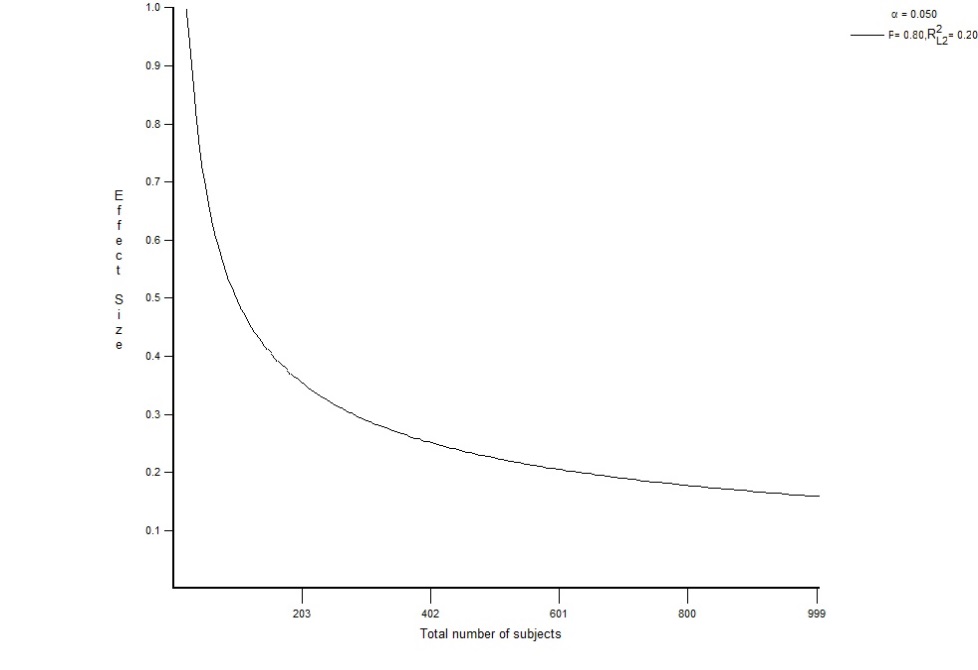
|  |  |  |  |
| --- | --- | --- | --- |
| **Minimum Detectable Effect (MDE) vs Households**  **per Cluster** | | | |
| MDE (SD) | n adj. by imperfect compliance | | Total Households |
| 15-21 | 20 | | 2600 |
| ***13-20*** | ***28*** | | ***3611*** |
| 12-19.7 | 33 | | 4333 |
| 12-19.3 | 39 | | 5056 |
| 10-18.6 | 50 | | 6500 |
| **Parameters:**  - Number of Clusters: 130 Villages  - Power: 80%  - Significance Level: 5%  - One Baseline and two follow-ups | | **Assumptions:**  - Intra-class Correlation: [0.37-0.20]  - R2: 50%  - reliability: 66% | |

J:\SU-L1009\IE_Plan\Power_2.emf

Since the double difference approach will be applied to a small sample of two villages, the power analysis for this case will be done considering a person-randomize-blocked design, where blocks represent villages. Using the assumptions above mentioned, and for a power of 80%, the figures below suggests a total sample of at least 1,000 persons in around 40-50 villages, for a minimum detectable effects of at least 20%. This is consistent with our previous estimation of around 28 household per village will be representative.

Besides, since this is quasi-experimental design, in practice the sample size should be adjusted to account for non-random selection. That is, we enlarge the sample size in around 30% in terms of villages (because it is a cluster treatment) returning around 67 villages. Since the 130 villages will be surveyed, the overall design gives us enough room for making this sample adjustment in sample for quasi-experimental designs.

