Terms of Reference

DETERMINING THE RENEWABLE ENERGY HOSTING CAPACITY LIMITS IN THE DISTRIBUTION SYSTEM OF GUYANA POWER & LIGHT INC.

AND

DEVELOPMENTOF DISTRIBUTION CODES FOR GUYANA

November, 2025

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1. Background and Justification

1.1 As renewable energy sources continue to occupy a growing share of the electricity generated and consumed, the challenges to grid stability, security, reliability, quality of electricity supply and associated system risks associated with the intermittent and unpredictable output of renewable energy systems, such as Solar PV and Wind energy, must be identified and mitigated.

1.2 Notably, with present solar photovoltaic and wind energy technologies, experiences drawn from some countries have demonstrated that grid stability can be maintained without a technical cap on hosting capacity in some power systems and at certain voltage levels. Nevertheless, other countries have taken a prudent path by establishing measures that address the planning, market design, grid regulation and management, need for advanced grid-tied inverter, and power system supervision and control technology.

1.3 For Distributed Energy Resources (DER) – intermittent renewable energy systems, international practice is that the technical and operational requirements vary depending on the capacity and voltage connection level. The capability to absorb and integrate variable solar and wind energy as distributed generation can depend significantly on the interconnection requirements for distributed energy resources and energy storage systems, which must be aligned with grid performance and national energy emission reduction targets.

1.4 Considering recent developments in Guyana's Oil and Gas Sector, the Government aims at leveraging available opportunities to achieve an aggregated 70% of carbon emissions by 2030 at the national level[1]. The electricity generation portfolio plans make significant contributions in the achievement of this emission reduction target by utilising a combination of natural gas, hydropower, and renewable energy systems at utility and distribution scale. Additionally, current 230kV and 69kV transmission line construction projects are using ACCC - Aluminium Conductor Composite Core conductor to reduce technical losses, which by extension will result in reduced carbon emissions from the collective group of generator units.

2. Background on Guyana Power & Light Inc.

2.1 Guyana Power & Light Inc. (GPL) is a vertically integrated public utility company and the premier electricity supplier in Guyana, South America. Its franchise coverage areas encompass the coastal plain, capturing 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 in the County of Essequibo.

[1] In 2021, the President of Guyana informed that its Government will work with local communities to conserve, protect and sustainably manage its forests, biodiversity and freshwater supplies, and at the same time reduce its carbon emissions by at least 70 per cent by 2030; Guyana Chronicles, November 3, 2021.

2.2 Thermal simple-cycle plants presently dominate electricity generation using reciprocating engine-driven generators that utilize Heavy and Light fossil fuels (HFO and LFO). GPL's aggregated electric power system has 15 power plants, where 226.93 MW is available capacity. The aggregated installed capacity includes the eleven (11) power plants in the DBIS and four (4) in Essequibo County.

2.3 The Transmission and Distribution section of GPL's electric power system comprises four main voltage levels; 230 kV and 69 kV for bulk power transfer, 13.8 kV for primary power distribution and lower utilisation voltages for customer-specific applications.

2.4 GPL's present transmission and distribution systems result in an electricity supply coverage of approximately 99.5% and comprises the following:

1. The transmission and sub-transmission voltage level of 230 kV and 69 kV respectively is currently present only in the DBIS and has a total length of 24 km and 330.77 km, respectively.
2. Forty-Two (42) primary 13.8 kV distribution feeders actively serving loads, having a total estimated length of 969 km in the DBIS; and
3. Ten (10) primary 13.8kV distribution feeders actively serving loads, having a total estimated length of 149.68 km in the aggregated Isolated Power Systems. A disaggregation of the Isolated Systems is presented below:
    a Anna Regina – 897.01 km.
    b Wakenaam – 28.8 km.
    c Leguan – 21.19 km.
    d Bartica – 120.64 km.

2.5 GPL forecast energy demand growth of 2,508 GWh for all GPL Systems, from year 2025 to 2030, representing a significant increase of 171%. DBIS, which accounts for over 95% of GPL's system demand, is forecast an energy demand growth of 2,397 GWh or 172% for the same period.

2.6 This projection is based on the expected stimulation from the present Oil and Gas Industry's economy. GPL projects an increase in its customer base from 232,823 in 2024 to potentially 279,803 by the end of 2029. The projected customer base is primarily due to the increased economic activities expected from population growth, increased business activities (commercial and industrial), national residential housing programmes and self-generators migrating to the grid.

2.7 At present, the most competitive and abundant renewable energy sources in Guyana include solar, hydropower, wind, biomass, and municipal solid waste. GPL does not consider energy from hydropower, large scale solar PV and wind systems, biomass and municipal solid waste as distributed energy resources.

