IDB Inter-American Development Bank

# REQUEST FOR EXPRESSIONS OF INTEREST
# CONSULTING SERVICES

*Selection # as assigned by e-Tool: GY-T1167-P004*
*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 TO DETERMINE THE RENEWABLE ENERGY HOSTING CAPACITY LIMITS IN GPL'S DISTRIBUTION SYSTEM AND DEVELOPMENT OF A DISTRIBUTION CODE FOR GUYANA*

*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: *September 26, 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 modernisation (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 end of April 2023.*

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 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.*

Inter-American Development Bank
Division: *ENE/GY*
Attn: *Lenin Balza and Malaika Masson, Program Team Leaders*

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## Annex A: Terms of Reference

### TERMS OF REFERENCE

*CONSULTANCY TO DETERMINE THE RENEWABLE ENERGY HOSTING CAPACITY LIMITS IN GPL'S DISTRIBUTION SYSTEM AND DEVELOPMENT OF A DISTRIBUTION CODE FOR GUYANA*

**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, when the penetration level of renewable energy is low. Nevertheless, many countries have taken a prudent and necessary 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 2030. The electricity generation plans to achieve these emission reduction targets are centred around a combined use of natural gas, hydropower, and utility and distributed scale of 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 Guyana's Low Carbon Development Strategy[1].

**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. The Isolated Power Systems are located 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, however, their economic life is typically 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 volage 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 354.8 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

**1.11.** Table B10 Table B2).

Appendix A (page 13) has further technical details on demand forecast.

**1.12.** 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), self-generators becoming grid connected and providing electricity service to all existing un-served areas.

**1.13.** 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**

**1.14.** For the arbitrarily chosen location shown in Figure 1 (Lat: 6.82008° and Long: -58.150635°), the Global Horizontal Irradiation of 5.515 kWh/$m^2$ per day (Table B11) indicates that solar energy systems in Guyana are exceptionally productive and feasible for further uptake.

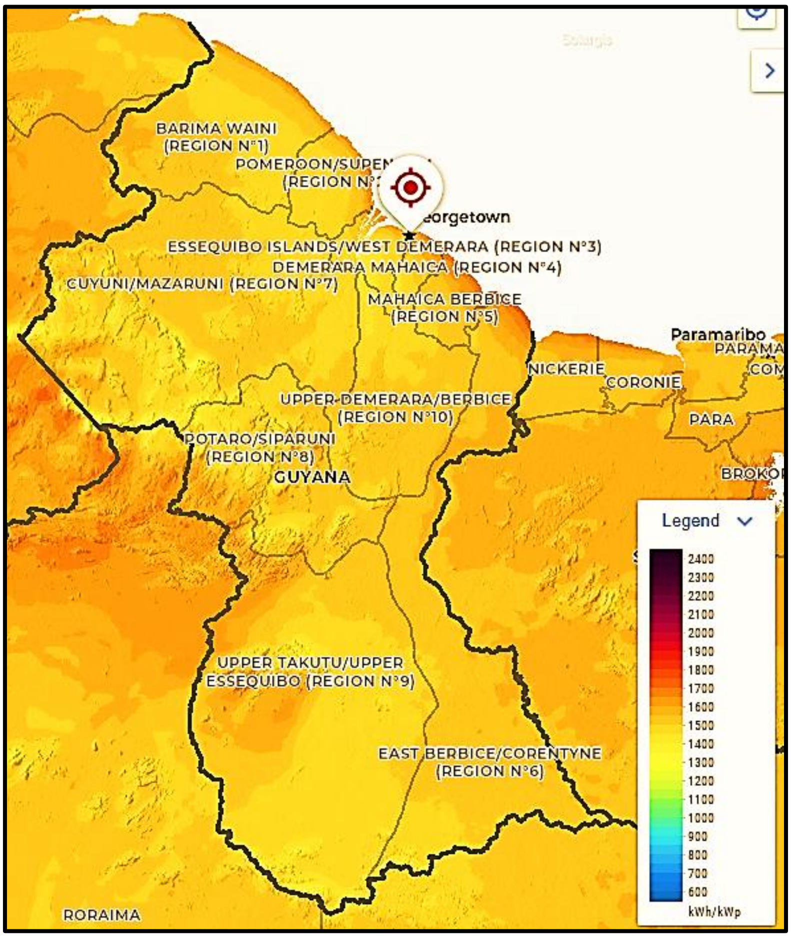


Figure 1: Guyana Global Horizontal Irradiation Solar Atlas (*source: Global Solar Atlas*)

**High-level Wind Resource Assessment – Small wind turbines**

**1.15.** 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**

**1.16.** 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 Low Carbon Development Strategy-2030 (LCDS) is the encouragement of distributed renewable energy systems – grid-tie solar PV systems.

