December 4, 2024

# Belize Electricity Limited Report 1: Implementation of the Regulatory Sandbox for Demand Charge Rate in Belize

The Public Utilities Commission (PUC) continues its commitment to advancing the regulatory framework that supports the acceleration of Belize's energy transition. On April 10, 2024, the PUC issued a Final Decision and Order on BEL's Proposed New Customer Classifications and Associated Tariff where it adopted the Regulatory Sandbox Framework and approved a "Demand Charge Rate" to be applied under the associated tariff scheduled related to Grid-tied Distributed Generation and Feed-in Tariff.

Additionally, BEL was required to conduct a study to test and evaluate pricing related to the introduction of the new customer classifications and associated tariffs, define the interconnection requirements for Distributed Generation Feed-in, and submit a comprehensive report of their findings to the PUC for consideration before implementation.

BEL's report titled **"Report 1: Implementation of the Regulatory Sandbox for Demand Charge Rate in Belize"**, **the interconnection standards and customer agreement, and sample customer Credit Note for Distributed Generation Feed-in** can be found below:


# Report 1: Implementation of the Regulatory Sandbox for Demand Charge Rate in Belize

**Reporting Period: May 1, 2024 – September 30, 2024**
**Submitted by: Belize Electricity Limited**

**Date: November 15, 2024**

# Executive Summary

This report presents the initial findings and roadmap for the Regulatory Sandbox, implemented by Belize Electricity Limited (BEL) as part of a broader strategy to modernize Belize's electricity pricing model. The Regulatory Sandbox, implemented with effect from May 1, 2024 and mandated by the Public Utilities Commission (PUC, 2024)[1], allows BEL to test and evaluate how demand-based pricing can optimize energy consumption patterns, encourage renewable energy integration, ensure appropriate cost recovery for grid services, and enhance grid stability through a rate structure that includes a **Demand Charge**, **Peak and Off-Peak Energy Charges**, and a **Feed-In Tariff (FIT)** for Distributed Generation (DG) customers.

This mechanism enables experimentation in a controlled environment, allowing BEL to gather data, engage with customers, and adjust the rate structure before full-scale implementation.

Similar initiatives have been implemented in Jamaica, Barbados, and the Cayman Islands, each demonstrating the benefits of demand-based pricing models in reducing peak demand, improving grid efficiency, and fostering a market for renewable energy sources such as solar PV. Outcomes from these jurisdictions may inform the approach in Belize.

Despite some challenges (including customer unfamiliarity with Demand Charge models and its impact on wide DG solar penetration), the sandbox shows promising potential to meet key objectives and align with regional and international trends in energy rate reforms. Some key recommendations include phased implementation of the Demand Charge to aid in customer adjustment and transition; conducting periodic reviews for iterative improvements; conducting system health checks and quality assurance exercises to ensure accurate data reporting and monitoring of energy exports; outlining next steps for implementation with the aim of aligning the Regulatory Sandbox with broader public policy objectives and BEL's strategic pillars.

**Summary of Key Outcomes to Date:**

- **Meter Deployment:** BEL has programmed bidirectional meters to capture the monthly demand, peak and off-peak consumption, and feed-in quantities for deployment to customers as operational requirements evolve. The Company has deployed those meters to identified DG Customers. BEL intends to acquire AMI meters in anticipation of the additional DG Customers and for the promulgation of time-of-use rates for demand-side management.
- **Process Documentation:** Several internal and customer-oriented process tools have been developed and deployed to facilitate the implementation of the Demand Charge Rate

[1] (PUC), P. U. C. (2024). *Final Decision and Order: Belize Electricity Limited new Customer Classifications and Associated Tariff Schedules for Grid-Tied Distributed Generation & Feed-In, Electric Vehicle Charging, Spanish Lookout and Tourism.* Belize City: Public Utilities Commission.

including: an *Application & Engineering Review Process; Field Inspection Forms; DG Interconnection Standards and a Draft Interconnection Form (attached).*

- **Partial Rate Implementation**: The initial rollout has successfully introduced the **Feed-In Tariff** for DG customers. **Actuals**: The Company has identified and interconnected 78 grid-tied DG Customers as at end September 2024. The Excel Spreadsheet attached to this report titled "BEL Demand Charge Rate Readings and Shadow Billing Calculations" provides detailed readings as captured by Meter Readers. Quality assurance and data accuracy inspections are ongoing to validate data and meter readings submitted in this report (to update where necessary), and credit note letters (Sample Attached) have been issued to DG customers where feed-in values have been confirmed and validated through quality assurance mechanisms. The credit note is being issued while BEL teams fully establish the back-end system in its CIS and Invoicing infrastructure.

| Month (2024) | Total Feed-In by DG Customers (kWh) |
|---|---|
| June | 8,010.70 |
| July | 18,471.046 |
| August | 29,396.00 |
| September | 56,804.796 |

- **Feedback and stakeholder resistance** suggests that the Demand Charge may discourage widespread DG solar penetration. There is also a need for enhanced direct customer communication (Demand Charge Rate Customers) to clarify discrepancies in understanding rate components – which has slowed progress in implementing the full scope of the rate.

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# Background and Rationale

On April 2, 2023, BEL made an application to the PUC which included a proposal to establish new customer classifications and associated tariff schedules for Distributed Generation, Electric Vehicle Charging, Spanish Lookout and Tourism. In its Decision (April 2024) on this submission, the PUC approved a "Demand Charge Rate" to be applied in a Regulatory Sandbox Framework.

Regulatory Sandboxes are an innovative approach to rate reform, allowing utilities and regulators to, among other functions, experiment with new pricing models in a controlled environment. These experiments are essential as the global energy sector undergoes significant transformation, with increasing emphasis on **energy efficiency**, **energy security, grid modernization, environmental sustainability** and **customer-centricity**.

By introducing a demand charge and other dynamic pricing models, BEL aims to:

1. **Manage Peak Demand & Encourage Efficient Energy Use**.