3. High-level Solar Resource Assessment

3.1 For the arbitrarily chosen location shown in Figure 1 (Lat: 6.82008° and Long: 58.150635°), the Global Horizontal Irradiation of 5.407 kWh/m2 per day indicates that solar energy systems in Guyana are productive and feasible for further uptake.

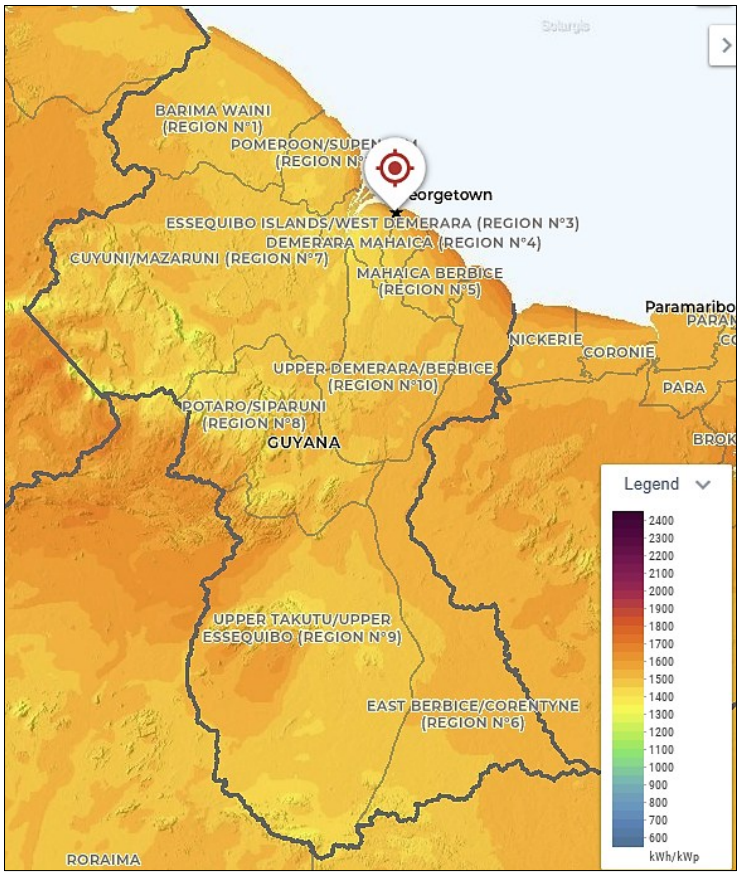

Figure 1: Guyana Global Horizontal Irradiation Solar Atlas (*source: Global Solar Atlas*)

4. High-level Wind Resource Assessment – Small wind turbines

4.1 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 annual average mean wind speeds in Guyana of 2 m/s[1] to 2.8 m/s[2] indicate that wind energy systems have a lower consumer adoption probability. Consequently, in Guyana there is considerable scope for developing small to large scale grid-connected solar energy systems compared to wind.

[1] At 10 m hub height, referencing mean seal-level.
[2] At 15 m hub height, referencing mean seal-level.

5. Distributed Energy Resource

5.1 The total installed grid-tied solar PV systems across the aggregated GPL Power System to date is 9.451 MWac, representing a total of 338 grid-tied customers. It is expected that the uptake of grid-tied solar PV systems will further increase as the acquisition and installation costs continue to decrease. Among the many emission reduction strategies mentioned in the Low Carbon Development Strategy (LCDS) 2030, distributed renewable energy systems – grid-tied solar PV systems are encouraged.

5.2 The cost to install solar PV energy systems has declined over the years[1], and per projections, the cost is expected to decrease further[2]. However, many of GPL's customers cannot currently, and in the near future, may not be able to afford to invest in solar PV systems. A Feed-in Tariff, through a Net Billing Programme (NBP), is viewed as a significant revenue stream for the current and future grid-tied customers. As a result, credits for electricity export to the grid could help reimburse investment costs and provide an additional revenue stream for the owners of distributed scale renewable energy system.

5.3 The Net Billing Programme was introduced in Q3 of 2022 with the following objectives:

1. To increase the contribution of renewable energy in the national energy supply mix;
2. To provide grid-tied customers with a framework for renewable energy investments; and
3. To facilitate energy sector investments, while ensuring transparency, safety, sustainability, continuity, and increase reliability of electricity supply.

5.4 Salient interim characteristics of the Net Billing Programme are:

1. GPL customers with renewable systems up to 1,500 kW are eligible for grid interconnection under the Net Billing Programme. (Larger installations (categorised as Independent Power Producers - IPP's) are outside the programme and 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 1,500 kW shall be grid tied at the primary distribution level, 13.8 kV, through a dedicated voltage step-up transformer.
3. Customers' Renewable Energy Systems must be certified by the Government Electrical Inspectorate Department (GEI) to participate in the

[1] https://www.nrel.gov/news/program/2021/documenting-a-decade-of-cost-declines-for-pv-systems.html
[2] https://rameznaam.com/2020/05/14/solars-future-is-insanely-cheap-2020/

Net Billing Programme. Once certified and connected (grid-tied), the customer shall qualify for the Net Billing Programme, which will provide compensation for the excess electricity exported to the electric grid.

