

REQUEST FOR EXPRESSIONS OF INTEREST CONSULTING SERVICES

Selection # as assigned by e-Tool:

Selection Method: Full Competitive

Country: Guyana

Sector: Energy

Funding – TC #: GY-T1167

Project #: ATN/OC-17844-GY

TC name: Strengthening the Technical Functions of the Department of Energy

Description of Services: CONSULTANCY FOR THE QUANTITATIVE ANALYSIS FOR GRID INTEGRATION OF DISTRIBUTED RENEWABLE ENERGY RESOURCES

Link to TC document: [GY-T1167](#)

The Inter-American Development Bank (IDB) is executing the above-mentioned operation. For this operation, the IDB intends to contract consulting services described in this Request for Expressions of Interest. Expressions of interest must be delivered using the IDB Portal for Bank Executed Operations (<http://beo-procurement.iadb.org/home>) by: *March 25, 2022*, 5:00 P.M. (Washington D.C. Time).

The consulting services (“the Services”) include *the hiring of a consulting firm to support the Guyana Power and Light (GPL) in their grid modernization (smart grid deployment) which will accommodate intermittent renewable energy systems into the grid. This consultancy is estimated for a period of 6 months to be completed by October 2022.*

Eligible consulting firms will be selected in accordance with the procedures set out in the Inter-American Development Bank: [Policy for the Selection and Contracting of Consulting firms for Bank-executed Operational Work](#) - GN-2765-4. All eligible consulting firms, as defined in the Policy may express an interest. If the Consulting Firm is presented in a Consortium, it will designate one of them as a representative, and the latter will be responsible for the communications, the registration in the portal and for submitting the corresponding documents.

The IDB now invites eligible consulting firms to indicate their interest in providing the services described above in the [draft summary](#) of the intended Terms of Reference for the assignment. Interested consulting firms must provide information establishing that they are qualified to perform the Services (brochures, description of similar assignments, experience in similar conditions, availability of appropriate skills among staff, etc.).

Eligible firms should note that it is expected that the firm retain the following key experts to undertake the consultancy: a Project Manager with a minimum of 20 years’ experience managing grid integration studies of renewable energy resources and the development of power system standards and codes; a Renewable Energy Engineering Specialist with a minimum of 15 years’ experience conducting electrical power system

and distributed renewable energy interconnection studies, and production cost modelling; and a Power System Protection Engineer with a minimum of 15 years' experience in power system protection in utility transmission and distribution systems.

Eligible consulting firms may associate in a form of a Joint Venture or a sub-consultancy agreement to enhance their qualifications. Such association or Joint Venture shall appoint one of the firms as the representative.

Interested eligible consulting firms may obtain further information during office hours, 09:00 AM to 05:00 PM, (Washington D.C. Time) by sending an email to: [Malaika Masson, malaikac@iadb.org](mailto:malaikac@iadb.org).

Inter-American Development Bank

Division: [ENE/CGY](#)

Attn: [Lenin Balza and Malaika Masson, Program Team Leaders](#)

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Web site: www.iadb.org

Annex A: Terms of Reference

TERMS OF REFERENCE

CONSULTANCY FOR THE QUANTITATIVE ANALYSIS FOR GRID INTEGRATION OF DISTRIBUTED RENEWABLE ENERGY RESOURCES

GUYANA

GY-T1167

ATN/OC-17844-GY

Strengthening the Technical Functions of the Department of Energy

1. Background and Justification

- 1.1. As renewable energy sources occupy a growing share of the electricity generated, the challenges to grid stability, security, reliability, quality of electricity supply and associated system risks will increase due to the intermittent output of the renewable energy system.
- 1.2. Notably, with the present wind and solar photovoltaic technologies, experiences drawn from many countries have demonstrated that grid stability can be maintained without a cap on hosting capacity in some power systems. Nevertheless, many countries have taken a prudent path that resulted in establishing measures that address planning, market design, grid regulation and management, and advanced grid-tie inverter and power system supervision and control technology.
- 1.3. Some Caribbean utilities, for example, Barbados Light and Power Company, Jamaica Public Service Company and Anguilla Electricity Company, have already increased their intermittent renewable energy generation share up to the point where grid modernisation is required to bolster the deployment of distributed renewable energy systems.
- 1.4. In light of the recent developments in Guyana's Oil and Gas Sector, the Government aims at achieving a 50% reduction of current emissions associated with electricity generation by 2025 and 70% by 2027. The electricity generation plans to achieve these emission reduction targets are centred around using natural gas (as a bridging or transitioning fuel), hydropower and distributed renewable energy systems. Additionally, the planned Arco Norte Project, which aims to develop approximately 4,500 MW of hydropower and interconnect the electric power systems of Guyana, Suriname, French Guyana, and Brazil, will further support the goals of the Low Carbon Development Strategy¹.

Background on Guyana Power & Light Inc.

- 1.5. Guyana Power & Light Inc. (GPL) is a vertically integrated utility company and the most prominent public electricity supplier in Guyana, South America. Its franchise coverage encompasses the coastal plain of the three (3) counties - Essequibo, Demerara, and Berbice. GPL operates its primary power system in the Demerara-Berbice Counties – the Demerara-Berbice Interconnected System (DBIS) and Isolated Power Systems on the Essequibo Coast (Anna Regina), Leguan Island, Wakenaam Island, and Bartica. These locations are in the County of Essequibo.
- 1.6. Thermal plants presently dominate electricity generation with reciprocating engine-driven generators that utilise Heavy and Light fossil fuels (HFO and LFO). GPL's aggregated electric power system has 13 power plants totalling 236.6 MW of installed capacity, where 227.5 MW is available capacity. The aggregated installed capacity includes the nine power plants in the DBIS and four in Essequibo County (see **Error! Reference source not found.** B1) for breakdown details based on plant available capacity).

¹ Further details on Stimulating Future Growth using Clean Energy can be found in Chapter 3 of the Low Carbon Development Strategy.

- 1.7. With scheduled maintenance and efficient operation, generator units generally have a maximum operational life of 25 years, although, in most instances, their economic life is limited to 20 years. To date, a total of 57.6 MW of available capacity in the DBIS has surpassed the economic lifespan threshold.
- 1.8. The Transmission and Distribution section of GPL's electric power system comprises three main voltage levels; 69 kV for bulk power transfer (transmission), 13.8 kV for primary power distribution and lower utilisation voltages for customer-specific applications.
- 1.9. GPL's present transmission and distribution systems result in an electricity supply coverage of approximately 96.7% and comprise the following:
1. The transmission voltage level of 69 kV is currently present only in the DBIS and has a total length of 276 km;
 2. Thirty-nine (39) primary distribution feeders actively serving loads, having a total estimated length of 809 km in the DBIS; and
 3. Ten (10) primary distribution feeders actively serving loads, having a total estimated length of 143.56 km in aggregated Isolated Power Systems. A breakdown of the Isolated Systems is as follow:
 - a. Anna Regina – 75.97 km;
 - b. Wakenaam – 21.19 km;
 - c. Leguan – 28.8 km; and
 - d. Bartica – 17.6 km.
- 1.10. The Company has forecasted energy demand growth of 3,299.7 GWh for all GPL Systems, representing a significant increase of 333.7% for the next 5 years. The DBIS, which accounts for over 95% of GPL's system demand, has forecasted energy demand growth by 2,226 GWh or 237.4% in the same period (see Table B10 Table B2).
- Appendix A (page 12) has further technical details on demand forecast.
- 1.11. This projection is based on the expected significant stimulation in the emerging Oil and Gas Industry's economy. The Company projects an increase in its customer base from 210,732 in 2021 to potentially 261,272 by the end of 2026 (Table B3). The projected customer base is primarily due to the increased economic activities expected from population growth, increased business activities (commercial and industrial), and providing electricity service to all existing un-served areas.
- 1.12. At present, the most competitive and abundant renewable source options in Guyana include hydropower, wind, biomass, municipal solid waste, and solar PV systems. Energy from hydropower, large scale wind and solar PV systems, biomass and municipal solid waste are not considered distributed energy resources.