2. **Promote Renewable Energy Integration**: Facilitate DG customers through a FIT.
3. **Ensure appropriate Cost Recovery for Grid Services**.
4. **Support Grid Modernization & Innovation**: Develop a rate structure that incentivizes the use of technologies like EVs, DG and storage.
5. **Support National Policy**: Align energy consumption with decarbonization goals.

**Strategic Pillars** supported by this initiative:

1. **Cost of Power Stabilization**: By transitioning to a Demand Charge Rate, BEL can better manage peak demand and integrate more renewable energy sources, reducing reliance on fossil fuels and stabilizing cost of power over time.
2. **Grid Modernization and Innovation**: The introduction of advanced metering infrastructure (AMI) and automated customer consumption reports and billing systems sets up the foundation for grid modernization, enabling BEL to efficiently track and manage energy use while fostering a culture of customer-centric innovation.
3. **Evolving with Our Customers and Market**: The new rate structure, coupled with customer education initiatives, enables a more customer-centric approach, offering tailored solutions and improving customer satisfaction. For Customers in general, DG, in the form of rooftop Solar PV, represents an opportunity to lower their costs, reduce their carbon footprint, improve reliability of their supply, and gain more control over supplying their own energy needs.
4. **Service Excellence**: By addressing operational inefficiencies and enhancing customer engagement, BEL aims to deliver exceptional service quality and reliability. For BEL, DG represents an opportunity to lower energy supply and system demand costs, improve reliability of service in areas where it is deployed, and increase overall and in-country reserves of energy in the system.
5. **Reinforcing and Expanding the Grid**: Integration of DG systems and AMI and enhancing interconnection standards supports grid expansion, ensuring that renewable energy sources and demand side management technologies are effectively incorporated into the system.

**The Regulator's Mandate**

The PUC's mandate to implement this Regulatory Sandbox underscores the experimental nature of this project. The goal is to assess customer behaviour, grid stability, and economic feasibility while allowing for real-time adjustments based on stakeholder feedback and data.

A secondary outcome has been BEL's supporting the PUC's implementation of its new licensing regime as enacted in **Statutory Instrument 39 of 2024: Electricity Licensing and Consent**

**Regulations**. BEL intends to share experiences to explore the efficacy of this new regime with a view towards securing the best interests of all stakeholders.

By virtue of interactions with customers and onboarding interconnected DG Systems classified under the new license categories, BEL acts as a communication source on these regulations and the associated processes for its implementation. It has, therefore, become prudent for BEL to act collaboratively with the PUC in implementing the Regulatory Sandbox.

**BEL's Proposed Implementation Timeline:**

- **Phase 1 (Month 1-6)**: Formation of implementation team, initial contact with DG customers identified via BEL rooftop solar penetration survey, customer information sharing and orientation, rollout of **DG interconnection standards** via site inspection and application of the **Feed-In Tariff** rate component.
- **Phase 2 (Month 6-onwards)**: Rollout of demand-based rates, with adjustments based on stakeholder feedback. Quality assurance and system health checks.
- **Phase 3 (Month 8-12)**: Promotion of voluntary opt-in for customers (based on implementation data), and enhancements to customer engagement and information sharing.
- **Phase 4 (Quarterly reviews)**: Regular assessment and adjustments based on data, feedback, and operational insights.
- **Phase 5**: Full scope implementation, with automation of data collection using AMI and further adjustments based on findings.

# Regional Context

In the Caribbean, countries such as Jamaica, Barbados, and the Cayman Islands have piloted similar regulatory sandbox programs to promote energy reform. The following regional cases serve as critical references for the sandbox implementation in Belize:

- **Jamaica Public Service (JPS)**[2] introduced a time-of-use rate for large industrial customers to reduce peak demand. Jamaica's pilot program showed early successes in lowering operational costs for industries and improving load balancing on the grid. One of the critical learnings from Jamaica's implementation was the necessity of a robust customer education campaign. Many customers were initially confused about the TOU rate's structure, leading to underutilization of off-peak periods.

[2] Jamaica Public Service. (2022). *Annual Rate Review by the Office of Utilities Regulation (OUR)*. Jamaica Public Service. Retrieved from https://our.org.jm/wp-content/uploads/2022/08/Media-Release-OUR-Completes-Review-of-JPS-2022-Annual-Rate-application.pdf

- **Lessons Learned:**
    - Investing in communication tools, workshops, and customer service enhancements can ensure that consumers understand the benefits of the demand charge and how it affects their energy bills.
    - Phased implementation of TOU rates helps ease customer transitions. BEL can consider a phased onboarding of the $30/kVA/month demand charge to facilitate broader adoption, like Jamaica's approach.

- **Barbados Light & Power (BLP)**[3] piloted a demand charge for commercial customers with solar PV systems, which has fostered greater investment in solar.
    - **Lesson Learned:**
        - Like Jamaica, a takeaway from Barbados's implementation was the importance of engaging stakeholders (particularly large commercial clients and renewable energy advocates) early in the process.

- **Cayman Islands' Electricity Regulatory Authority (ERA)**[4] launched a sandbox to explore dynamic pricing models, including demand charges, to promote electric vehicle (EV) adoption and improve grid efficiency. The sandbox allowed for the testing of various rate structures, including demand charges and time-of-use tariffs for residential and commercial EV owners. This program has contributed to a growing market for EVs and improved energy management.
    - **Lesson Learned:**
        - One of the major lessons from the Cayman Islands was the effective integration of EVs into their grid system through dynamic pricing models. The demand charge rates provided a clear incentive for EV owners to charge their vehicles during off-peak hours, reducing strain on the grid and contributing to a more balanced energy load.

These regional success stories reinforce the potential benefits of Belize's own sandbox in achieving similar outcomes.