4. GPL will install the appropriate bi-directional metering systems to facilitate the Net Billing Programme. This metering system records the electricity consumed and exported by the grid-tied customer.
5. All inverters or electric power devices interconnecting with GPL's grid shall comply with GPL's technical guidelines, in keeping with the IEEE 1547 and UL 1741 Standards.

5.5 GPL and IRENA collaboratively developed and launched the SolarCity Simulator on GPL's website, as an enabling tool to the Net Billing Programme. This tool, with default data based on consultation, allows potential prosumers within the Capital City, Georgetown, to define the relevant technical and financial parameters of a solar rooftop system and to ascertain an estimated value of return on investment, amongst other results of interest. Though the SolarCity Simulator presently captures Georgetown only, its versality and flexibility also allow potential prosumers of other locations in Guyana to benefit equally.

6. DERs in the Existing Distribution Systems

6.1 For the purposes of this document, a Distributed Energy Resource (DER) is a small-scale unit of power generation that generates and exports electricity at the primary (13.8 kV) or secondary distribution voltage levels (240/120 V). DERs can include grid-tied PV solar, small wind energy systems and electric vehicles.

6.2 The present distribution systems in Guyana are designed and operated in the classical regime i.e. electricity flows in one direction, from the substation to customer interconnection points on the feeders/circuits. With the current number of grid-tied customers, GPL has not observed reverse power flow at the substation level or any negative impacts on either power systems to date.

6.3 Notwithstanding the above, the expected increase in DER penetration level will increase the aggregated intermittent electricity injected into the grid. This increase could offset local demand on some respective primary distribution feeders during daylight hours and may result in intermittent reverse power flow i.e. power flowing into the substation at the primary distribution level, stepped-up and then into the 69 kV transmission grid, and perhaps into the 230 kV, resulting in operational issues.

6.4 There is a need to establish interconnection requirements for DER, residential and utility battery energy storage systems, and other distribution system reinforcements to avoid negative impact, such as to address potential issues:

1. Exhaustion of thermal ratings of existing distribution infrastructure (lines, cables, transformers, fuses, switches, etc.).

2. Steady-state and transient overvoltage conditions on the distribution feeders adversely impacting conventional generator outputs and resulting in tripping of units.
3. Degradation of Power Quality – voltage fluctuations, flickering and harmonics.
4. Increased fault level, potentially breaching the short-circuit withstand rating of existing equipment.
5. Protection relay desensitisation and potential breach of protection relay coordination and selectivity.
6. Malfunction of protection relays or damages to switches resulting in islanding.
7. Interference in the operation of automatic voltage regulators and capacitor banks.
8. Conflicting voltage regulation objectives – transformer tap-position during daylight hours and nights.
9. Incorrect operation of control equipment resulting in 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.
10. Inefficient loading of conventional generators resulting in increasing generation operation costs.
11. Unnecessary and uneconomic energy curtailment either on the utility or the grid-tied customer side.
12. Adversely impact the available spinning up and spinning down reserve, resulting in grid instability and reducing grid security.
13. Increase ancillary power system operational cost.
14. Complicates the operation of the Smart Grid Scheme/Smart Equipment across all voltage levels.

6.5 There is great interest in grid modernisation (smart grid deployment) to assist in accommodating intermittent renewable energy systems into the grid; however, there is a need to assess the current technical penetration limits and reinforcement methods to extend these limits without exceeding the grid stability limit, in order to achieve the emission and other energy-related goals of the LCDS-2030.

6.6 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 effort will provide the timely assistance and support to GPL's desired alignment with the LCDS-2030 and other stakeholders within Guyana's Energy Sector.