Double Differences Power Estimations



The main treat to this estimation is the unbalanced between both treatments and controls, due to only two villages treated. Even when we reduce the probability of selection bias by matching first at village level and performing a Dif&Dif estimations, we still face two relevant risks. First, there still could be non-observables cofounders that change over time in different way in the treat from the non-treated. Second, with only two clusters in treatment; the estimation will subject of sampling variability with two implications: (i) the results will be only representative for the treated villages, and (ii) the estimations will be expose greatly to sample variability. It is expected that these risks will be reduced by the careful construction of a counterfactual and by saturating the specification to be evaluated in order to control for potential confounders.

It is expected to perform 4 annual surveys; a base line (2014), two follow-ups (2015; 2016) and one final line (2017). The design of the survey (baseline and follow-ups) will be performed during the implementation of the evaluation. The basic content of the baseline will have the following sections:

|  |  |
| --- | --- |
| **Sections** | **Description** |
| Section 1: General Characteristics of the household | General characteristics of the members of the household (gender, age, ethnicity, precedence, beneficiary of a public social program, etc.) |
| Section 2: Education | Literacy of people above 16, years of schooling of people below 16, school attendance |
| Section 3: Health | Occurrence and frequency of accidents and illnesses (diarrheal, respiratory, etc.), practices of health care in the household, life satisfaction, etc. |
| Section 4: Dwellings Characteristics | Ownership of the household, rent for the household, type of material of the dwelling, number of rooms, access to public services (i.e. water and sanitation, electricity, etc.), appliances, economic use of the dwellings |
| Section 5: Public Services | Public Services available in the village, proximity to school, markets, hospital, main and secondary roads, etc., Source of energy supply. |
| Section 6: Time Use | Time allocation per activity of the household heads (by gender) |
| Section 7: Energy Consumption and Expenditure | Consumption and expenditure of energy by type and use of fuel, uses each type of fuel/energy, loans and savings, |
| Section 8: Household Expenses | Quantity and expenses by type of item (food, education, leisure, transport, health, clothes, electricity, etc.), monetary and non-monetary transfers, and production for own consumption. |
| Section 9: Economic Activities | Employment, Self-Employment, type of economic activities, income, |
| Section 10: Social Capital | Participation in social organizations such as energy and water user associations, producers, etc. This module includes social networking section, in which producers investigates each producer who shares information and interaction with agricultural technicians. |

1. Information of Results:

The results of the impact assessment will consist of four reports. The analysis of the baseline will compare the baseline characteristics between the target group and the control group. Two reports for each follow-up survey, analysing the annual impacts in the treated villages, and monitoring the trend in the control villages. The final report includes data from baseline and follow-ups surveys. In this report we present the identification of the impacts and the dose-analysis using the methodologies presented in the previous sections. These reports should be socialized with other actors besides the executor, including other future implementers, academic institutions.

The socialization of the impact assessment will be conducted by the Bank and will serve as a tool to demonstrate the effectiveness in developing of the electrification projects and generate lessons for the design and implementation of similar projects in Latin America and the Caribe.

1. Work plan

The next table presents the schedule of the major activities that are related to the implementation of the impact assessment and correspond mainly to the rise of a baseline and follow-up surveys. The impact assessment will be financed with resource of the Program (US$ 850,000).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Activities** | **2014** | | **2015** | | | | **2016** | | | | **2017** | | | | **2018** | | | | **2019** | | | | **2020** | | | | **Responsible** | **Cost (US$)\*** | **Source of Financing** |
| 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |  |  |  |
| Sampling and Pilots for baseline survey |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultor/BID | 80,000 | SU-L1009 |
| Baseline implementation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultor | 160,000 | SU-L1009 |
| Baseline report and Dissemination |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultor; BID | 15,000 | SU-L1009 |
| Survey review and Pilots for follow-up 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultor/BID | 20,000 | SU-L1009 |
| Follow-up 1 implementation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultor | 160,000 | SU-L1009 |
| Follow-up 1 report and dissemination |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultor; BID | 15,000 | SU-L1009 |
| Pilots for follow-up 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultor/BID | 20,000 | SU-L1009 |
| Follow-up2 implementation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultor | 160,000 | SU-L1009 |
| Follow-up2 report and dissemination |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultor; BID | 15,000 | SU-L1009 |
| Pilot for Final Survey |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultor | 20000 | SU-L1009 |
| Survey implementation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultor | 160,000 | SU-L1009 |
| Impact evaluation report and dissemination |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | BID/ENE | 25,000 | SU-L1009 |