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[3] Barbados Light & Power (BLPC). (n.d.). Energy Transition Initiatives and Renewable Energy Programs. Barbados Light & Power. Retrieved from https://www.blpc.com.bb

[4] Electricity Regulatory Authority of the Cayman Islands. (n.d.). *Renewable Energy Programs and Solar PV Integration*. Cayman Islands Electricity Regulatory Authority. Retrieved from https://www.ofreg.ky

## Policy Domains and Objectives Analysis

This section outlines national policy objectives, BEL's strategic goals, and regulatory sandbox targets in implementing the Demand Charge Rate.

| Domain | Objective | Policy Target | Strategic Pillar Alignment | Reporting Requirements |
|---|---|---|---|---|
| **Regulatory Sandbox – Rate Testing** | Test demand-based pricing impact | Evaluate feasibility.<br>Adjust rates based on feedback | Cost of Power Stabilization | Adoption rate; track customer feedback; assess savings on peak demand reduction. |
| **DG Integration** | Facilitate DG interconnection and FIT adoption | Facilitate compliance with interconnection standards<br>Support FIT<br>Support PUC's new licensing regime rollout and enforcement | Reinforcing and Expanding the Grid | Track DG customer growth, report on system reliability, compliance rates. |
| **Data Collection Automation** | Enhance data collection accuracy | Implement AMI, reduce manual reads | Grid Modernization | AMI installation progress. |
| **Regulatory Sandbox – Charge Point Activity** | Engage Actors in the EV Industry for EV charging solutions | Develop partnerships for charging network strengthening<br>Foster EV adoption and align with decarbonization goals | Evolving with Our Customers | Track transformation in the EV Sector, charging station data, and overall EV energy consumption. |
| **Environment & Climate Change Mitigation** | Reduce environmental emissions | Where possible – report on emissions reduction<br>Align DG and EV charging infrastructure with CO2 reduction targets | Sustainability, Decarbonization & Grid Modernization | Track emissions data and report on renewable energy's contribution to total generation. |
| **Energy Security** | Improve energy affordability and grid reliability | Increase renewable energy sources and demand-side management technologies and reduce dependency on imports | Cost of Power Stabilization | Report on energy mix, peak demand adjustments, and overall cost reduction trends. |
| **Economic Development** | Foster industry growth | Support renewable energy technology integration | Reinforcing and Expanding the Grid | Report on new installations |

# Recommendations

The **First Phase** of the sandbox has focused on DG customer integration, implementing BEL's interconnection standards, and the implementation of the FIT. While the sandbox has laid the groundwork for future success, several critical challenges must be addressed to ensure its full potential is realized including improving public communication.

**Key Recommendations:**

1. **Evaluate the Demand Charge**
    - **Current Feedback**: The demand charge of $30.00/kVA/month has been met with resistance by many customers. This is consistent with findings in Jamaica, where similar feedback led to a gradual phase-in of demand charges.
    - **Recommendations**:
        1. A phased implementation of the Demand Charge by 6-month markers to aid in customer adjustment and transition, with a view to reviewing the rate structure at intervals.
        2. Use data and simulations to illustrate potential savings for customers under the demand-based model.
2. **Increase Focus on Potential CPO Engagement**:
    - **Current Feedback**: Clarity is needed on what constitutes a CPO and their role and obligations in Belize's energy landscape. A lack of clarity may lead to challenges in policy enforcement, operational consistency, financial implications which deter investment and engagement from prospective operators, and misalignment of stakeholder expectations.
    - **Recommendations:**
        1. Develop, and refine as necessary, a working definition of the term 'Charge Point Operator' for the Belize energy landscape. At a meeting between PUC and BEL representatives on September 23, 2024, a working definition was discussed.

| |
|---|
| **Working Definition**: A Charge Point Operator (CPO) is an entity that owns, operates, or manages electric vehicle (EV) charging infrastructure and engages in the retail sale of electricity as a service at the charge point. Within the EV ecosystem, a CPO's role is to provide charging services to third-party users, as opposed to self-supplying for internal or operational purposes. |

2. Clarify the role and expectations of CPOs within the demand charge model, evaluating the benefits of participating in the demand charge model. This includes articulating the economic incentives of participation and demonstrating how the rate structure supports cost recovery for grid services, operational efficiency and profitability for CPOs. Addressing this gap is critical to fostering confidence and clarity in the evolving EV charging ecosystem.
3. Strengthen communication with potential CPOs (EV Car Dealers, EV Fleet Operators) encouraging early adoption and integration into the sandbox framework.

**3. Explore Voluntary Opt-In Efforts**

- **Current Feedback**: There is limited understanding of the advantages and long-term benefits of opting into demand charge frameworks.
- **Recommendations**:
    1. Create clear, accessible materials highlighting cost-saving opportunities, grid efficiency benefits, and other benefits associated with a transition to demand charge rates structures.
    2. Consider temporary incentives for entities that opt into the program during the regulatory sandbox phase.
    3. Facilitate information sessions with target groups to address concerns, demonstrate case studies, and provide tailored guidance on leveraging the rate structure effectively.

4. **Enhance Customer and Public Communication and Clarify the Rate Structure**:

- **Current Feedback**: Majority of DG Customers (over 90%) expressed confusion about the rate structure, with discrepancies in understanding the definitions of demand charge, peak and off-peak energy rates.
- **Recommendation**:
    1. Launch a customer awareness campaign, focusing on education, including FAQ sessions and community outreach and information initiatives. (Also see 3.1 above.)
    2. BEL should prioritize stakeholder engagement with large-scale energy users and DG investors to build support and ensure that all parties understand how the demand charge benefits their operations.

5. **Enhance Data Collection, Quality and Integration**:

- **Current Feedback**: Some DG customers may have inadvertently turned off feed-in portions of their systems, impacting the reliability of data.
- **Recommendation**s:
    1. Conduct **system health checks** to ensure accurate data reporting and monitoring of energy exports. (This is already underway with grid-tied DG Customers participating in the Regulatory Sandbox.)
    2. Accelerate the rollout of AMI to replace manual meter readings and ensure accurate and timely data entry and data processing.
    3. Train staff on the new systems and work with customers to ensure proper functioning of their DG systems, reducing data discrepancies.