7. Objectives

7.1 The objectives of this engagement are as follows:

1. To develop appropriate Distribution Interconnection, Operation and Metering Codes that supports the increase of intermittent renewable energy from Distributed Energy Resources (DER) to satisfy the emission reduction targets and renewable energy goals of the LCDS and beyond, without deteriorating the stability, reliability, power quality and security of the power system.
2. To conduct detailed quantitative analyses to ascertain the impact, capability and hosting capacity limits of the distribution systems to interconnect additional intermittent renewable energy resources.
    a. Study shall take into account the already existing DER and Utility-scale renewable energy systems, as well as committed Utility-scale renewable energy systems.
    b. Further, the study shall include the relevant technical and economic assessments to ascertain the aggregated impact of DER and Utility-scale renewable energy systems at the 230kV and 69kV voltage levels, inform of potential adverse impacts/outcomes and required mitigation measures to safeguard the stability and integrity of power grid, ensuring power quality remains within the limits of standard utility practices to support a modern economy.
3. To identify, define and produce mitigation solutions that address the technical and economic constraints of achieving a stable and reliable power system and emission reduction targets, while delivering quality and affordable electric services to all customers.
    a. Mitigation solutions shall be in alignment with the quantitative results obtained from Objective No. 2 and not limited to the distribution level.
    b. Ensure mitigation solutions amongst other relevant details are aligned with the developed Distribution Codes.
4. To revise, where applicable, the National Grid Codes and ensure that there is alignment and synergy with the Distribution Codes.
5. To develop a Data Protection Policy and Dispute Resolution Mechanism for DER customer.
    a. Documents to be aligned with applicable Laws and Acts of Guyana.

6. To develop a cost-effective scheme that advice the need for residential/ prosumers BESS and utility-scale BESS at the distribution level and sub-transmission level.
7. To advise the necessary distribution infrastructure, equipment and systems upgrades that support the increased use of intermittent renewable energy in a modern and resilient distribution power system.
8. To develop an appropriate mechanism to determine the requisite compensation to grid-tied customers.
9. To define the functional requirement specifications of an appropriate Distribution Energy Resource Management System (DERMS) for the Guyana National Control Centre and the technical specifications of the necessary equipment and communication infrastructure for seamless integration.
10. To provide capacity building to relevant GPL staff, by including its engineers on the description, methodology, and model building of all studies, and development of codes and procedures.

GPL will work with the Guyana Energy Agency in implementing this project. All approvals will be a collaborative effort between the agencies for successful implementation.

8. Scope of Tasks

8.1 To achieve the objectives, the Consultant will be responsible to complete the following tasks:

Task 1: Detailed Quantitative Analyses – Grid Planning and Impact Studies

1.1 Model, develop scenarios of DER penetration levels, and carry out a comprehensive grid impact study assessment. Details and expected scope of the study are provided in Annex B.

1.2 Consistent with the draft Distribution Interconnection and Operation Code for DER, the studies scenarios and results shall guarantee compliance with the transmission grid operations' parameters, such as voltage and/or frequency limits specified by the National Grid Code.

Deliverable of Task No. 1

1.1 Detailed Report of Models, Assessments, Results, Observations and Findings, and Recommendations.

Task No. 2: Development of Distribution Codes

1.2 Develop a Distribution Codes to address Objective Nos. 1, comprising all requirements and procedures for the interconnection, operation and metering of intermittent renewable Distributed Energy Resources (DER) to the distribution systems of GPL, differentiating requirements and procedures by capacity and

voltage level, based on relevant international practices and creating predictability, and to protect the safety, stability, reliability and quality of distribution services and all GPL customers.

1.3 The Consultant shall draft the code covering at least the scope described in Annex A, and in particular the followings:

a. The Distribution Interconnection Code shall include all technical, safety and procedural requirements, including standard contracts and agreements, considering prevailing conditions of GPL systems and amendments to procedures, as well as relevant standards and guidelines defined in the National Grid Code. The code will also cover the information, equipment (e.g. Metering) that will be provided by GPL, and clarify the limit of responsibilities between GPL and the DER. Limit in this case is referred to technical and administrative responsibilities and shall be consistent with the Electricity Sector Reform Act (ESRA).

b. The distribution interconnection code, where applicable, shall integrate the existing Net Billing policies seamlessly.

c. Ensure consistency with the prevailing legal framework and harmonize with the National Grid Code. If amendments are required to the National Grid Code, these should be identified and justified explicitly by the Consultant.

d. The Operation Code shall include all necessary procedures, protocols and standards to ensure compliance where applicable and to promote safety, grid stability and reliability, supporting the supply of quality electric services.

e. Further, the Operation Code shall define all necessary operational parameters to be monitored, recorded and transfer in accordance with, for example, IEEE 1159, IEEE 1159, for remote monitoring and supervision of DER using DERMS to manage the integrated energy systems.

f. Consultant to advice on the Metering Code for DER, taking into consideration the need to peruse and amend where necessary the Metering Code of the National Grid Code or to have a specific Metering Code for DER where all relevant subject matters as defined in the National Grid Code are included.

g. The Distribution Code shall be complimented with an applicable Dispute Resolution Mechanism that aligns with prevailing Laws, Acts and Procedures/Protocols of Guyana.

h. The Consultant shall ensure that the Distribution Codes, especially the Interconnection and Operation Codes, are aligned with the results and recommendations of the Study to be conducted in Task 2. pro

Deliverable of Task No. 2

1.4 Distribution Codes for Guyana.

Task 3: Review of GPL's Distribution Design and Construction Manuals

1.5 Revise GPL Distribution Design and Construction Manuals to:

a. Identify inconsistencies and gaps, if any, with the proposed draft Distribution Interconnection, Operation and Metering Codes for DER, and Design and Construction technical guidelines. Following the review, provide necessary amendments to obtain a resilient distribution system.

b. Provide recommendations to improve the robustness/resiliency and quality of electric services provided by the Distribution System.