High-level Solar Resource Assessment

- 1.13. For the arbitrarily chosen location shown in Figure 1 (Lat: 6.82008° and Long: -58.150635°), the Global Horizontal Irradiation of 5.515 kWh/m² per day (Table B11) indicates that solar energy systems in Guyana are exceptionally productive and feasible for further uptake.

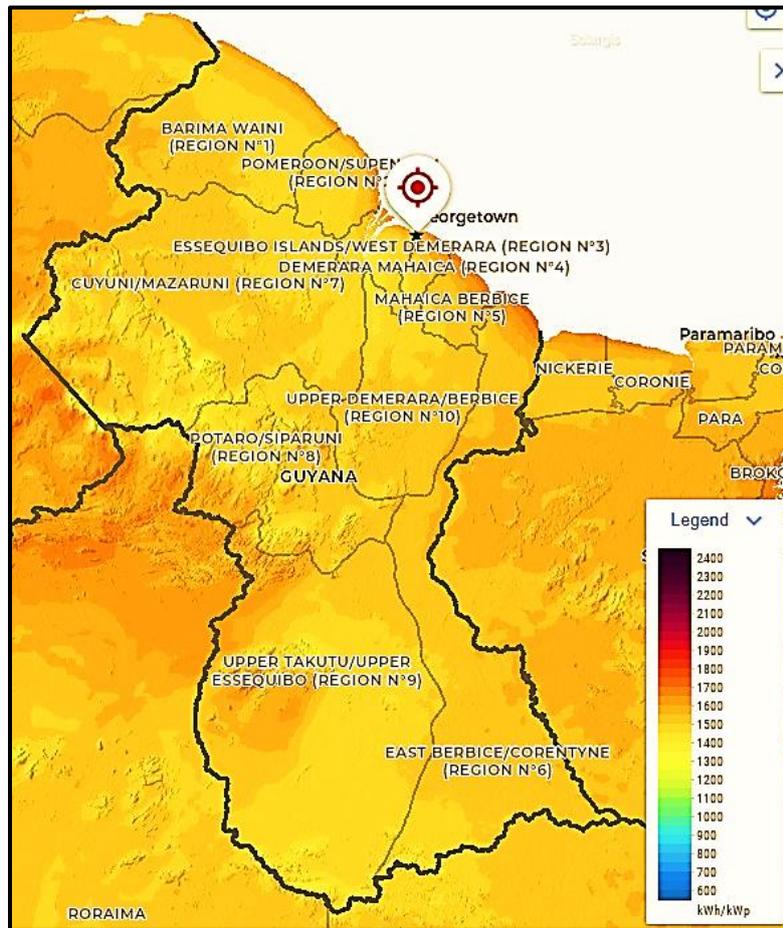


Figure 1: Guyana Global Horizontal Irradiation Solar Atlas (*source: Global Solar Atlas*)

High-level Wind Resource Assessment – Small wind turbines

1.14. Unlike solar, wind energy is site-specific. The minimum cut-in wind speed for most small wind turbines ranges from 2 m/s to 2.5 m/s, while the wind speed to generate electricity is typically 3 m/s to 3.5 m/s. The mean wind speeds in Appendix B, Table B5 indicate that wind energy systems have a lower consumer adoption probability. Consequently, there is considerable scope for developing small to medium scale grid-connected solar energy systems compared to wind.

Distributed Energy Resource

1.15. In the absence of a feed-in tariff, the total installed grid-tie solar PV systems across the aggregated GPL Power System to date is 5.087 MWac, representing a total of 289 grid-tie customers. It is expected that the uptake of grid-tie solar PV systems will further increase as their acquisition and installation costs continue to decrease. Among the many emission reduction strategies mentioned in the LCDS is the encouragement of distributed renewable energy systems – grid-tie solar PV systems.

1.16. The cost to install solar PV energy systems has declined over the years², and as per projections, the cost is expected to decrease further³. However, many of GPL's customers cannot afford the present and near future CapEx of solar PV systems. A Feed-in Tariff through a Net Billing Programme (NBP) is considered a significant revenue stream for the present and future grid-tie customers. As a result, credits for electricity export to the grid would enable CapEx reimbursement and an additional revenue stream for renewable energy system owners.

GPL is currently developing the Net Billing Programme with the following objectives:

1. To increase the contribution of renewable energy in the energy supply mix;
2. To provide Grid-tie Customers with a framework for renewable energy investments; and

² <https://www.nrel.gov/news/program/2021/documenting-a-decade-of-cost-declines-for-pv-systems.html>

³ <https://rameznaam.com/2020/05/14/solars-future-is-insanely-cheap-2020/>

3. To facilitate energy sector investments while ensuring transparency, safety, sustainability, continuity, and reliability of electricity supply.

Salient interim characteristics of the Draft Net Billing Programme are:

1. GPL customers with renewable systems up to 1.5 MW will be eligible for grid interconnection. Larger installations (categorised as IPP's) would be accommodated under the framework of the National Grid Code.
2. Renewable energy systems up to 100 kW can be grid-tied at the customer utilisation voltage level. Larger installation capacity up to 1.5 MW shall be grid-tied at the primary distribution level, 13.8 kV, through a dedicated transformer.
3. Once connected, the customer will qualify for the Net Billing Programme and be compensated for the excess solar energy exported to the grid. In addition, the Net Billing Programme will only apply to renewable energy systems and the Guyana Electrical Inspectorate (GEI) must inspect and certify such systems.
4. GPL will install the appropriate metering systems to facilitate the Net Billing arrangement. This metering system must record the electricity consumed and exported by the prosumer.
5. All applicants must maintain their insurance policies for their renewable energy system to mitigate the risk of personal loss or damage to equipment and risk to GPL's staff and grid. Grid-tied customers will also be asked to produce copies of their insurance policy.
6. All inverters or electric power devices interconnecting with the utility grid must comply with GPL's Interim Arrangements for Grid-Tie Distributed Energy Resources, which are in keeping with the IEEE 1547 Standard. Only inverters and other devices that are UL1741 Standard listed will be considered applicable.

DERs in the Existing Distribution Systems

- 1.17. The present distribution systems are designed and operated in the classical regimen – electricity flows in one direction, from the substation to customer interconnection points on the feeders/circuits. However, with the number of prosumers, the Company has not observed reverse power flow at the substation level to date and any negative impacts on the power systems.
- 1.18. Notwithstanding the above-mentioned, the expected growth of the DER penetration level will increase the aggregated intermittent electricity injected into the grid. This increase is projected to offset local demand on respective primary distribution feeders during daylight hours and result in reverse power flow – power flowing into the substation at the primary distribution level, stepped-up, and then into the transmission grid.