6. **Conduct Quarterly Reviews for Iterative Improvements**:
    - **Current Feedback**: Stakeholders have emphasized the need for ongoing evaluation of the Regulatory Sandbox to address challenges, refine processes, and ensure the framework supports meeting wide stakeholder objectives.
    - **Recommendations:**
        1. Establish a robust quarterly reporting process to continuously review the sandbox's performance. (Both PUC and BEL are open to periodic meetings for knowledge sharing and roadmap charting.)
        2. Use data and review outcomes from the first year of implementation to assess the impact of the demand charge and adjust as needed.
        3. Engage with stakeholders in meetings to ensure transparency and incorporate feedback into ongoing improvements.

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# Preliminary Conclusions

The Regulatory Sandbox has set the stage for a significant transformation in Belize's energy sector. This initial report highlights areas of success, such as the implementation of the Feed-In Tariff and the groundwork for DG integration. However, immediate action is required to address feedback on the Demand Charge, improve public communication, and resolve operational inefficiencies.

The recommendations presented in this report focus on making iterative improvements that will better align the sandbox with its intended goals. By continuing to engage stakeholders, improving data collection

BELIZE ELECTRICITY LIMITED
2 1/2 Miles Philip Goldson Highway | P.O. Box 327
Belize City, Belize C.A.
Telephone: 501.227.0954 | Fax: 501.223.0891

Date: 20th September 2024
Customer Name: Anthony Staine
Account Number: Hidden due to confidentiality
Meter Number: Hidden due to confidentiality

**BEL Customer Feed-In Credit**

Dear: Anthony Staine,

Thank you for your ongoing participation in BEL's Distributed Generation (DG) Program. This notice serves as an official update on your solar feed-in credits, which have been accurately tracked since June 2024. As we work on the final steps of integrating these credits into your monthly bill, we are providing this memo to keep you updated on your feed-in energy generation and the credits earned.

Until the billing software modifications are completed, you may deduct this credit amount from your current bill to determine your payable balance. **Please note that your current charges, minus the feed-in credit, should be paid as indicated below:**

| | | |
|---|---|---|
| Bill Balance at 20/09/2024 | $ | 120.99 |

FEED-IN

| Month | KWh | Rate Per kWh | GST | Credit |
|---|---|---|---|---|
| May | 0 | ($0.13) | 12.5% | $0.00 |
| June | 0 | ($0.13) | 12.5% | $0.00 |
| July | 76 | ($0.13) | 12.5% | ($11.12) |
| August | 206 | ($0.13) | 12.5% | ($0.44) |
| Total FEED IN Credit | | | | ($11.55) |

| | | |
|---|---|---|
| Total amount due | $ | 109.44 |

We are in the process of finalizing the billing software updates and anticipate completion within the next month. In the meantime, this memo is being provided to ensure you remain up-to-date on your feed-in generation and credits.

Should you have any questions, please feel free to contact our Invoicing team at 0-800-BEL-CARE (0-800-235-2273) or via email at Billing@bel.com.bz.

BELIZE ELECTRICITY LIMITED
2 1/2 Miles Philip Goldson Highway | P.O. Box 327
Belize City, Belize C.A.
Telephone: 501.227.0954 | Fax: 501.223.0891

Thank you again for your participation in our DG program and your commitment to renewable energy.

Sincerely,

Signature hidden to protect against unauthorized use.

Marjorie Vasquez
Invoicing Supervisor

# Distributed Energy Resource Technical Interconnection Requirements


**Belize Electricity Limited**

**Distribution System Planning & Engineering Department**

## LIMITATION OF LIABILITY AND DISCLAIMER

Belize Electricity Limited (BEL) Distributed Energy Resource Technical Interconnection Requirements (DER TIR): Interconnections Requirements at Voltages 22 kV and below, identifies minimum requirements for generation projects connecting to the BEL's distribution system. Additional requirements may need to be met by the owner of the generation project to ensure that the final connection design meets all local and national standards and codes and is safe for the application intended.

The TIR is base on several assumptions, only some of which has been identified. Changing system conditions, standards and equipment may make those assumptions invalid. In no way shall BEL, its affiliates, directors, officers, or employees be liable for any loss or damage arising from the use of the TIR.

Reference to the TIR, or the use of the TIR, in any specific project or project document should be for information and shall not constitute endorsement, recommendation, or favouring by BEL, its affiliates, directors, officers, or employees.

BEL reserves the right to amend the TIR at any time. Any person wishing to make a decision based on the content of the TIR should consult with BEL prior to making any such decision. The specific quantities outlined in sections of the TIR relating to the amps etc. are based on the BEL's engineer's judgment regarding the system performance viability considering varying generation scenarios and locations along the Distribution system.

As such, the specific quantities shall only be used as a guide, subject to in-depth evaluation, in the Connection Impact Assessment (CIA) process.

## DOCUMENT CREDIT

Credit is given to Hydro One Networks Inc., Barbados Light & Power and Fortis Alberta for reference to their interconnection documents.

# Contents

# 1. Introduction

This document, — "BEL DER TIR: Interconnection Requirements at Voltages 22 kV and below" (the "TIR") - outlines the technical, planning and operational requirements for the installation, or modification, of Distributed Generation (DER) projects connecting to Belize Electricity Limited's (BEL) Distribution System feeders at ≤ 22 kV.

The connection of DER supply sources to the BEL's Distribution System feeders affects the steady state and transient voltage profiles and current distribution along the feeder in response to changing supply, load and fault conditions. These connections must:

1. Preserve acceptable safe operation of the Distribution System for the public, customers and employees that work on the BEL System.
2. Maintain reliability and quality of service to BEL customers.
3. Abide by the requirements of the Belize Public Utilities Commission (PUC), BEL Safety procedures, BEL Service Installation Manual, the National Fire Protection Association (NFPA) 70, National Electric Code (NEC) standards, and other standards stated below.
4. Be compatible with BEL's standard operating, protection, control and metering systems and practices.

To accomplish this, the design of the power equipment, protection, control and metering systems used at the DER Facility interconnection must meet specific minimum requirements. Depending on the capacity and electrical characteristics of the connecting DER Facility, specific additions and/or modifications may be required to BEL's equipment, protection, control and metering systems to facilitate the connection. This document has been developed with reference to the requirements of the Institute of Electrical and Electronics Engineers (IEEE) Standard 1547, the BEL Standard Protection Code, and the UL 1741 standards - Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources 2023.