Deliverable of Task No. 3

1.6 Detailed Review Report of GPL's Distribution Design and Construction Manual, with cost-effective, practical and implementable recommendations.

Task 4: Training and Workshop

1.7 **Task 4.1:** Design and deliver interactive in-persons Induction and Client Orientation – Interactive In-person training workshop early in the workplan to describe the key concepts that will be employed throughout the study and to support the key energy stakeholders, including the Public Utilities Commission (PUC) and Electricity Regulatory Advisor to the Hon. Prime Minister, to establish institutional, organizational, and regulatory frameworks for grid integration of distributed renewable energy resources.

1.8 **Task 4.2:** Final Training Workshop and Project Closeout. The purpose is to facilitate all stakeholders understanding of the associated concepts and principles incorporated in the study. A more detailed technical workshop shall follow at the end of the study and finalisation of the Distribution Codes with the aim of equipping the key technical energy stakeholders with the relevant knowledge and skillset to conduct benefit-cost analyses of new scenarios.

1.9 Consultant shall be responsible for all relevant costs of host trainings and workshops in Guyana, accommodating the total number of representatives of each key stakeholder.

Deliverable of Task No. 4

1.10 **Training Component No.1 (Task 4.1): Induction and Client Orientation - Interactive in-person Training Workshop** - key concepts that will be employed throughout the study and to support the key energy stakeholders. Consultant shall submit the Workshop Plan and Agenda at least one week in advance of the in-person session.

1.11 **Training Component No. 2 (Task 4.2):** Final In-Person Training Workshop and Project Closeout – Training Plan and Agenda. Consultant shall submit the Workshop Plan and Agenda at least three (3) week in advance of the in-person session. GPL and GEA will review and revert within one (1) week of receipt of the Training Plan and Agenda.

9. Required Software/Tools

1.12 Software modelling and simulations of Steady-State, Short-Circuit and Protection and Coordination Studies shall be performed and completed using PSS Sincal 15.1 and/or PSSE v33, where applicable.

1.13 Distribution models developed in PSS Sincal shall be geo-referenced.

1.14 Production cost modelling shall be performed using the latest version of Plexos.

1.15 These tools are extensively used by GPL engineers. During the review stages, GPL should be able to utilise the developed model(s) to explore, analyse, and compare results obtained from the study.

10. Deliverables and Indicative Timetable

1. Reports shall be delivered in Microsoft WORD format and searchable PDF. All files shall allow for inputs of comments and edits.
2. The duration of the assignment shall be six (6) consecutive months following the effective date of Contract.
3. **Indicative timetable**:
    1. **Kick-Off Meeting:** Shall be held within 2 weeks of the effective date of Contract.
    2. **Inception Report:** Shall be delivered within 2 weeks of the date of the Kick-off Meeting. GPL and GEA will review and revert within 1 week of date of submission. The Consultant shall make good the report within 4 days of receipt of reviews/comments and resubmit as final report on the 5th day.
    3. **Task No. 1: Detailed Quantitative Analyses – Grid Planning and Impact Studies**.

        The report shall include all relevant details of Models, Assessments, Results, Observations and Findings, and Recommendations.

        To be delivered within three (3) months after the Kick-Off Meeting.

        i. GPL and GEA will review and revert within 3 weeks of receipt of Report(s).

        ii. Consultant shall discuss comments with GPL and GEA and make good in final report.

Notwithstanding the stipulated delivery timeline of three (3) months, the Consultant shall submit a minimum of three (3) interim reports as soon as practicable that include the outlined details to aid the timely completion process of the report to be delivered.

4. **Task No. 2.1: Draft Distribution Codes for Guyana.**

   To be delivered within two (2) months after the date of the Kick-off Meeting.

   i. GPL and GEA will review and revert within two (2) weeks of receipt of Draft Distribution Codes for Guyana.

5. **Task No. 3:** Report Review and Amendments of GPL Distribution Design and Construction Manual.

   The review report and amendments within one (1) months after the delivery date of the Official Report – **Detailed Quantitative Analyses – Grid Planning and Impact Studies (Task 1)**.

   i. GPL will review and revert within 2 weeks of receipt of Report and Amendments.

   ii. Consultant shall discuss comments with GPL and GEA and make good in final report.

6. **Task No. 1.1: Final Report - Detailed Quantitative Analyses – Grid Planning and Impact Studies**.