**1.17.** The cost to install solar PV energy systems has declined over the years[2], and as per projections, the cost is expected to decrease further[3]. However, many of GPL's customers cannot afford the present and near future CapEx of solar PV systems. A Feed-in Tariff (FIT)[4] can be considered a significant revenue stream for the present and future grid-tie customers. As a result, credits for electricity export combined with the avoided cost for the self-supply should provide customers with adequate return on investment and promote the development of distributed renewable energy system resources.

[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/
[4] The FIT will compensate customers for the energy delivered to the grid considering the avoided cost of production of the energy that would otherwise be necessary to supply the load.

GPL is currently developing the Feed-In-Tariff 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
3. To facilitate energy sector investments while ensuring transparency, safety, sustainability, continuity, and reliability of electricity supply.

Salient interim characteristics of the Feed-In-Tariff 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 FIT Programme and be compensated for the excess solar energy exported to the grid. In addition, the FIT 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 system to facilitate the FIT 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.
7. GPL will define the rules for the determination of the FIT and publish the actual values to be used for compensation of energy injected periodically and at least at the same time that electricity rates are updated.

**DERs in the Existing Distribution Systems**

**1.18.** 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 current 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.

**1.19.** 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 may 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, unless properly designed and modernised to operate under this condition. These problems include but are not limited to the following:

1. Overloading of the distribution infrastructure (lines, cables, transformers, etc.);
2. Steady-state and transient overvoltage conditions on the distribution feeders that of allowed to persist would damage equipment and trip generation;
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 equipment and customers that may result in 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;

**1.20.** There is great interest in grid modernisation (smart grid deployment) to assist in accommodating intermittent renewable energy systems into the grid; however, Technical Assistance (TA) is required to assess the current technical penetration limits and reinforcement methods to extend the limits without exceeding grid thermal, voltage and 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.

**1.21.** 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 determine the maximum technical and economic penetration limits of intermittent renewable energy resources with and without the coupling of storage either at the customer level (behind the meter - BTM) or utility;
2. To guarantee the defined maximum technical and economic hosting capacity limits take into consideration, at minimum, the fifteen (15) issues highlighted in section 1.18, pages 4-5;
3. To develop a distribution code for full compliance with Smart Grid requirements for primary and secondary distribution systems, which shall include, but limited to:
   a. Distribution Planning & Distribution Resources Interconnection Connection Codes
   b. Distribution Operation Code
   c. Construction and Maintenance Code
   d. Distribution Metering Code
4. To provide in-person training workshop(s) covering the scope of work completed in this study and the development of the Distribution Code.

## 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. GPL will also provide a forecast of expected utility scale renewable generation and conventional generation to be considered in the study.

**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 and GPL as a whole 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. All elements at the feeder, transmission, and generation are maintained within their nominal ratings;

III. There is adequate protection coordination; including verifying on the selected feeders that fault currents are maintained within the range determined by overcurrent protection devices for adequate sensitivity and coordination (see 3.6 and 3.7 below);

IV. Short-circuit level of breakers/reclosers at the transmission, distribution and power plant level are not exceeded (see 3.4 and 3.5 below); and

**3.3.** Thermal plants operate withing their technical limits (minimum down time, minimum up time, number of starts, maximum / maximum output, ramp rates), there is not excessive renewable curtailment and operating costs are minimized (see 3.8 and 3.9 below). 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, including distributed and utility scale storage, 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. The consultant shall also make recommendations for a system protection scheme to increase system security and avoid major blackouts.

**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 (e.g., storage additions) 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 FIT 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 $CO_2$ emission for GPL; and
3. Financial benefits based on increased operational flexibility imposed by the scenarios including the integration storage.

**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 and GPL as a whole over 10 years and for high-level penetration over 20 years.

**3.12.** The Consultant shall develop a contextualized and holistic distribution code in support of distributed energy resources and a full-fledge distribution Smart Grid to enhance efficiency, reliability, and quality of electricity service.

**3.13.** The distribution code shall encapsulate all technical and procedural requirements necessary for distribution systems having high levels of penetration of intermittent renewable energy systems and a full-fledge Smart Grid. Further, the distribution code shall integrate the already existing Net Billing policies seamlessly.