Significant reverse power flow would cause operational issues for the existing power systems, which includes but is not limited to the following:

1. Exhaustion of thermal ratings of existing distribution infrastructure (lines, cables, transformers, etc.);
2. Steady-state and transient overvoltage conditions on the distribution feeders adversely impact conventional generator outputs and result in tripping of units;
3. Reduced Power Quality – voltage fluctuations, flickering and harmonics;
4. Increased fault level, potentially breaching the short-circuit withstand rating of equipment;
5. Protection relay desensitisation and potential breach of protection relay coordination and selectivity;
6. Interference of the operation of automatic voltage regulators and capacitor banks;
7. Conflicting voltage regulation objectives – transformer tap-position during daylight hours and nights;
8. Incorrect operation of control equipment that may lead to an increase in the number of operations and related equipment wear, or further aggravation of problems that affect more equipment and customers that would likely result in extensive outages;
9. Mal-operation of protection relays or damages to switches resulting in islanding;
10. Non-compliance with the National Grid Code;

11. Inefficient loading of conventional generators resulting in increasing generation operation costs;
 12. Unnecessary energy curtailment either on the utility side or at the prosumer side;
 13. Adversely impact the available spinning up and spinning down reserve, resulting in grid instability and reducing grid security;
 14. Increase ancillary power system operation cost;
 15. Complicates the operation of Smart Grid/Smart Equipment across all voltage levels;
- 1.19.** There is great interest in grid modernisation (smart grid deployment) to accommodate intermittent renewable energy systems into the grid; however, Technical Assistance (TA) is required in assessing the current technical penetration limits and methods to extend the limits without exceeding grid stability limits, to achieve the emission and other energy-related goals of the LCDS. Further, the TA will inform GPL on the distribution system requirements from a planning, operation, and minimum technical requirements perspective, in accommodating increasing penetration levels of DERs.
- 1.20.** The solutions provided will undoubtedly allow GPL to provide greater value to its customers by supporting their investments in renewable energy systems and their contributions towards Guyana's National Energy Initiatives. In addition, the proposed TA will provide the support needed in a timely and responsive manner to GPL and other stakeholders within Guyana's Energy Sector.

2. Objectives

The objectives of this consultancy are to complete the following:

1. To conduct detailed quantitative analyses on distribution feeders to define the maximum technical and economic penetration limits of intermittent renewable energy resources;
2. To guarantee the defined maximum technical and economic limits takes into consideration, at minimum, the fifteen (15) issues highlighted in section (g), page 8;
3. To develop procedures for the development, maintenance, and operation of an efficient, coordinated, and economical distribution system with high penetration levels of DERs;
4. To set-out standards and technical procedures for expansion planning and operations of the distribution systems with high penetration levels of DERs;
5. To establish minimum technical requirements for the interconnection to the primary and secondary distribution systems; and
6. To provide in-person training workshop(s) covering the work.

3. Scope of Services

- 3.1.** The Consultant shall propose several supply-demand modelling scenarios based on feeder characteristics, such as loading and lengths for various DER injection points using a minimum of 25 distinct feeders. Under the Consultant's guidance, GPL will provide all available modelling data for the selected feeders.
- 3.2.** The Consultant shall conduct detailed quantitative steady-state, dynamic and cost production analyses of each scenario to define the maximum technical and economic penetration limits of distributed renewable energy resources on each distribution network – feeder technical and economical hosting capacities (primary and secondary) and to ensure that:
- I. At no given time of day, week or year, feeder voltage levels would violate the ANSI C84.1-Range A limits;
 - II. Feeder currents are maintained within the range determined by overcurrent protection devices; and
 - III. Short-circuit withstand ratings of distribution, substation, generation, and transmission equipment are not exceeded.
- 3.3.** The Consultant shall also perform impact studies for the said scenarios with renewable energy resource penetration levels increasing to twice the maximum limit in steps of 15%. Consultant to advise on the necessary

planning and engineering measures to mitigate grid impact and ensure voltage levels at any time of the day, week or year are maintained within the ANSI C84.1-Range A, and there will not be any thermal violation on any system element. In addition, the Consultant shall provide information on the likely cost impacts of these scenarios and propose contingency risk mitigation measures.

- 3.4.** The Consultant shall conduct short circuit analyses using the sequence data obtained in the data gathering and models. The Consultant shall determine the three-phase and single-phase currents (symmetric, asymmetric and DC components) as necessary on the distribution systems. The short circuit current will be determined in the most conservative configuration characterised by the most generation online, parallel lines, substation transformers and busses in service, and the scenarios with renewable energy resources and energy storage systems. Short circuit levels shall be calculated based on IEEE/ANSI C37.5.
- 3.5.** The Consultant shall compare the results of this study with the short circuit withstand ratings of existing equipment on the distribution systems, substations, and power plants. In the event of underrated equipment, the Consultant shall provide recommendations in the report.
- 3.6.** In GPL's distribution network, protection functions for the primary distribution feeder are presently provided by rural cut-outs (RCO's), Auto-Reclosers and digital relays at the substation and/or power station busbars. In some cases, the protection functions are provided by electromagnetic relays.
- 3.7.** Following the fault level studies in each scenario, the Consultant shall review and comment on the likely impact of the various penetration scenarios on the existing protection settings and the implications on existing protection coordination.
- 3.8.** The Consultant shall conduct Production Cost Assessments of each scenario. The analyses shall compare the base case with each scenario, including those where the penetration level is considered twice the maximum technical limit on distribution feeders. The analysis shall comprise an evaluation of the net economic benefits and costs (if any) of the scenarios versus the base case, where the operational and investment implications of renewable energy integration must be considered for GPL and prospective grid-tied customers in support of the draft Net Billing Programme.
- 3.9.** The analyses shall be conducted using PLEXOS with the cost production routine therein and supplemented by spreadsheets as required by GPL. The benefits should comprise, but are not limited to the following:
 1. Reduced Levelized production costs for GPL;
 2. Reduced CO₂ emission for GPL; and
 3. Financial benefits based on increased operational flexibility imposed by the scenarios.
- 3.10.** The costs are primarily those of the technology employed in the scenarios plus the cost of the mitigation measures in the case of high penetration levels. These benefits and costs shall be used to calculate each scenario's discounted net present value and benefit-cost ratio.
- 3.11.** In addition, based on the analyses results, the Consultant shall recommend the least-cost pathway to meet the maximum technical and economic penetration limits on the distribution systems over 10 years and for high-level penetration over 20 years.
- 3.12.** The Consultant shall develop the necessary distribution planning, interconnection standards, and operational procedures for distributed renewable energy resources to operate safely and stably with GPL power systems.
- 3.13.** The grid interconnection standards for distributed renewable energy resources should consider that GPL is Guyana's primary utility company and continuously provides baseload generation. As such, grid-connected distributed renewable energy resources should never attempt to adjust or influence the operational parameters, such as voltage or frequency of the power system, beyond the limits specified by the National Grid Code.

The Consultant shall address the following objectives of goal nos. 3 to 5:

1. To review information to be provided by all potential prosumers and format(s);
2. To inform on distribution planning standards (voltage, frequency, harmonics, reliability, and security) to accommodate increasing penetration levels of DERs at 13.8 kV and customer utilisation voltage levels;
3. To advise on coordination procedures and responsibility of planning;
4. To determine auditing procedures;

5. To set-out technical requirements for connection to the distribution system (equipment, protection, communication for Smart Grid Application);
 6. To establish the minimum technical requirements: frequency response – ride through, reactive requirements and voltage control participation during the solar hour periods; voltage ride through requirements, harmonics, etc.
 7. To define the DER system installation capacity limits at customer utilisation and 13.8 kV primary distribution voltage levels.
 8. To recommend procedure(s) for interconnection requests: Feasibility study, system impact studies and facility studies based on the above defined limits.
 9. To ascertain distribution operation planning in a medium and high penetration level of DERs;
 10. To develop a framework for distribution system maintenance coordination in a DER environment, DER monitoring using Smart Grid, and Solar Forecast for DER application;
 11. To define operational parameters under normal and emergency conditions;
 12. To create guidelines for voltage, thermal loading, frequency, Under-voltage Load Shedding (UVLS), Under-frequency Load Shedding (UFLS) relays
 13. To study the impact of various penetration levels on generator unit commitment and economic dispatch, considering the following:
 - a. Demand and technical losses, spinning reserve and Automatic Generation Control (AGC) response (AGC – future application); and
 - b. Emergency operation considerations of distribution feeders with DER
 14. To advise, from an operational perspective, communication requirements with and without Smart Grid, voltage and frequency control, automatic connections/disconnections;
- 3.14.** The Consultant shall also design and deliver a training workshop early in the work-plan that describes the key concepts, which will be employed throughout the study and to support GPL and other key stakeholders such as the Guyana Energy Agency (GEA), the Government Electrical Inspectorate (GEI), and the Public Utilities Commission (PUC) to establish institutional, organisational, and regulatory frameworks for grid integration of renewable energy resources.
- The purpose is to facilitate all stakeholders understanding of the associated concepts and principles incorporated in the study. A more detailed workshop shall follow at the end of the study that would equip GPL to conduct benefit-cost analyses of new scenarios.
- 3.15. Preferred Software/Tools.** Software modelling and simulations for Steady-State, Short-Circuit and Protection and Coordination Studies shall be performed and completed using PSS Sincal 15.1 and/or PSSE v33. Production cost modelling shall be performed using Plexos. During the review stages, GPL should be able to utilise the model(s) developed by the Consultant to explore, analyse, and compare results obtained from the study.