   To be delivered within three (3) weeks of receipt of reviews from GPL and GEA.

   i. GPL and GEA will review and revert within 2 weeks of receipt of Final Report.

   ii. Consultant shall discuss comments with GPL and GEA and make good in final report.

7. **Task No. 2.2: Final Draft Distribution Codes for Guyana**

   To be delivered within one (1) month of receipt of reviews from GPL and GEA.

   i. GPL and GEA will review and revert within 2 weeks of receipt of Final Draft Distribution Codes for Guyana.

   ii. Consultant shall discuss comments with GPL and GEA and make good in final report.

   iii. Final Submission of the Report - **Detailed Quantitative Analyses – Grid Planning and Impact Studies**, shall be made no later than 2 weeks after receipt of reviews from GPL and GEA.

8. **Task No. 2.3: Final Distribution Codes for Guyana**

   Final submission of Distribution Codes for Guyana within 3 weeks of receipt of GPL and GEA's reviews.

9. **Task No. 4.1: Induction and Client Orientation Training and Workshop** to commence within two (2) weeks after date of the Kick-Off Meeting.

10. **Task No. 4.2: Training and Closeout Workshop** to commence within 3 weeks after Final submission of Distribution Codes for Guyana.

    All training and workshop shall be performed as in-persons sessions with the representatives of the Guyana Power & Light Inc. and Guyana Energy Agency.

4. **Project Close-out Package**: The followings shall be delivered one (1) week prior to the commencement date of the Training and Closeout Workshop via an accessible OneDrive or SharePoint URL.

   4.1 Complete Package of Final Models (software and excel spreadsheets). Recipients shall be able to have full access to and be able to edit the models for further applications.

   4.2 Complete Package of Training Materials and Presentations submitted as soft and searchable copy to each participant of the Training and Workshop.

11. Qualifications of the Consultant

11.1 General

a. The Consultant shall be a legally registered and qualified consulting firm with verifiable international experience in projects related to Distributed Energy Resources (DER) and Grid/Distribution Code Development.

b. The firm must demonstrate independence, objectivity, and absence of conflict of interest, in line with international consultancy standards (e.g., World Bank, IDB, or similar guidelines).

11.2 Relevant Experience

c. Within the last 10 years, the Consultant must have successfully completed at least five (5) assignments of similar nature and complexity, covering:
   - DER Roadmap Development and Strategic Energy Planning
   - Grid/Distribution Code Development
   - Power System Studies and Grid Modernization

d. Each referenced project should include:
   - Client name, project scope, duration, contract value, and role of the firm
   - Contact details for verification

11.3 Technical Expertise

The Consultant shall demonstrate proven capabilities in the following areas:

a. **DER Strategy & Roadmap:** Development of DER integration strategies for centralized utilities, preferably in developing or emerging markets.

b. **Grid/Distribution Code Development:** Expertise in international technical standards (IEEE, IEC) and industry best practices for grid compliance and modernization.

c. **Power Systems Engineering:** Advanced knowledge of DER integration, grid stability, and modernization technologies (e.g., energy storage, smart inverters).

d. **Regulatory & Market Analysis:** Experience with electricity market structures, tariff design, and policy frameworks for DER adoption.

e. **Customer Engagement & Protection**: Familiarity with consumer protection frameworks, data privacy, and public communication strategies for DER programs.

f. **Distribution Feeder Design & Construction:** Competence in distribution planning, constructability review, and integration of modern technologies for resilient feeder systems.

11.4 Analytical & Modelling Capabilities

a. Ability to conduct:
   - Supply-demand modelling
   - Production cost analysis
   - Grid impact and short-circuit studies

b. Proficiency in industry-standard software, including:
    - PSS® Sincal 15.1, PSSE v33 for steady-state, transient dynamic, protection coordination and short-circuit studies.
    - Plexos for production cost modelling.

11.5 Team Composition & Key Experts

a. The Consultant shall propose a multidisciplinary team with clearly defined roles and responsibilities.
b. Key experts must have:
    - Minimum 10 years' experience in relevant fields
    - Proven track record in DER integration, grid code development, and regulatory analysis
c. GPL reserves the right to review and approve CVs of all key experts.

11.6 Project Management & Delivery

a. Demonstrated ability to:
    - Mobilize resources quickly
    - Deliver within agreed timelines and budget
b. Strong project management methodology, aligned with PMI standards.
c. Experience in stakeholder engagement, including regulators, utilities, and customers.

11.7 Compliance & Reporting

a. Adherence to international consultancy standards.
b. Regular progress reporting, quality assurance, and knowledge transfer to GPL and GEA.