It is imperative that these requirements are understood by those delegated or contracted by the DER Owner for the planning, design, equipment manufacture and supply, construction, commissioning, operation and maintenance of the DER Facility.

# 2. Scope

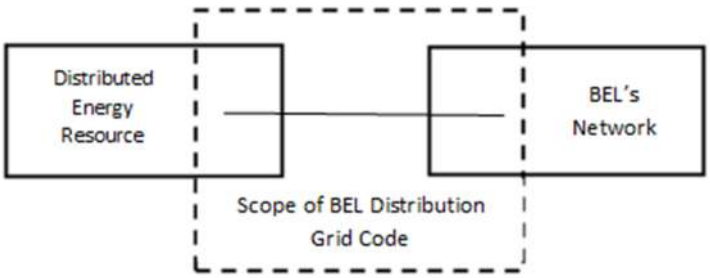
This document applies to all single-phase or three-phase DER facilities that seek to connect to BEL's Distribution System at ≤ 22 kV. Existing generation facilities with existing connections need to comply with this document.

This document is intended to be applied to electric power DER using all types of energy sources, energy storage and energy conversion technologies – and those connecting via inverters or static power converters, which connect at or below the threshold mentioned above.

This Technical Interconnection Requirements contains minimum technical requirements that the DER Owner must comply with in order to connect to BEL's Distribution System. Depending on the size of the interconnecting DER Facility, the voltage of the interconnected distribution feeder, and whether the facility is single phase or three-phase, certain requirements may or may not apply.

It is the DER owner's responsibility to ensure that requirements are met for the specific system configuration. These requirements have been developed to ensure that the integrity and power quality of BEL's Distribution System are maintained to acceptable levels after connection of the DER Facility. Additional requirements may be necessary to address unique situations and the DER Owner shall be advised of any such requirements at the appropriate stage by BEL. Any exemptions require written approval from BEL. This document does not specify all of the protection requirements at the DER Facility. Minimum protection requirements for interconnection are, however, specified in Section 8.5(for DER ≤ 150 kW) and Section 12 (for DER > 150 kW). The DER Owner should ensure that adequate generator protections as well as protections for other equipment within the DER Facility are installed. This is to protect them from damage from faults or abnormal conditions which may originate at the DER Facility or from BEL Transmission and/or Distribution System.

This document does not constitute a design handbook and is not a substitute for any Safety Code. DER Owners, who are considering the development of a DER facility to connect to BEL's system, shall engage the services of a PUC licensed wireman, technician, engineer or a registered consulting firm qualified to provide design and consulting services for electrical interconnection facilities in Belize.



# 3. Objectives

BEL is committed to establishing the rules for connection of approved forms of generation to the Distribution System, while preserving a safe and reliable electrical supply to all of its customers. Interconnection of the DER Facilities must conform to relevant regulations in Belize and international design standards.

The following objectives shall be integrated into the design specification, construction, operation and maintenance of the DER Facility interconnection.

**SAFETY** - The DER interconnection must not create a safety hazard to the public, BEL customers, BEL employees who work on the Distribution System or to personnel working in the DER Facility.

**POWER QUALITY** - Connection of DER Facilities must not materially degrade the power quality of the BEL Distribution System below acceptable levels.

**RELIABILITY** - Connection of DER Facilities must not compromise the reliability of Distribution System.

**ACHIEVABILITY** - The DER Facility interconnection requirements will allow fair and equitable access for all DER Owners.

**OPERABILITY** - The DER Facility connection must not restrict the operation of the BEL Distribution System. All aspects of the interconnection that can affect the BEL Distribution System must be compatible with BEL standard operating, protection, control and metering systems and practices.

# 4. Definitions and acronyms

For the purposes of this document, the following terms and definitions apply.

**Abnormal operating performance category:** The grouping for a set of requirements that specify technical capabilities and settings for a distributed energy source (DER) under abnormal operating conditions, i.e., outside the continuous operation region.

**Applicable voltage:** Electrical quantities that determine the performance of a local electric power system (EPS) or DER specified with regard to the reference point of applicability, individual phase-to-neutral, phase-to-ground, or phase to-phase combination and time resolution.

**Automatic transfer switch (ATS):** is a device that automatically transfers a power supply from its primary source to an alternate source when it senses a failure or outage in the primary source. When a failure occurs in a primary power system, the ATS invokes a standby power source, such as an uninterruptable power supply. An ATS can also start up more long-term backup power systems, such as DER, to run electric equipment until utility power is restored.

**Bi-directional interval meter** Electricity-measuring device that measures at two separate data points the total electrical energy that flows in a circuit between intervals of usually 15 minutes. One data point shows the amount of electrical energy that has been exported to the grid. The other data point shows the amount of electrical energy that has been imported from the grid.

**Distributed energy resource (DER):** A source of electric power that is not directly connected to a bulk power system. DER includes both DER and energy storage technologies capable of exporting active power to an EPS. An interconnection system or a supplemental DER device that is necessary for compliance with this standard is part of a DER.

**Small Distributed Energy Resource (SDER) -** DER facilities with aggregate capacity at or less than 150 kW.

**Distributed energy resource operator (DER operator):** The entity responsible for operating and maintaining the distributed energy resource.

**Distributed energy resource (DER) unit**: An individual DER device inside a group of DER that collectively form a system.

**Distributed generation (DG):** Generating unit that is connected to BEL's distribution system.

**DGEO –** Distributed Generator End Open – A signal use to confirm status of the generator breaker – used to prevent out-of-phase reclosing onto the generator.

**Electric power system (EPS):** Facilities that deliver electric power to a load. This refers to the Belize Electricity limited (BEL) grid.

**Effectively grounded**: A distribution system or DER facility shall be grounded where the neutral conductor is grounded.