**3.14.** The distribution code shall guarantee that the collective capacity of distributed energy resources never attempts to adjust, influence, or regulate the transmission grid operations' parameters, such as voltage and/or frequency beyond the limits specified by the National Grid Code.

The Consultant shall address objectives no. 3, having a primary focus:

1. To allow for development, maintenance, and operation of an efficient, coordinated, and economical system.
2. To review information to be provided by all potential prosumers and format(s);
3. To define the technical & design criteria, procedures to be followed in planning and development of the primary and secondary distribution systems.
4. To describe in full details, the connection requirements specifying the technical, design & operational criteria to be complied with by all prosumers connected to or seeking to be connected to the levels of the distribution system. All interconnection requirements shall be Smart Grid compliant.
5. To outline standard industry operating practices and, technical and safety guidelines governing the development, operation, and maintenance of an effective and well-coordinated primary and secondary distribution systems, all within the context of a full-fledge SMART grid – up to the customer's/prosumer's meter interface, inclusive of the grid tie inverters.
6. To elaborate the construction and maintenance guidelines of the primary and secondary distribution systems operating within a full-fledge Smart Grid environment
7. To specify the standards to be met, in view of Smart Metering:
    a. in the provision, location, installation, operation, and maintenance of metering and data systems
    b. by those bounded by this code:
        i. in relation to all matters associated with the metering systems
        ii. ownership and management of metering systems and meters and the provision of use of meter and metering data; and
        iii. storage of metered data.
8. To define the DER system installation capacity limits at customer utilisation and 13.8 kV primary distribution voltage levels.
9. 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

10. To advise, from an operational perspective, communication requirements with and without Smart Grid, voltage and frequency control, automatic connections/disconnections;

**3.15.** 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 distributed 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 aims to equip GPL to conduct benefit-cost analyses of new scenarios.

**3.16.** **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.

**<u>Key Activities</u>**

**4** 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 Objectives of Consultancy (see section 2, page 5)

**c.** Preparation of Distribution Code addressing item no.3 of the Objectives of Consultancy (see section 2, page 5)

**4.1 Expected Outcome and Deliverables**

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 objectives 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) calendar days for both reports.**

b. Preparation of Draft Report addressing item nos. I and 2 of the Objectives of Consultancy

- **Deliverables – Draft Report: Grid Impact Studies**
- **Duration – allow Forty (40) calendar days for the Consultant to prepare the draft report and a total of seven (7) calendar days for the Client's review and acceptance of results.**

c. Preparation Distribution Code addressing item no. 3 of the Objectives of Consultancy

- **Deliverables – Draft of Distribution Code.**

- **Duration – allow Thirty-five (35) calendar days for the Consultant to prepare the draft report and a total of Fourteen (14) calendar days for the Client's review and acceptance of contents.**

**4. <u>Project Schedule and Milestones</u>**

i. Summary Report of Kick-Off Meeting & Data Request Schedule.
Duration – allow a total of five (5) calendar days for both reports.

ii. Deliverables – Draft Report: Grid Impact Studies
Duration – allow Forty (40) calendar days for the Consultant to prepare the draft report and a total of Seven (7) calendar days for the Client's review and acceptance of results.

iii. Deliverables – Draft of Distribution Code.
Duration – allow Thirty-five (35) calendar days for the Consultant to prepare the draft report and a total of Fourteen (14) calendar days for the Client's review and

iv. Final Report incorporating the Grid Impact Studies and Distribution Code.
Duration – allow ten (10) calendar days for the Consultant to prepare the Final reports and a total of seven (7) calendar days for the Client's review and acceptance of the Reports.

**5. <u>Reporting Requirements</u>**

**5.1.** *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 Distribution Code; and (iv) Final Report incorporating the Grid Impact Studies and Distribution Code. All reports must be in English.

**6. <u>Acceptance Criteria</u>**

**6.1.** *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.*

**7. Key Personnel**

The Consultant team must comprise the following Key Experts:

1. **Project Manager**:
   (a) Minimum of 20 years of working experience in project management consultancy for grid integration studies of renewable energy resources and development of power system standards and grid codes.
   (b) Master's Degree in the relevant engineering discipline.
2. **System Studies Specialist (Renewable Energy Engineering):**
   (a) Minimum of 15 years of working experience in conducting electric power system studies, distributed renewable energy resources interconnection studies and production cost modelling.
   (b) Master's Degree in Electrical or Renewable Energy Engineering or its equivalent.
3. **Power System Protection Engineer:**
   (a) Minimum of 15 years of working experience in power system protection coordination in utility transmission and distribution systems.
   (b) Master's Degree in electrical or Power Systems Protection Engineering or its equivalent.