11.8 Expected Skill Set and Team Composition

The consultant shall provide the estimated resources listed in the following table to support this project:

Resource	Qualifications	Responsibilities
Project Manager	Bachelor's or master's degree in engineering, Business Administration, Economics, Public Policy, or related field; 10+ years managing large-scale energy projects; strong leadership and stakeholder engagement skills.	Oversee project execution, manage communication with PLN, and ensure quality and timely delivery of outputs.

Power Systems Engineer	Bachelor's or master's degree in electrical engineering; 8+ years in power systems planning; expertise in DER integration, grid stability, and energy storage solutions	Conduct technical assessments, develop grid integration standards, and recommend infrastructure upgrades.
Regulatory and Policy Specialist	Bachelor or master's degree in Energy Policy, Law, or Public Administration; 7+ years in energy regulation; experience in designing DER policy frameworks.	Analyse regulations, recommend policy changes, and engage with government stakeholders to ensure alignment with national goals.
DER Specialist	Bachelor's or master's degree in Renewable Energy or Electrical Engineering; 5+ years in DER technologies, including solar PV, energy storage, and EVs.	Define DER scenarios, design pilot projects, and provide technical expertise on DER solutions.
Financial Analyst	Bachelor's degree in finance or economics; 5+ years in financial analysis and energy investment; expertise in economic modelling.	Conduct financial analysis of infrastructure investments, evaluate economic feasibility, and develop cost-recovery strategies.
Administrative Support	2+ years of experience with administrative support.	To assist with project scheduling, documentation, and coordination

12. Languages Requirements:

- Fluency in written and spoken English (excellent writing, editing and communication skills) is a must

13. **Facilitation and Logistics**

- Office accommodation, workshop logistics, field visits, secretarial service will be borne by the Consultancy Firm.

14. ANNEX A: Detailed Quantitative Analyses – Grid Planning and Impact Studies

14.1 The Distribution Codes for Guyana shall be prepared/developed in accordance with or under the guidance or in parallel with Detailed Quantitative Analyses – Grid Planning and Impact Studies. Essentially, to use insights from the Studies to inform the Distribution Code development.

14.2 The Detailed Quantitative Analyses – Grid Planning and Impact Studies shall be guided by the development and use of several required modelling scenarios of supply-demand modelling based on feeder characteristics, such as loading and lengths for various DER injection points, preferably using a minimum of 25 distinct feeders. GPL will provide all available modelling data for the selected feeders – a combination of primary and secondary feeders.

14.3 Perform quantitative steady-state load flow, short-circuit, transient dynamic stability and cost production analyses of each modelling scenario to ascertain and quantify the impact, capability and hosting capacity limits (technical and economic penetration limits) of the distribution systems to interconnect the additional intermittent renewable energy resources to achieve the emission reduction goals of the LCDS and beyond, ensuring that:

1. Calculation approach complies with IEEE 1547.7;
2. At the 69kV and 230 kV levels, power system operational parameters are not in violation of the National Grid Code or standard utility practices;
3. At no given time of day, week or year, feeder voltage levels should violate the ANSI C84.1-Range A limits;
4. Relay protection functions maintain coordination with all relevant upstream and downstream protective devices, compliant with IEEE 1574.
5. Short-circuit withstand and thermal ratings of distribution, substation, generation and transmission equipment are not exceeded.
6. Power systems operate stable and reliable, and power quality remains in compliance with IEEE 519-2022, IEEE 1547-2018 and IEC equivalents, where applicable, that do not conflict with standard voltage limits defined by ANSI C84.1. Further harmonics and flicker results shall be in compliance with the those of National Grid Code for 69kV and 230kV and at the point of interconnection of DERs and Substation Distribution Busses.

14.4 Repeat the above studies for scenarios with renewable energy resource penetration levels increasing to twice the hosting capacity limits obtained in incremental steps of 15%. Consultant shall also assess and advice the whether the power system can accommodate three-times the obtained hosting capacity limits. For all scenarios:

1. Consultant to determine the necessary cost-effective planning and engineering measures to mitigate grid impacts and ensure voltage levels at any time of the day, week or year are maintained within the ANSI C84.1-Range A, there will not be any thermal violation on any system element, and the power systems operate stable and reliable.
2. Power Systems' frequency is not adversely affected; violating the limits defined in the National Grid Code.
7. Power Quality remains in compliance with IEEE 519-2022, IEEE 1547-2018 and IEC equivalents, where applicable, that do not conflict with standard voltage and frequency defined by ANSI C84.1.
3. The planning and engineering measures shall not be limited to the use of BESS but also include for static voltage compensators and any other necessary system reinforcements to ensure stable and reliable operation of the power systems.
4. Consultant shall also define the functional requirements specifications of the BESS and any other recommended necessary system reinforcements.
5. In addition, the determination and provision of information on the likely cost impacts of these scenarios and the proposed contingency risk mitigation measures would be extremely useful to the Company.