**Inverter:** A machine, device, or system that changes direct-current power to alternating-current power.

**IRC:** Interconnection Review Committee.

**HVI:** High Voltage Interconnection.

**LSBS -** Low Set Block Signal – signal sent over the same channel as DGEO which blocks the Low Set Instantaneous Protections at BEL's substations.

**Per unit (p.u.) / percent of (percentage):** Quantity expressed as a fraction of a defined base unit quantity. For active power (active current), the base quantity is the rated active power (rated active current). For apparent power (current), the base quantity is the rated apparent power (rated current). For system frequency, the base quantity is the nominal frequency (i.e., 60.0 Hz in Belize). Quantities expressed in per unit can be converted to quantities expressed in percent of a base quantity by multiplication with 100.

**Point of common coupling (PCC):** the point of connection between the wires owner and the a DER facility.

**Point of connection (PoC):** the point of connection to where a DER unit is connected to a DER system.

**Supplemental DER device:** Any equipment that is used to obtain compliance with some or all of the interconnection requirements of this standard. Examples include capacitor banks, STATCOMs, harmonic filters that are not part of a DER unit, protection devices, plant controllers, etc.

# 5. Acronyms

| | |
|---|---|
| ATS | automatic transfer switch |
| BEL | Belize Electricity Limited |
| BPS | bulk power system |
| DER | distributed energy resources |
| EPS | electric power system |
| ES | energy storage |
| Local EPS | local electric power system |
| PV | photovoltaic |
| RMS | root mean square |
| TIR | Technical interconnection requirements |

# 6. Definition of Generators Interconnected to Grid

### 6.1.1 Separate System

A separate system is one in which there is no possibility of electrically connecting or operating the Customer's generation in parallel with the utility's system. The Customer's equipment must transfer load between the two power systems in an open transition or non-parallel mode. If the Customer claims a separate system, BEL may require verification that the transfer scheme meets the non-parallel requirements.

Emergency or Standby generators, used to supply part or all of the Customer's load during a power outage, must have transfer equipment designed and installed to prevent the inadvertent interconnection of normal and emergency sources of supply in any operation of the transfer equipment.

For these system, the generators must be connected to the Customer's wiring through a double throw, "break-before-make" transfer switch specifically designed and installed for that purpose. The transfer switch must be of a fail-safe mechanical throw over design, which will under no circumstances allow the generator to electrically interconnect or parallel with BEL. The transfer switch must always disconnect the Customer's load from the utility's power system prior to connecting it to the generator. Conversely, the transfer switch must also disconnect the load from the generator prior to re-connecting it back to the utility. These requirements apply to both actual emergency operations as well as to testing the generator. All transfer switches and transfer schemes must be inspected and approved by BEL. In the case of an automated closed transition transfer switch, any parallel with BEL's system shall only be maintained for six cycles (100ms) or less during a source transfer.

### 6.1.2 Parallel System

A parallel, or interconnected, generator is connected to a bus common with the utility's system, and a transfer of power between the two systems is a direct result. A consequence of such interconnected operation is that the Customer's generator becomes an integral part of the utility system that must be considered in the electrical protection and operation of the utility system.

Parallel generators encompass any type of distributed generator or generating facility that can electrically parallel with, or potentially back feed the utility system. Additionally, any

generator system using a “closed transition” type transfer switch or a multi-breaker transfer scheme, or an electrical inverter that can be configured or programmed to operate in a “utility interactive mode” constitutes a potential back feed source to the utility system and is classified as an interconnected generator.

The utility has specific interconnection and contractual requirements that must be complied with, and information that needs to be submitted for all interconnected generators as is specified in the various sections of this document. In summary, these include a “visible open” disconnect switch meeting certain requirements to isolate the Customer’s system from the utility system, as well as protective, metering, and other safety and information requirements. The Customer will be responsible for having the generation system protective schemes tested by qualified testing/calibration personnel. Utility personnel will inspect the system and the Customer will be required to sign an Interconnection Agreement. Utility “blanket approval” is not extended to any specific type of generator or generator scheme since each project is site specific and needs to be reviewed on a case-by-case basis.

### 6.1.3 Dual System

A dual system is one which contains a parallel system and a separate system in its electrical wiring. These systems are capable of connecting to the grid during normal operations and operate independently during periods in which the utility is not available. An example of a dual system is one which has an inverter based connection and stand-by generator.

**Any system, which is considered a Dual System, must meet requirements, as stated in this document of both a Separate System and Parallel System.**

The utility has specific interconnection and contractual requirements that must be complied with, and information that needs to be submitted for all dual systems. These include a “visible open” disconnect switch meeting certain requirements to isolate the Customer’s parallel system from the utility system, a double throw “break-before-make” transfer switch as well as protective, metering, and other safety and information requirements. Utility personnel will inspect the system and the Customer will be required to sign an Interconnection Agreement.

# Separate Systems

# 1. Separate Systems.

This document provides a guideline to standby generator owner's that are normally available at their facilities and can be used as a standby source of power. These standby generators can run in parallel with BEL's system, for a short period during the transfer of load from BEL supply to standby generator or vice versa.

These standby generators are fitted for a closed-transition transfer to and from the grid and are not to export power to BEL's system across the revenue meter.

**<u>Generators greater than 25kW</u> in a separate system must be installed with an ATS.**

**<u>Generators greater than 750kW</u> in a separate system must meet minimum requirements identified in *Section 1.3 Minimum Protection Device Requirements for a Separate Systems ≥ 750kW***

## 1.1 General Requirements of a Separate Systems

### 1.1.1 Interconnection Agreement

The Customer is required to sign an **Interconnection Service Agreement with** BEL prior to **installation**. The **Interconnection Service Agreement outlines** the applicable interconnection standards and requirements.

### 1.1.2 Unauthorized Connections

BEL must grant approval in writing before any installation of a separate system. For the Purposes of public and utility personnel safety, BEL reserves the right to disconnect and suspend, as required, the service to any Customer who connects a separate system installation without written authorization from BEL. BEL reserves the right to conduct inspections at the site to ensure compliance with the terms of the Interconnection Service Agreement.