\*taking as reference 3,600 households per survey at a unitary cost of US$40. This cost includes all fixed and variable expenses (wages, per-diem, transport, etc.) related with the execution of the survey. The pilots also include the cost of capacitation of required personnel to perform the assignment.

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1. The GOS has acknowledged the need to strengthen the electricity sector through a comprehensive and coordinated approach. To this extent in 2012, the GOS sought support from the Inter-American Development Bank (IDB) to establish a Sustainable Energy Framework for Suriname (SEFS) with the objective of creating conditions for the economic, social, financial and environmental sustainability of the sector, thereby anticipating future demand growth. [↑](#footnote-ref-1)
2. See PMR draft IDBDOCS#38054923 [↑](#footnote-ref-2)
3. Suriname´s power sector consists of a number of individual power systems operated by EBS (Energie Bedrijven Suriname): the EPAR system (the system serving Paramaribo and the surroundings), the ENIC system (for New Nickerie in West Suriname) and other smaller systems. [↑](#footnote-ref-3)
4. As greater information related to the project will be available, it is expected to write a conceptual note, describing the details of the impact evaluation methodology. [↑](#footnote-ref-4)
5. In the case of rural electrification projects to improve the quality of the service provided, additional benefits results in direct economic and environmental impacts by the reduction or phase-out of fossil fuel for electricity supply. [↑](#footnote-ref-5)
6. Research attempting to evaluate these benefits from a causal perspective include: Dinkelman (2011), Khandker et al (2009), Khandker et al, (2012), Gonzales-Eiras and Rossi (2007). [↑](#footnote-ref-6)
7. It is equally scarce empirical evidence on aspects of pricing of electricity services, energy-use patterns at household level and energy-spending. In the case of Latin America, available studies are restricted to the case of Chile, Peru and Panama, countries that made specific energy surveys to capture energy consumption and expenditure. However, these studies did not perform an impact evaluation of the effects of pricing on consumption and expenditure of energy. Even when the case of Guyana represents an ideal setting to analyse these aspects, there is still not a clear picture of the pricing that will be apply. We know that treated villages are going to be subject to a new pricing schedule, however there is not certainty about the possibility of use different structures in order to analyse different responses. [↑](#footnote-ref-7)
8. The 130 villages has been addressed by the IDB/GEF initiative (SU-G1001 [↑](#footnote-ref-8)
9. The certainty of the treatment will depend on the availability of financial resources (of the GOS) to extend the program. However, it is expected that future operations (of the IDB) and Budget resources from the government will allow to treat the remaining villages. Even more, the Government of Suriname has shown interest in support the evaluation through facilitating the survey process and collaborating with the random selection of the cohorts (for the phase-in approach). [↑](#footnote-ref-9)
10. Both villages located in different sites of the Hinterlands. [↑](#footnote-ref-10)
11. See for example Torero (2009) and Bloom et al (1996), respectively. [↑](#footnote-ref-11)
12. This exercise will be revised after the Statistical Bureau of Suriname makes public the dataset from the Population Census of 2012. Data from other neighbour countries could be also used to improve these estimations. [↑](#footnote-ref-12)
13. The reliability is defined as . It is a function of the between-person variance (), the within-person variance (), the study duration (D), the frequency of the observations (f), and the number of occasions (M). It represents the capacity to discriminate between growth rate (in the repeated measures) and the polynomial of interest using least squares estimate. Here we assume the, the outcome growth linearly. [↑](#footnote-ref-13)