14.5 Conduct short circuit analyses using the sequence data obtained in the data gathering and models. 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 buses in service and the scenarios with renewable energy resources, energy storage systems and recommended necessary grid reinforcements. Short circuit levels shall be calculated based on ANSI/IEEE C37.5.

14.6 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, then the recommendations to address such findings shall be discussed with the GPL's engineers and the official report shared with the Company.

14.7 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.

14.8 Following the fault level studies in each scenario, the Company requires an expert review and comment(s) on the likely impact of the various penetration scenarios on the existing protection schemes and settings and the implications on existing protection coordination. The Consultant shall recommend an appropriate relay protection scheme and protection coordination philosophy for substations, power plants and feeders to increase system security, and avoid islanding and major blackouts and outage spreads. Additionally, the Consultant shall advise on the use of specific relay functions and logic, anti-islanding strategies and coordination with DER ride-through requirements.

14.9 Complete Production Cost Assessments of each scenario for the complete power systems. The analyses shall compare the base case with each scenario, including those where the penetration level is considered multiplies of the originally obtained hosting capacity limits of distribution feeders. The analysis shall comprise an unconstrainted economic and specific constrained dispatch to evaluate 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 Net Billing Programme and LCDS.

a. Specific constrained dispatch shall involve the use of existing conventional generators, where and as appropriate, to avoid generation cost excursions; maintaining alignment with electricity tariffs reduction initiatives by the Government.

b. The analyses shall be conducted using the latest version of 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:

i. Reduced Levelized production costs for GPL;

ii. Reduced CO2 emission for GPL; and

iii. Estimated financial benefits based on increased operational flexibility imposed by the scenarios.

14.10 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, Feed-in Tariff and Power Purchase Agreement (PPA).

14.11 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.

15. ANNEX B: Indicative scope of the Distribution Codes for Guyana.

15.1 The scope of the Distribution Codes shall include at least the following:

1. Introduction and objectives
2. Applicability and responsibilities of GPL and of the DER
3. Compliance and Enforcement Mechanism
4. Revision Cycle
5. Classification of DER by capacity and connection voltage level
6. Hosting Capacity Integration
    - Define thresholds for fast-track vs detailed interconnection studies based on hosting capacity results.
7. Queue Management Rules
8. Definitions and table of acronyms
9. General description of the Net Billing Programme.
10. Interconnections: Differentiating per DER class and for the net billing program:
    a. Interconnection requirements: general, safety, and as applicable for the DER class quality and reliability requirements such as grounding, reactive power capability, voltage control (Volt/VAR) and under or over voltage ride through, frequency control (droop), active power ramp rate limits, and under or over frequency ride through, protections, grid forming/following inverter requirements, disconnection and reconnection (standards, certification, etc).
    b. Anti-islanding Detection Methods and Ride-Through Performance Criteria
    c. Special Equipment Technical Requirements and Standards.
        - BESS functional Requirements
        - Communication and Interoperability Standards
    d. Data and diagrams requirements for CPG modelling.
    e. Feasibility Interconnection and Full Interconnection Studies
    f. Application process and information and documentation requirements,
    g. GPL review and timeline, interconnection impact assessment when required, causes for rejection
    h. New interconnections: grid connection offer, when applicable, interconnection agreement, additional information (design diagram, etc), commissioning and testing.
11. Operation code: Differentiating per DER class:

a. Operating data

b. Cybersecurity and Communications for DER telemetry, protection signalling and SCADA/AMI/DERMS integration.

   - Compliance with IEC 62351 and NERC CIP
   - Define minimum encryption/authentication, incident response, and data privacy requirements.
   - Specify protocols (DNP3, IEC 61850) and telemetry refresh rates.

c. Power Quality Requirements/Performance requirements such as flicker and harmonics, voltage and current imbalance, low and reverse power factor.

   - Explicit harmonic limits (IEEE 519-2022), voltage imbalance limits, and compliance verification process.

d. Response upon disturbances/contingencies, applicable to DERMS.

e. Reconnection after tripping, applicable to DERMS.

12. Metering Code; amend Metering Code of National Grid Code or draft separate code for DER, taking into account all relevant subject matters under the Metering Code of the National Grid Code including but not limited to Define accuracy class, interval data requirements, remote reading, and settlement process for Net Billing.
13. Safety requirements; Utility and Prosumers.
14. Utility Lockout/Tagout Procedures for DER
15. Safe Reconnection Protocols after Outages.
16. Verification and testing or certification of compliance.
17. Interconnection Application.
18. Interconnection Agreement/Contract
19. Dispute Resolution Mechanism
20. Timelines for Resolution and Escalation Path
21. DER Aggregator and Virtual Power Plants (Optional and Policy-based)
22. Definition of Code Review Panel and Members