Key Activities

- 4.1.** This assignment is for either a Consulting Firm or a Consortium of Consulting Firms to complete the following key activities:
- a. Inception Meeting: To ensure that the final results of the analyses accomplish GPL's needs and requirements in content and delivery time.
 - b. Preparation of Draft Report addressing item nos. 1 and 2 of the Goals of Consultancy
 - c. Preparation of Report addressing item nos. 3 to 5 of the Goals of Consultancy

4. Expected Outcome and Deliverables

This assignment is for either a Consulting Firm or a Consortium of Consulting Firms to deliver:

- a. **Inception Meeting:** To ensure that the final results of the analyses accomplish GPL's needs and requirements in content and delivery time.

The Consulting Team shall meet with representatives of GPL to formally start the Project activities geared towards achieving the goals of the consultancy. The objectives of the inception meeting are, but are not limited to the following:

- (i) To establish communication channels;
- (ii) To discuss requirements and availability of additional data/information;
- (iii) To review scope and work schedule;
- (iv) To identify special issues that should be included in the analysis; and
- (v) To clarify study methodology, processes, and deliverables.

- **Deliverables – Summary Report of Kick-Off Meeting & Data Request Schedule.**

- **Duration – allow a total of five (5) business days for both reports.**

- b. Preparation of Draft Report addressing item nos. 1 and 2 of the Goals of Consultancy

- **Deliverables – Draft Report: Grid Impact Studies**

- **Duration – allow Sixty-Six (66) business days for the Consultant to prepare the draft report and a total of Twenty (20) business days for the Client's review and acceptance of results.**

- c. Preparation of Report addressing item nos. 3 to 5 of the Goals of Consultancy

- **Deliverables – Draft of Technical Distribution System's Requirements for DER Interconnection, System's Planning and Expansion, and Operation.**

- **Duration – allow Forty-Four (44) business days for the Consultant to prepare the draft report and a total of Twenty (20) business days for the Client's review and acceptance of technical details.**

5. Project Schedule and Milestones

- i. Summary Report of Kick-Off Meeting & Data Request Schedule.
Duration – allow a total of five (5) business days for both reports.
- ii. Deliverables – Draft Report: Grid Impact Studies
Duration – allow Sixty-Six (66) business days for the Consultant to prepare the draft report and a total of Twenty (20) business days for the Client's review and acceptance of results.
- iii. Deliverables – Draft of Technical Distribution System's Requirements for DER Interconnection, System's Planning and Expansion, and Operation.
Duration – allow Forty-Four (44) business days for the Consultant to prepare the draft report and a total of Twenty (20) business days for the Client's review and
- iv. Final Report incorporating the Grid Impact Studies and Technical Requirements documents.
Duration – allow fourteen (14) business days for the Consultant to prepare the Final report and a total of ten (10) business days for the Client's review and acceptance of the Report.

6. Reporting Requirements

- 6.1. *The consultant will submit the following reports for the review and approval of GPL in coordination with the IDB: (i) Summary Report of Kick-Off Meeting & Data Request Schedule; (ii) Draft Report: Grid Impact Studies; (iii) Draft of Technical Distribution System's Requirements for DER Interconnection, System's Planning and Expansion, and Operation; and (iv) Final Report incorporating the Grid Impact Studies and Technical Requirements documents. All reports must be in English.*

7. Acceptance Criteria

7.1. All reports will be submitted to and reviewed by GPL in coordination with IDB, and all comments will be communicated to the consultant within the stipulated timelines. GPL in coordination with the IDB will be responsible for the final acceptance of all reports.

8. Supervision and Reporting

8.1. The Consultant will report on all aspects related to this assignment to Sector Specialist Energy INE/ENE.

9. Schedule of Payments

9.1. Payment terms will be based on project milestones or deliverables. The Bank does not expect to make advance payments under consulting contracts unless a significant amount of travel is required. The Bank wishes to receive the most competitive cost proposal for the services described herein.

9.2. The IDB Official Exchange Rate indicated in the RFP will be applied for necessary conversions of local currency payments.

Payment Schedule	
<i>Deliverable</i>	%
<i>1. Summary Report of Kick-Off Meeting & Data Request Schedule.</i>	10%
<i>2. Deliverables – Draft Report: Grid Impact Studies</i>	40%
<i>3. Draft of Technical Distribution System's Requirements for DER Interconnection, System's Planning and Expansion, and Operation.</i>	40%
<i>4. Final Report incorporating the Grid Impact Studies and Technical Requirements documents.</i>	10%
TOTAL	100%

Appendix A

5.1 Demand Analysis and Forecast

A historical analysis of GPL power systems (DBIS & Essequibo Isolated Systems) shows that for the period 2014 - 2021, total energy demand, by the proxy of gross generation, increased by an annual average of 8.23%, moving from 717 GWh to 968.75 GWh for the same period.

In the same period, the associated non-coincidental Peak Demand (Peak Load) from all systems increased by an annual average of 7.87%, moving from 115.7 MW to 147.42 MW. Compared with the total energy consumed, the slower growth in peak demand explains the improvement in the power system load factor from 70.78% in 2014 to 76.6%.

The load factor (discussed in a later subsection) is used to determine the peak demand forecast.

Note that the load factor measures the annual gross generation divided by the product of peak power and 8760 hours. In other words, higher load factors indicate a relative lowering of the difference between power demand at the highest peak and its lowest trough of the year in question.

The current 30-year base-case forecast is driven by robust economic growth projections arising from Guyana's Oil and Gas sector while incorporating the most realistic and likely impacts of Covid-19 that commenced in Q2 of 2020. However, GPL continues to monitor the impacts of Covid-19 and would make the appropriate updates should it become necessary to maintain the statistical significance of the energy and peak demand forecasts.

The base-case forecast for all GPL power systems shows the combined gross demand for electrical growing by the following annual averages for the respective 5-year periods: by 27% from 2022 to 2026 (1,256.94 GWh to 3,299.72 GWh); by 16% from 2027 to 2031 (up to 6,970.91 GWh), and 8% from 2032 to 2036 (up to 10,378.08 GWh). For the 14 years from 2037 to 2050, the gross energy demand is forecasted to grow by an annual average of 6%, reaching 21,970.9 GWh.

Base case forecasted growth of peak demand for the 29 indicative years of all GPL power systems are as follows: by 28% from 2022 to 2026 (196.6 MW to 501.64 MW); by 16% from 2027 to 2031 (up to 1,049 MW); and by 8% from 2032 to 2036 (up to 1,553.52 MW). For the 14 years from 2037 to 2050, peak demand is forecasted to grow by an annual average of 5%, reaching 3,277.41 MW.