The Consultant team shall also include Non-Key Experts with suitable qualifications and experience for their proposed roles including the ability to conduct training.

In addition, all Candidates **<u>MUST</u>** have the following:

(a) Substantial experience analysing projects of a similar nature. Previous project experience in developing countries, particularly the Caribbean region and specifically Guyana, will be advantageous.

(b) Experience developing Grid Codes for Countries in the Caribbean Region and particularly for power systems that are technically similar to the Power Systems in Guyana.

(c) Significant involvement in undertaking power grid stability, load flow and renewable energy integration studies, utilising standard industry software packages such as PSSE, PSS Sincal and Plexos. Adequate experience in intermittent renewable energy dispatching and institutional arrangements for dispatch and control centres.

(d) Excellent command of the English language (both written and oral forms) is strongly required to successfully complete this project. No exceptions through translation would be allowed.

## 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** | |
|---|---|
| ***Deliverable*** | **%** |
| 1. *Summary Report of Kick-Off Meeting & Data Request Schedule.* | 10% |
| 2. *Deliverables – Draft Report: Grid Impact Studies* | 50% |
| 3. *Draft of Distribution Code.* | 30% |
| 4. *Final Report incorporating the Grid Impact Studies and Technical Requirements documents.* | 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 4and 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

| | *select from list* | *GWh values unless stated otherwise* | 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** |
| | | *Energy Not served Factor (%)* | *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 |
| | | *Energy Efficiency factor (% of Total Demand)* | *2.4%* | *2.6%* | *3.1%* | *3.5%* | *4.1%* | *4.7%* | *4.9%* |
| | | *Potential Impact of EE measures* | (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** |
| | | *of which Commercial* | *211.05* | *192.44* | *250.48* | *329.90* | *432.84* | *605.41* | *757.38* |
| | | *Residential* | *139.03* | *177.31* | *228.22* | *290.60* | *368.15* | *494.38* | *599.03* |
| | | *Industrial* | *276.18* | *351.01* | *449.01* | *570.49* | *739.37* | *995.05* | *1,205.75* |
| | | Demand category factors (%) | | | | | | | |
| | | *Commercial* | 33.7% | 26.7% | 27.0% | 27.7% | 28.1% | 28.9% | 29.6% |
| | | *Residential* | 22.2% | 24.6% | 24.6% | 24.4% | 23.9% | 23.6% | 23.4% |
| | | *Industrial* | 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

| | *select from list* | *GWh values unless stated otherwise* | 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** |
| | | *Energy Not served Factor (%)* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* |
| | | Estimated Energy Not served | 0.09 | 0.10 | 0.10 | 0.11 | 0.11 |
| | | *Energy Efficiency factor (% of Total Demand)* | *5.1%* | *5.3%* | *5.6%* | *5.8%* | *6.0%* |
| | | *Potential Impact of EE measures* | (217.75) | (282.23) | (333.19) | (392.54) | (443.00) |
| | | 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** |
| | | *of which Commercial* | *967.31* | *1,234.88* | *1,438.30* | *1,669.15* | *1,895.60* |
| | | *Residential* | *741.32* | *917.36* | *1,036.09* | *1,166.33* | *1,280.22* |
| | | *Industrial* | *1,492.25* | *1,846.71* | *2,085.86* | *2,348.21* | *2,575.39* |
| | | Demand category factors (%) | | | | | |
| | | *Commercial* | 30.2% | 30.9% | 31.5% | 32.2% | 33.0% |
| | | *Residential* | 23.2% | 22.9% | 22.7% | 22.5% | 22.3% |
| | | *Industrial* | 46.6% | 46.2% | 45.7% | 45.3% | 44.8% |
| | | 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