## 1.2 Technical Requirements for Separate Systems

1. Should a manual switch be utilized, the switch must be a "break-before-make" transfer switch specifically designed and installed for that purpose. The transfer switch must be of a fail-safe mechanical throw over design, which will under no circumstances allow the generator to electrically interconnect or parallel with BEL. The transfer switch must always disconnect the Customer's load from the utility's power system prior to connecting it to the generator. Conversely, the transfer switch must also disconnect the load from the generator prior to re-connecting it back to the utility. These requirements apply to both actual emergency operations as well as to testing the generator.
2. Should transfer switch be a closed transition transfer switch, it must be UL/ANSI Standard 1008 listed and must be labelled as such.
3. The installation and operation of all closed transition transfer switch and the emergency generator shall comply with NEC Articles 700-705.
4. The closed transition, make before break, transfer mode is not to be intended to parallel the distribution electric system with the backup generation system for more than **100 milliseconds**.
5. The closed transition, make before break, transfer mode must be supervised and controlled by a customer owned synchronism check relay and the transfer shall take place only when both the distribution source and the backup generation source are within 5% of each other in voltage, within 0.2 Hz in frequency, and within five electrical degrees in phase.
6. The customer will be responsible for the protection of its facilities from any voltage or frequency excursions that occur on the distribution system. This includes any voltage and frequency excursions that occur during the closed transition transfer.

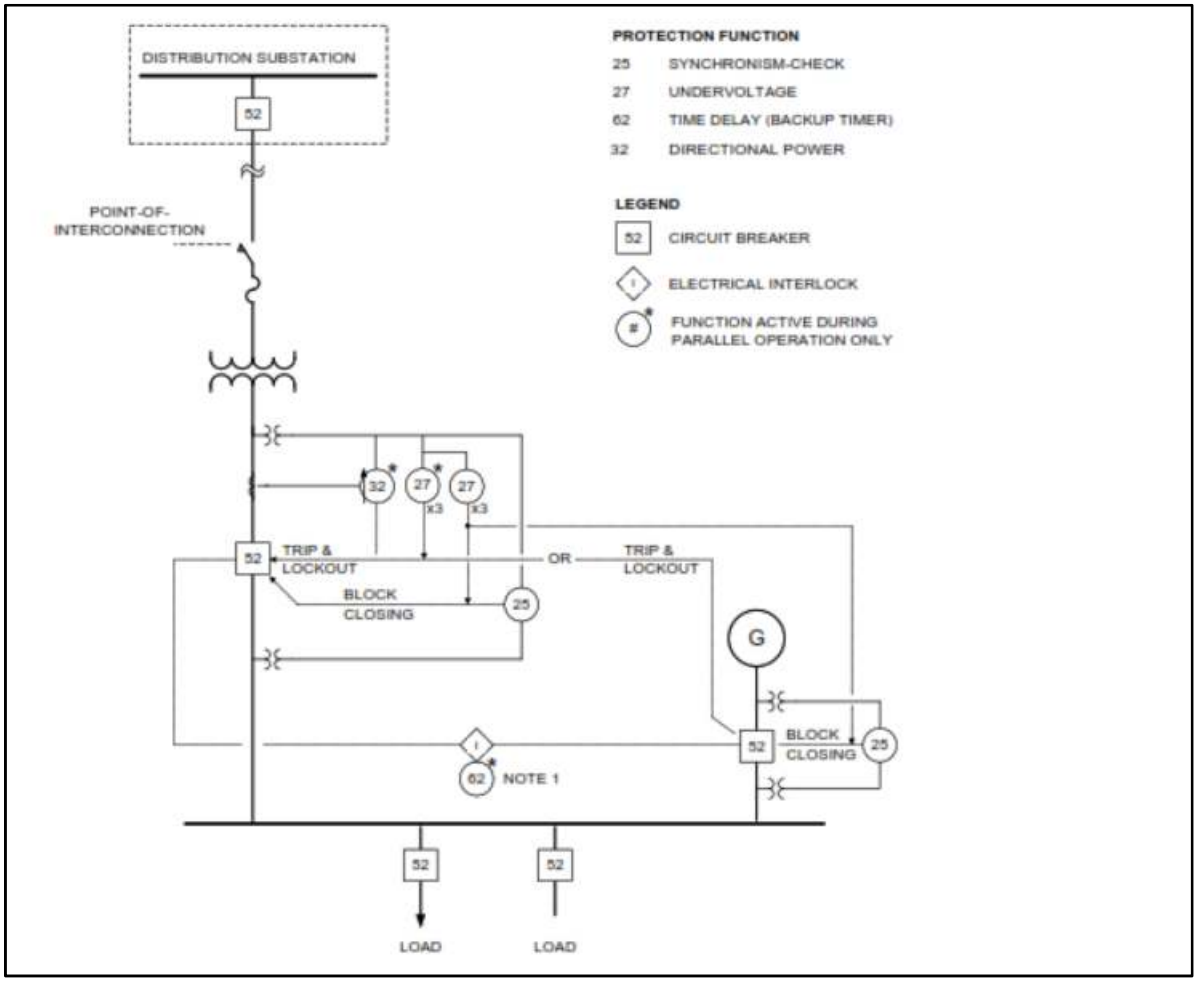
***Table 1 – ATS minimum requirements.***

| Automatic transfer requirements | |
|---|---|
| 1 | UL1008 standard and NEC Articles 700-705 |
| 2 | Shall not parallel with distribution system for more than 100milliseconds |
| 3 | Synchronism feature - within 5% of voltage, 0.2 HZ in frequency and 5 electrical degrees in phase of distribution source. |

## 1.3 Minimum Protection Device Requirements for a Separate Systems ≥ 750kW

Minimum protection requirements to prevent export of power to BEL's system shall include:

1. Sensitive directional three phase power (32) relay with trip direction towards BEL.
2. Timing Delay (62) relay which supervises the 32 relay.
3. Under voltage (27)
4. Synchronism-check (25)