The current forecast (as of September 27, 2021) was built on, and to some extent, incorporated elements of work previously done in preparing the energy demand projections; (1) the Generation Expansion Study 2018[1] referred to as the "Brugman Study", and (2) The Demand Forecast Capacity Building Consultancy by ETS consultants (2019-2020). Reference is also made to forecasts prepared under the Gas to Power Feasibility Assessment in Guyana by K&M Advisors in 2019, mainly for comparison.

5.1.1 Disaggregated Forecast

The disaggregated forecast in this document is broken down into:

1. Gross Generation;
2. Net Generation;
3. Electricity Sales (per tariff and self-generation):
 - a. Residential;
 - b. Commercial;
 - c. Industrial;
4. Unserved Electricity;
5. Energy Efficiency Measure

See Table 1,

Table 2, Table 3,

Table 4 and Table 5 for details of the disaggregated electricity and peak demand forecasts of the Demerara Berbice Interconnected System.

Regarding self-generated customers, in Brugman's Study, it was assumed for these customers to become grid-connected by 2025. In this report, GPL endorses this assumption against the backdrop of recent amendments to its license to purchase power from self-generated customers.

Table 1: DBIS Disaggregated Electricity and Peak Demand Forecast 2021-2026

	<i>select from list</i>	<i>GWh values unless stated otherwise</i>	2020	2021	2022	2023	2024	2025	2026
Area	All GPL								
Scenario	BASE								
		Gross Gen (No New EE Measures)	900.42	1,015.41	1,296.92	1,648.21	2,119.92	2,864.66	3,466.58
		<i>Energy Not served Factor (%)</i>	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Estimated Energy Not served	12.30	0.01	0.00	0.00	0.01	0.07	0.08
		<i>Energy Efficiency factor (% of Total Demand)</i>	2.4%	2.6%	3.1%	3.5%	4.1%	4.7%	4.9%
		<i>Potential Impact of EE measures</i>	(21.85)	(26.52)	(39.98)	(57.40)	(87.62)	(133.50)	(168.94)
		Potential Demand Post-EE	878.57	988.90	1,256.94	1,590.80	2,032.30	2,731.16	3,297.64
		EVs consumption (DBIS only)	-	-	-	-	0.80	1.60	2.08
		New Gross Gen. with EE & Evs	878.57	988.90	1,256.94	1,590.80	2,033.10	2,732.76	3,299.72
		Auxiliaries & Self-Consumption	(22.20)	(20.14)	(26.56)	(33.95)	(40.40)	(50.50)	(56.48)
		Net Energy Exported to Grid	856.38	968.75	1,230.38	1,556.85	1,992.70	2,682.26	3,243.25
		Technical loss factor (%)	12.0%	11.5%	11.0%	10.5%	10.3%	10.2%	10.1%
		Non-Technical loss factor (%)	14.9%	14.1%	13.6%	13.0%	12.4%	11.7%	10.9%
		Technical & Non-technical losses	(230.11)	(248.00)	(302.67)	(365.86)	(452.34)	(587.41)	(681.08)
		Total Sales	626.27	720.75	927.71	1,190.99	1,540.36	2,094.84	2,562.16
		<i>of which Commercial</i>	211.05	192.44	250.48	329.90	432.84	605.41	757.38
		<i>Residential</i>	139.03	177.31	228.22	290.60	368.15	494.38	599.03
		<i>Industrial</i>	276.18	351.01	449.01	570.49	739.37	995.05	1,205.75
		Demand category factors (%)							
		<i>Commercial</i>	33.7%	26.7%	27.0%	27.7%	28.1%	28.9%	29.6%
		<i>Residential</i>	22.2%	24.6%	24.6%	24.4%	23.9%	23.6%	23.4%
		<i>Industrial</i>	44.1%	48.7%	48.4%	47.9%	48.0%	47.5%	47.1%
		Load Factor (%)	76.633%	76.57%	73%	73%	76%	73%	75%
		Peak MW (with EV's & En. Efficiency)	130.87	147.42	196.60	249.51	304.26	428.10	501.64
		Peak MW (without EV's & En. Efficiency)	134.13	151.38	202.85	258.51	317.25	448.77	527.00

Table 2: Disaggregated Electricity and Peak Demand Forecast 2027-2031

	<i>select from list</i>	<i>GWh values unless stated otherwise</i>	2027	2028	2029	2030	2031
Area	All GPL						
Scenario	BASE						
		Gross Gen (No New EE Measures)	4,265.51	5,283.23	5,973.47	6,734.55	7,407.16
		<i>Energy Not served Factor (%)</i>	<i>0.0%</i>	<i>0.0%</i>	<i>0.0%</i>	<i>0.0%</i>	<i>0.0%</i>
		Estimated Energy Not served	0.09	0.10	0.10	0.11	0.11
		<i>Energy Efficiency factor (% of Total Demand)</i>	<i>5.1%</i>	<i>5.3%</i>	<i>5.6%</i>	<i>5.8%</i>	<i>6.0%</i>
		<i>Potential Impact of EE measures</i>	<i>(217.75)</i>	<i>(282.23)</i>	<i>(333.19)</i>	<i>(392.54)</i>	<i>(443.00)</i>
		Potential Demand Post-EE	4,047.76	5,001.00	5,640.28	6,342.01	6,964.17
		EVs consumption (DBIS only)	2.71	3.54	4.61	6.00	6.75
		New Gross Gen. with EE &Evs	4,050.47	5,004.54	5,644.89	6,348.01	6,970.91
		Auxiliaries & Self-Consumption	(64.32)	(73.65)	(76.82)	(79.96)	(83.23)
		Net Energy Exported to Grid	3,986.15	4,930.89	5,568.06	6,268.05	6,887.68
		Technical loss factor (%)	9.6%	9.6%	9.6%	9.6%	9.6%
		Non-Technical loss factor (%)	10.1%	9.3%	8.5%	7.7%	6.9%
		Technical & Non-technical losses	(785.27)	(931.94)	(1,007.82)	(1,084.37)	(1,136.47)
		Total Sales	3,200.88	3,998.95	4,560.24	5,183.68	5,751.21
		<i>of which Commercial</i>	<i>967.31</i>	<i>1,234.88</i>	<i>1,438.30</i>	<i>1,669.15</i>	<i>1,895.60</i>
		<i>Residential</i>	<i>741.32</i>	<i>917.36</i>	<i>1,036.09</i>	<i>1,166.33</i>	<i>1,280.22</i>
		<i>Industrial</i>	<i>1,492.25</i>	<i>1,846.71</i>	<i>2,085.86</i>	<i>2,348.21</i>	<i>2,575.39</i>
		Demand category factors (%)					
		<i>Commercial</i>	<i>30.2%</i>	<i>30.9%</i>	<i>31.5%</i>	<i>32.2%</i>	<i>33.0%</i>
		<i>Residential</i>	<i>23.2%</i>	<i>22.9%</i>	<i>22.7%</i>	<i>22.5%</i>	<i>22.3%</i>
		<i>Industrial</i>	<i>46.6%</i>	<i>46.2%</i>	<i>45.7%</i>	<i>45.3%</i>	<i>44.8%</i>
		Load Factor (%)	75%	75%	76%	76%	76%
		Peak MW (with EV's & En. Efficiency)	613.22	758.82	852.09	954.97	1,049.10
		Peak MW (without EV's & En. Efficiency)	645.78	801.08	901.69	1,013.12	1,114.75