| | *select from list* | *GWh values unless stated otherwise* | 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** |
| | | *Energy Not served Factor (%)* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* |
| | | Estimated Energy Not served | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| | | *Energy Efficiency factor (% of Total Demand)* | *6.1%* | *6.2%* | *6.3%* | *6.5%* | *6.6%* |
| | | *Potential Impact of EE measures* | (492.54) | (546.76) | (605.00) | (667.66) | (735.14) |
| | | 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** |
| | | *of which Commercial* | *2,140.39* | *2,406.14* | *2,689.64* | *2,990.28* | *3,238.96* |
| | | *Residential* | *1,397.73* | *1,519.89* | *1,644.01* | *1,769.25* | *1,916.39* |
| | | *Industrial* | *2,809.43* | *3,052.33* | *3,298.71* | *3,546.80* | *3,841.77* |
| | | Demand category factors (%) | | | | | |
| | | *Commercial* | 33.7% | 34.5% | 35.2% | 36.0% | 36.0% |
| | | *Residential* | 22.0% | 21.8% | 21.5% | 21.3% | 21.3% |
| | | *Industrial* | 44.3% | 43.7% | 43.2% | 42.7% | 42.7% |
| | | 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 WIT | | | | | |
|---|---|---|---|---|---|---|---|
| | *select from list* | *GWh values unless stated otherwise* | 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** |
| | | *Energy Not served Factor (%)* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* |
| | | Estimated Energy Not served | 0.13 | 0.13 | 0.13 | 0.13 | 0.14 |
| | | *Energy Efficiency factor (% of Total Demand)* | *6.8%* | *7.0%* | *7.2%* | *7.4%* | *7.4%* |
| | | *Potential Impact of EE measures* | (807.87) | (886.32) | (970.99) | (1,062.43) | (1,125.76) |
| | | 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** |
| | | *of which Commercial* | *3,495.21* | *3,758.98* | *4,030.19* | *4,289.77* | *4,550.94* |
| | | *Residential* | *2,068.00* | *2,224.06* | *2,384.53* | *2,538.12* | *2,692.64* |
| | | *Industrial* | *4,145.71* | *4,458.56* | *4,780.25* | *5,088.15* | *5,397.92* |
| | | Demand category factors (%) | | | | | |
| | | *Commercial* | 36.0% | 36.0% | 36.0% | 36.0% | 36.0% |
| | | *Residential* | 21.3% | 21.3% | 21.3% | 21.3% | 21.3% |
| | | *Industrial* | 42.7% | 42.7% | 42.7% | 42.7% | 42.7% |
| | | 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

| | *select from list* | *GWh values unless stated otherwise* | 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** |
| | | *Energy Not served Factor (%)* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* |
| | | Estimated Energy Not served | 0.15 | 0.15 | 0.16 | 0.17 | 0.18 | 0.19 | 0.20 | 0.21 | 0.22 |
| | | *Energy Efficiency factor (% of Total Demand)* | *7.4%* | *7.4%* | *7.4%* | *7.4%* | *7.4%* | *7.4%* | *7.4%* | *7.4%* | *7.4%* |
| | | *Potential Impact of EE measures* | (1,190.30) | (1,256.04) | (1,322.99) | (1,391.14) | (1,460.50) | (1,531.07) | (1,602.84) | (1,675.82) | (1,750.00) |
| | | 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** |
| | | *of which Commercial* | *4,812.31* | *5,078.66* | *5,350.01* | *5,626.35* | *5,907.72* | *6,194.14* | *6,485.61* | *6,782.18* | *7,083.87* |
| | | *Residential* | *2,847.28* | *3,004.88* | *3,165.42* | *3,328.93* | *3,495.40* | *3,664.86* | *3,837.32* | *4,012.79* | *4,191.29* |
| | | *Industrial* | *5,707.94* | *6,023.86* | *6,345.70* | *6,673.48* | *7,007.22* | *7,346.93* | *7,692.66* | *8,044.42* | *8,402.25* |
| | | Demand category factors (%) | | | | | | | | | |
| | | *Commercial* | 36.0% | 36.0% | 36.0% | 36.0% | 36.0% | 36.0% | 36.0% | 36.0% | 36.0% |
| | | *Residential* | 21.3% | 21.3% | 21.3% | 21.3% | 21.3% | 21.3% | 21.3% | 21.3% | 21.3% |
| | | *Industrial* | 42.7% | 42.7% | 42.7% | 42.7% | 42.7% | 42.7% | 42.7% | 42.7% | 42.7% |
| | | 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

| | *GWh values unless stated otherwise* | 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

| | *GWh values unless stated otherwise* | 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

| | *GWh values unless stated otherwise* | 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

| | *GWh values unless stated otherwise* | 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[5] | 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 |

[5] 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.

| 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*)

| | | | |
|---|---|---|---|
| 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 |