Table 3: Disaggregated Electricity and Peak Demand Forecast 2032-2036

	<i>select from list</i>	<i>GWh values unless stated otherwise</i>	2032	2033	2034	2035	2036
Area	All GPL						
Scenario	BASE						
		Gross Gen (No New EE Measures)	8,100.07	8,825.88	9,567.98	10,326.38	11,101.07
		<i>Energy Not served Factor (%)</i>	<i>0.0%</i>	<i>0.0%</i>	<i>0.0%</i>	<i>0.0%</i>	<i>0.0%</i>
		Estimated Energy Not served	0.12	0.12	0.12	0.12	0.12
		<i>Energy Efficiency factor (% of Total Demand)</i>	<i>6.1%</i>	<i>6.2%</i>	<i>6.3%</i>	<i>6.5%</i>	<i>6.6%</i>
		<i>Potential Impact of EE measures</i>	<i>(492.54)</i>	<i>(546.76)</i>	<i>(605.00)</i>	<i>(667.66)</i>	<i>(735.14)</i>
		Potential Demand Post-EE	7,607.53	8,279.12	8,962.97	9,658.71	10,365.93
		EVs consumption (DBIS only)	7.59	8.54	9.60	10.80	12.15
		New Gross Gen. with EE &Evs	7,615.12	8,287.65	8,972.57	9,669.51	10,378.08
		Auxiliaries & Self-Consumption	(85.40)	(87.47)	(87.40)	(88.98)	(95.66)
		Net Energy Exported to Grid	7,529.72	8,200.18	8,885.17	9,580.53	10,282.42
		Technical loss factor (%)	9.6%	9.6%	9.6%	9.6%	9.6%
		Non-Technical loss factor (%)	6.1%	5.3%	4.5%	3.7%	2.9%
		Technical & Non-technical losses	(1,182.17)	(1,221.83)	(1,252.81)	(1,274.21)	(1,285.30)
		Total Sales	6,347.55	6,978.36	7,632.36	8,306.32	8,997.12
		<i>of which Commercial</i>	<i>2,140.39</i>	<i>2,406.14</i>	<i>2,689.64</i>	<i>2,990.28</i>	<i>3,238.96</i>
		<i>Residential</i>	<i>1,397.73</i>	<i>1,519.89</i>	<i>1,644.01</i>	<i>1,769.25</i>	<i>1,916.39</i>
		<i>Industrial</i>	<i>2,809.43</i>	<i>3,052.33</i>	<i>3,298.71</i>	<i>3,546.80</i>	<i>3,841.77</i>
		Demand category factors (%)					
		<i>Commercial</i>	<i>33.7%</i>	<i>34.5%</i>	<i>35.2%</i>	<i>36.0%</i>	<i>36.0%</i>
		<i>Residential</i>	<i>22.0%</i>	<i>21.8%</i>	<i>21.5%</i>	<i>21.3%</i>	<i>21.3%</i>
		<i>Industrial</i>	<i>44.3%</i>	<i>43.7%</i>	<i>43.2%</i>	<i>42.7%</i>	<i>42.7%</i>
		Load Factor (%)	76%	76%	76%	76%	76%
		Peak MW (with EV's & En. Efficiency)	1,144.86	1,244.62	1,346.01	1,448.98	1,553.52
		Peak MW (without EV's & En. Efficiency)	1,217.77	1,325.45	1,435.33	1,547.41	1,661.75

Table 4: Disaggregated Electricity and Peak Demand Forecast 2037-2041

		THIS SHEET HAS NOT BEEN UPDATED WITH					
	<i>select from list</i>	<i>GWh values unless stated otherwise</i>	2037	2038	2039	2040	2041
Area	All GPL						
Scenario	BASE						
		Gross Gen (No New EE Measures)	11,892.06	12,699.35	13,522.93	14,362.81	15,218.99
		<i>Energy Not served Factor (%)</i>	<i>0.0%</i>	<i>0.0%</i>	<i>0.0%</i>	<i>0.0%</i>	<i>0.0%</i>
		Estimated Energy Not served	0.13	0.13	0.13	0.13	0.14
		<i>Energy Efficiency factor (% of Total Demand)</i>	<i>6.8%</i>	<i>7.0%</i>	<i>7.2%</i>	<i>7.4%</i>	<i>7.4%</i>
		<i>Potential Impact of EE measures</i>	<i>(807.87)</i>	<i>(886.32)</i>	<i>(970.99)</i>	<i>(1,062.43)</i>	<i>(1,125.76)</i>
		Potential Demand Post-EE	11,084.19	11,813.03	12,551.94	13,300.38	14,093.22
		EVs consumption (DBIS only)	13.66	15.37	17.28	19.44	21.87
		New Gross Gen. with EE &Evs	11,097.85	11,828.40	12,569.22	13,319.82	14,115.09
		Auxiliaries & Self-Consumption	(102.47)	(109.43)	(116.53)	(123.76)	(131.14)
		Net Energy Exported to Grid	10,995.38	11,718.97	12,452.70	13,196.06	13,983.95
		Technical loss factor (%)	9.6%	9.6%	9.6%	9.6%	9.6%
		Non-Technical loss factor (%)	2.1%	1.3%	0.5%	0.1%	0.0%
		Technical & Non-technical losses	(1,286.46)	(1,277.37)	(1,257.72)	(1,280.02)	(1,342.46)
		Total Sales	9,708.92	10,441.60	11,194.98	11,916.04	12,641.49
		<i>of which Commercial</i>	<i>3,495.21</i>	<i>3,758.98</i>	<i>4,030.19</i>	<i>4,289.77</i>	<i>4,550.94</i>
		<i>Residential</i>	<i>2,068.00</i>	<i>2,224.06</i>	<i>2,384.53</i>	<i>2,538.12</i>	<i>2,692.64</i>
		<i>Industrial</i>	<i>4,145.71</i>	<i>4,458.56</i>	<i>4,780.25</i>	<i>5,088.15</i>	<i>5,397.92</i>
		<i>Demand category factors (%)</i>					
		<i>Commercial</i>	<i>36.0%</i>	<i>36.0%</i>	<i>36.0%</i>	<i>36.0%</i>	<i>36.0%</i>
		<i>Residential</i>	<i>21.3%</i>	<i>21.3%</i>	<i>21.3%</i>	<i>21.3%</i>	<i>21.3%</i>
		<i>Industrial</i>	<i>42.7%</i>	<i>42.7%</i>	<i>42.7%</i>	<i>42.7%</i>	<i>42.7%</i>
		Load Factor (%)	76%	76%	76%	77%	77%
		Peak MW (with EV's & En. Efficiency)	1,659.60	1,767.20	1,876.31	1,986.93	2,105.56
		Peak MW (without EV's & En. Efficiency)	1,778.37	1,897.33	2,018.68	2,142.51	2,270.23

Table 5: Disaggregated Electricity and Peak Demand Forecast 2042 – 2050

	<i>select from list</i>	<i>GWh values unless stated otherwise</i>	2042	2043	2044	2045	2046	2047	2048	2049	2050
Area	All GPL										
Scenario	BASE										
		Gross Gen (No New EE Measures)	16,091.46	16,980.23	17,885.29	18,806.66	19,744.31	20,698.27	21,668.52	22,655.07	23,657.91
		<i>Energy Not served Factor (%)</i>	<i>0.0%</i>								
		Estimated Energy Not served	0.15	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22
		<i>Energy Efficiency factor (% of Total Demand)</i>	<i>7.4%</i>								
		<i>Potential Impact of EE measures</i>	<i>(1,190.30)</i>	<i>(1,256.04)</i>	<i>(1,322.99)</i>	<i>(1,391.14)</i>	<i>(1,460.50)</i>	<i>(1,531.07)</i>	<i>(1,602.84)</i>	<i>(1,675.82)</i>	<i>(1,750.00)</i>
		Potential Demand Post-EE	14,901.16	15,724.19	16,562.30	17,415.51	18,283.81	19,167.20	20,065.68	20,979.25	21,907.91
		EVs consumption (DBIS only)	24.59	27.66	31.11	34.99	39.36	44.27	49.79	56.00	62.99
		New Gross Gen. with EE &Evs	14,925.75	15,751.85	16,593.41	17,450.50	18,323.17	19,211.47	20,115.47	21,035.25	21,970.90
		Auxiliaries & Self-Consumption	(138.66)	(146.32)	(154.12)	(162.05)	(170.13)	(178.35)	(186.71)	(195.22)	(203.86)
		Net Energy Exported to Grid	14,787.09	15,605.53	16,439.30	17,288.45	18,153.03	19,033.11	19,928.75	20,840.04	21,767.04
		Technical loss factor (%)	9.6%	9.6%	9.6%	9.6%	9.6%	9.6%	9.6%	9.6%	9.6%
		Non-Technical loss factor (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Technical & Non-technical losses	(1,419.56)	(1,498.13)	(1,578.17)	(1,659.69)	(1,742.69)	(1,827.18)	(1,913.16)	(2,000.64)	(2,089.64)
		Total Sales	13,367.53	14,107.40	14,861.13	15,628.76	16,410.34	17,205.93	18,015.59	18,839.39	19,677.41
		<i>of which Commercial</i>	<i>4,812.31</i>	<i>5,078.66</i>	<i>5,350.01</i>	<i>5,626.35</i>	<i>5,907.72</i>	<i>6,194.14</i>	<i>6,485.61</i>	<i>6,782.18</i>	<i>7,083.87</i>
		<i>Residential</i>	<i>2,847.28</i>	<i>3,004.88</i>	<i>3,165.42</i>	<i>3,328.93</i>	<i>3,495.40</i>	<i>3,664.86</i>	<i>3,837.32</i>	<i>4,012.79</i>	<i>4,191.29</i>
		<i>Industrial</i>	<i>5,707.94</i>	<i>6,023.86</i>	<i>6,345.70</i>	<i>6,673.48</i>	<i>7,007.22</i>	<i>7,346.93</i>	<i>7,692.66</i>	<i>8,044.42</i>	<i>8,402.25</i>
		<i>Demand category factors (%)</i>									
		<i>Commercial</i>	<i>36.0%</i>								
		<i>Residential</i>	<i>21.3%</i>								
		<i>Industrial</i>	<i>42.7%</i>								
		Load Factor (%)	77%	77%	77%	77%	77%	77%	77%	77%	77%
		Peak MW (with EV's & En. Efficiency)	2,226.48	2,349.71	2,475.25	2,603.10	2,733.28	2,865.79	3,000.64	3,137.84	3,277.41
		Peak MW (without EV's & En. Efficiency)	2,400.37	2,532.95	2,667.96	2,805.40	2,945.27	3,087.57	3,232.31	3,379.47	3,529.07

5.1.2 Electricity Demand – Essequibo Isolated Power Systems

The forecasts for Essequibo, which includes Anna Regina, Bartica, Wakenaam and Leguan, indicate that electricity and peak demand in these areas would continue to grow at a significant rate (Table 6 to Table 9). With these projections and the need to improve on generation reliability and quality of electricity service to customers, the Company plans to boost its firm generation capacity in these areas.

Table 6: Disaggregated Forecast for Essequibo: 2021-2026

	<i>GWh values unless stated otherwise</i>	2021	2022	2023	2024	2025	2026
Anna Regina	Gross Generation (GWh)	39.39	47.55	61.06	75.20	86.32	97.76
	Rate of Growth (%)						
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.04	0.05	0.06	0.08	0.09	0.10
	Anna Regina Electricity Demand (GWh)	39.43	47.60	61.12	75.28	86.41	97.86
	Peak Demand (MW)	6.90	8.59	11.08	13.15	15.69	17.30
	Rate of Growth (%)						
	Load Factor	0.65	0.63	0.63	0.65	0.63	0.65
Bartica	Gross Generation (GWh)	14.82	17.41	21.54	25.42	27.87	30.03
	Rate of Growth (%)						
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.01	0.02	0.02	0.03	0.03	0.03
	Anna Regina Electricity Demand (GWh)	14.83	17.43	21.56	25.45	27.90	30.06
	Peak Demand (MW)	2.33	2.81	3.49	3.99	4.51	4.75
	Rate of Growth (%)						
	Load Factor	0.73	0.71	0.71	0.73	0.71	0.72
Leguan	Gross Generation (GWh)	2.08	2.46	3.08	3.73	4.23	4.69
	Rate of Growth (%)						
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.00	0.00	0.00	0.00	0.00	0.00
	Anna Regina Electricity Demand (GWh)	2.09	2.46	3.08	3.74	4.23	4.69
	Peak Demand (MW)	0.43	0.52	0.66	0.77	0.90	0.98
	Rate of Growth (%)						
	Load Factor	0.55	0.54	0.54	0.55	0.54	0.55
Wakenaam	Gross Generation (GWh)	2.08	2.44	3.04	3.66	4.12	4.57
	Rate of Growth (%)						
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.00	0.00	0.00	0.00	0.00	0.00
	Anna Regina Electricity Demand (GWh)	2.08	2.45	3.05	3.66	4.13	4.57
	Peak Demand (MW)	0.37	0.45	0.56	0.65	0.76	0.82
	Rate of Growth (%)						
	Load Factor	0.64	0.62	0.62	0.64	0.62	0.64

Table 7: Disaggregated Forecast for Essequibo: 2027-2031

	<i>GWh values unless stated otherwise</i>	2027	2028	2029	2030	2031
Anna Regina	Gross Generation (GWh)	108.13	119.92	133.53	149.18	166.31
	Rate of Growth (%)					
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.11	0.12	0.13	0.15	0.17
	Anna Regina Electricity Demand (GWh)	108.24	120.04	133.66	149.33	166.48
	Peak Demand (MW)	19.10	21.21	23.52	26.24	29.35
	Rate of Growth (%)					
	Load Factor	0.65	0.65	0.65	0.65	0.65
Bartica	Gross Generation (GWh)	31.58	33.13	34.68	36.23	37.74
	Rate of Growth (%)					
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.03	0.03	0.03	0.04	0.04
	Anna Regina Electricity Demand (GWh)	31.61	33.16	34.72	36.27	37.78
	Peak Demand (MW)	4.99	5.23	5.45	5.69	5.99
	Rate of Growth (%)					
	Load Factor	0.72	0.72	0.73	0.73	0.72
Leguan	Gross Generation (GWh)	5.04	5.38	5.70	6.01	6.30
	Rate of Growth (%)					
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.01	0.01	0.01	0.01	0.01
	Anna Regina Electricity Demand (GWh)	5.04	5.39	5.71	6.01	6.31
	Peak Demand (MW)	1.05	1.12	1.18	1.24	1.31
	Rate of Growth (%)					
	Load Factor	0.55	0.55	0.55	0.55	0.55
Wakenaam	Gross Generation (GWh)	4.93	5.30	5.68	6.07	6.47
	Rate of Growth (%)					
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.00	0.01	0.01	0.01	0.01
	Anna Regina Electricity Demand (GWh)	4.93	5.30	5.69	6.08	6.48
	Peak Demand (MW)	0.88	0.95	1.02	1.08	1.16
	Rate of Growth (%)					
	Load Factor	0.64	0.64	0.64	0.64	0.63

Table 8: Disaggregated Forecast for Essequibo: 2032-2036

	<i>GWh values unless stated otherwise</i>	2032	2033	2034	2035	2036
Anna Regina	Gross Generation (GWh)	185.54	207.28	232.00	260.21	278.31
	Rate of Growth (%)					
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.19	0.21	0.23	0.26	0.28
	Anna Regina Electricity Demand (GWh)	185.72	207.49	232.23	260.47	278.59
	Peak Demand (MW)	32.74	36.58	40.94	45.91	49.11
	Rate of Growth (%)					
	Load Factor	0.65	0.65	0.65	0.65	0.65
Bartica	Gross Generation (GWh)	39.13	40.45	41.72	42.94	45.38
	Rate of Growth (%)					
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.04	0.04	0.04	0.04	0.05
	Anna Regina Electricity Demand (GWh)	39.17	40.49	41.76	42.98	45.43
	Peak Demand (MW)	6.21	6.42	6.62	6.81	7.20
	Rate of Growth (%)					
	Load Factor	0.72	0.72	0.72	0.72	0.72
Leguan	Gross Generation (GWh)	6.54	6.75	6.92	7.06	7.48
	Rate of Growth (%)					
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.01	0.01	0.01	0.01	0.01
	Anna Regina Electricity Demand (GWh)	6.55	6.76	6.93	7.06	7.49
	Peak Demand (MW)	1.36	1.41	1.44	1.47	1.56
	Rate of Growth (%)					
	Load Factor	0.55	0.55	0.55	0.55	0.55
Wakenaam	Gross Generation (GWh)	6.84	7.21	7.56	7.89	8.38
	Rate of Growth (%)					
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.01	0.01	0.01	0.01	0.01
	Anna Regina Electricity Demand (GWh)	6.85	7.21	7.56	7.90	8.39
	Peak Demand (MW)	1.23	1.30	1.36	1.42	1.51
	Rate of Growth (%)					
	Load Factor	0.63	0.63	0.63	0.63	0.63

Table 9: Disaggregated Forecast for Essequibo: 2037-2041

<i>GWh values unless stated otherwise</i>		2037	2038	2039	2040	2041
Anna Regina	Gross Generation (GWh)	296.84	315.78	335.13	354.90	375.09
	Rate of Growth (%)					
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.30	0.32	0.34	0.35	0.38
	Anna Regina Electricity Demand (GWh)	297.13	316.09	335.47	355.26	375.47
	Peak Demand (MW)	52.38	55.72	59.14	62.62	66.19
	Rate of Growth (%)					
	Load Factor	0.65	0.65	0.65	0.65	0.65
Bartica	Gross Generation (GWh)	47.89	50.45	53.07	55.75	58.49
	Rate of Growth (%)					
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.05	0.05	0.05	0.06	0.06
	Anna Regina Electricity Demand (GWh)	47.93	50.50	53.12	55.81	58.55
	Peak Demand (MW)	7.60	8.01	8.42	8.85	9.28
	Rate of Growth (%)					
	Load Factor	0.72	0.72	0.72	0.72	0.72
Leguan	Gross Generation (GWh)	7.91	8.36	8.81	9.27	9.75
	Rate of Growth (%)					
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.01	0.01	0.01	0.01	0.01
	Anna Regina Electricity Demand (GWh)	7.92	8.37	8.82	9.28	9.76
	Peak Demand (MW)	1.65	1.74	1.84	1.93	2.03
	Rate of Growth (%)					
	Load Factor	0.55	0.55	0.55	0.55	0.55
Wakenaam	Gross Generation (GWh)	8.89	9.40	9.93	10.46	11.01
	Rate of Growth (%)					
	Expected Energy Not Served (%)	0.1%	0.1%	0.1%	0.1%	0.1%
	Expected Energy Not Served (GWh)	0.01	0.01	0.01	0.01	0.01
	Anna Regina Electricity Demand (GWh)	8.90	9.41	9.94	10.47	11.02
	Peak Demand (MW)	1.60	1.69	1.79	1.88	1.98
	Rate of Growth (%)					
	Load Factor	0.63	0.63	0.63	0.63	0.63

Appendix B: Tables

Table B1: Breakdown of available generation capacity by fuel type

Fuel Type	Demerara	Berbice	Total DBIS	Anna Regina	Wakenaam	Leguan	Bartica	Total Isolated	Total GPL
MWs of HFO	155.9	19.0	174.9	5.40	-	-	-	5.4	180.3

MWs of LFO	12.3	21.4	33.7	6.70	1.06	0.82	4.96	13.5	47.2
MWs of Biomass	-	-	-	-	-	-	-	-	-
Total Available Capacity (MW)	168.2	40.4	208.6	12.10	1.06	0.82	4.96	18.9	227.5
Fuel Type	Demerara	Berbice	Total DBIS	Anna Regina	Wakenaam	Leguan	Bartica	Total Isolated	Total GPL
% of HFO	92.7%	47.0%	83.8%	44.6%	0.0%	0.0%	0.0%	28.5%	79.2%
% of LFO	7.3%	53.0%	16.2%	55.4%	100.0%	100.0%	100.0%	71.5%	20.8%
% of Biomass ⁴	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table B10: 5-Year Energy Demand and Peak Power Forecasts for all GPL systems

System	Description	Unit	2021	2022	2023	2024	2025	2026
All GPL	Electricity Demand	GWh	988.9	1,256.9	1,590.8	2,033.1	2,732.8	3,299.7
All GPL	Peak Power	MW	147.4	196.6	249.5	304.3	428.1	501.6
DBIS	Electricity Demand	GWh	937.9	1,195.5	1,516.7	1,942.8	2,617.6	3,164.8
DBIS	Peak Power	MW	138.8	185.8	236.4	288.8	407.4	478.0
Anna Regina	Electricity Demand	GWh	34.2	41.6	50.6	62.5	81.1	96.4
Anna Regina	Peak Power	MW	6.0	7.5	9.2	10.9	14.7	17.1
Bartica	Electricity Demand	GWh	13.1	15.5	18.3	21.6	26.2	29.4
Bartica	Peak Power	MW	2.1	2.5	3.0	3.4	4.2	4.7
Leguan	Electricity Demand	GWh	1.9	2.2	2.6	3.2	4.0	4.6
Leguan	Peak Power	MW	0.4	0.5	0.6	0.6	0.8	1.0
Wakenaam	Electricity Demand	GWh	1.8	2.2	2.6	3.1	3.9	4.5
Wakenaam	Peak Power	MW	0.3	0.4	0.5	0.6	0.7	0.8

Table B3: Customer growth

Year	2021	2022	2023	2024	2025	2026
No. of Existing Customers	210,732					
Total New Services (CH&PA + Other Potential Customers)		5,368	7,052	8,736	10,420	12,103
No. of Unserved Beneficiaries		1,945	4,611	306	-	-
Total No. of Projected Customers	210,732	218,045	229,708	238,749	249,169	261,272

Table B11: Summary of Solar Irradiation Performance (source: Global Solar Atlas)

⁴ At Skeldon there is 30 MW Biomass Plant. At the time of composing this TOR, the facility is out of service with an unknown date of return to operation.

Specific photovoltaic power output	PVOUT specific	4.412	kWh/kWp per day ▾
Direct normal irradiation	DNI	4.497	kWh/m ² per day ▾
Global horizontal irradiation	GHI	5.515	kWh/m ² per day ▾
Diffuse horizontal irradiation	DIF	2.323	kWh/m ² per day ▾
Global tilted irradiation at optimum angle	GTI opta	5.563	kWh/m ² per day ▾
Optimum tilt of PV modules	OPTA	8 / 180	°
Air temperature	TEMP	26.3	°C ▾
Terrain elevation	ELE	3	m ▾

Table B12: Mean wind speed at 10 m and 15 m hub height (Location: Lat: 6.82008° and Long: -58.150635°) (source: *renewable energy ninja*)

Months	Mean Wind Speed (m/s)	
	10 m hub height	hub height (m/s)
Jan	2.3	3.1
Feb	2.4	3.3
Mar	2.4	3.2
Apr	2.4	3.2
May	2.3	3.1
Jun	2.0	2.7
Jul	1.7	2.3
Aug	1.7	2.3
Sep	1.8	2.4
Oct	1.8	2.4
Nov	1.9	2.6
Dec	2.3	3.1