## 1.4 Commissioning Requirements

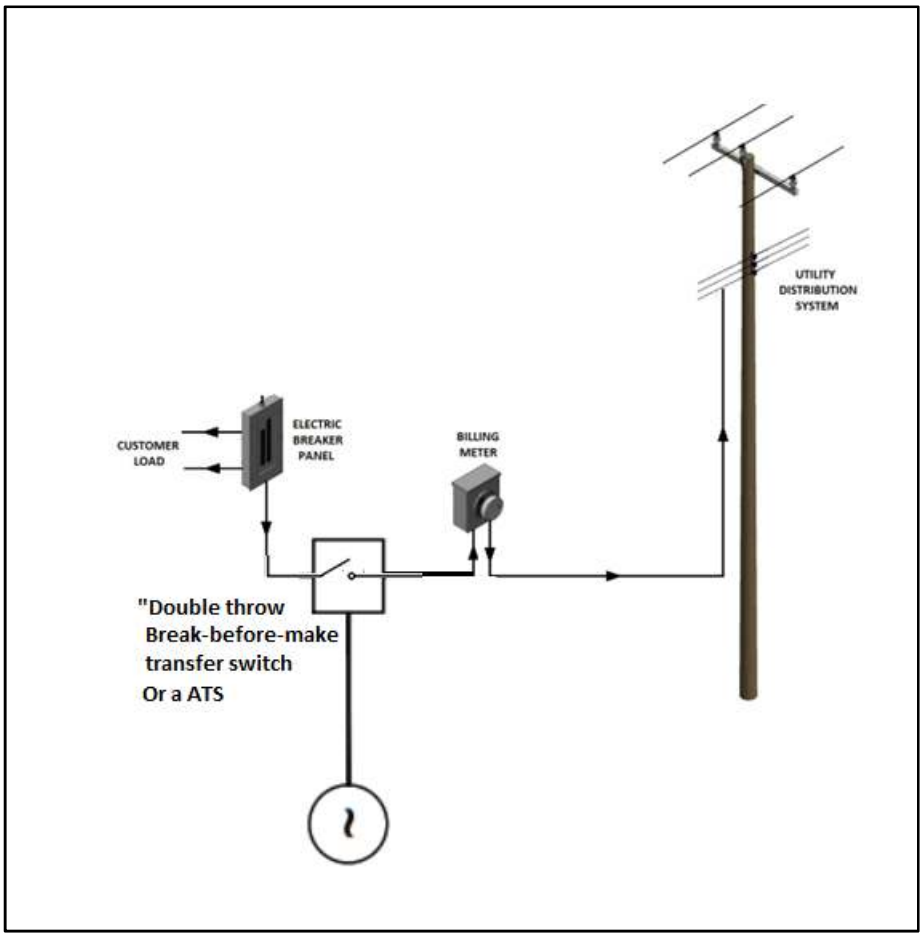
The owner has full responsibility for the inspection, testing, and calibration of its equipment, up to the Point- of-Interconnection. Competent personnel shall perform commissioning. BEL shall be advised in advance of testing and may send a representative to witness tests.

Commissioning tests confirm the safe, reliable and effective operation of all equipment at the owner's facility under normal and abnormal conditions. BEL employee would be assigned to ensure the compatibility with their system by:

1. Witness any part of the commissioning test.
2. Request additional testing.
3. Conduct his own testing.

- Deficiencies identified during commissioning must be corrected before the interconnection is approved for operation.

## 1.5 Separate System Typical Configuration



# Parallel Systems

# 2. Feeder Loading Limits for Parallel System DER

The capacity for all sections of all feeders, the "feeder limitation," is based mainly on the distance from the BEL's substation to the DER's Point of Common Coupling (PCC). The feeder limitation applies to all Parallel systems connected, or connecting, to the feeder and considers the rated output capacity of each parallel system. Any single DER connection can affect the capacity available for all sections of the feeder. The capacity indicated below considers all connected DER systems on a given feeder.

The total generation limits for all parallel DER Facilities interconnecting to the BEL Distribution System feeders is:

a. 2.8 MW to be connected on 6.6kV or 11kV feeders.
b. 5 MW to be connected on 22kV feeders.

Generation to be added after stated limit indicated above may be accepted on a case-by-case basis.

Feeder loading limits apply only to parallel generators. Generators that operate as a separate system are not considered in Feeder Loading Limits. For customers that have dual systems, only the parallel component will be considered.

# 3. Parallel DER Categorization

For ascribing varying levels of engineering and administrative effort based on the nature of the DER facility, the DER facilities have been classified as follows in **Table 2**

***Table 2 – Parallel DER Categorization***

| Category | Maximum Output | Connection Type |
|---|---|---|
| 1 | 5kW≤ | 240V or above |
| 2 | 5 kW ≤ 150 kW | 3 phase 208V or above |
| 3 | 150 kW ≤ 500 kW | 3 phase 480V or above |
| 4 | >500 kW | Dedicated Supply |

Categories are ascribed based on the parallel generation installed at DER facility.

## 3.1 Single Phase DER Systems

The maximum single-phase generation limits for DER interconnections cannot exceed 35kW considering parallel generation only.

## 3.2 Voltage Levels

All electricity across the Interconnection Point will be in the form of single-phase or three-phase, sixty-Hertz alternating current at BEL's Standard voltage levels associated with the Category of the DER Facility.

A voltage tolerance of +5% / -5 % is applicable to allow for varying load conditions as shown in below in

**Table 3.**

| Voltage Supply | Minimum(V) | Maximum(V) |
|---|---|---|
| 120/240 | 228 | 252 |
| 120/208 | 198V | 218 |
| 277/480 | 456 | 504 |

| Voltage Supply | Minimum(V) | Maximum(V) |
|---|---|---|
| 120/240 | 228 | 252 |
| 120/208 | 198V | 218 |

| | | |
|---|---|---|
| 277/480 | 456 | 504 |

*Table 3 - BEL's Standard Voltages*

# 4. General Conditions for Parallel System

Persons desirous of connecting a DER to BEL's Grid must be customers of BEL and the power source must be located at the customer's owned or rented premises. They must be current on their bill. The DER must operate in parallel with BEL's Grid and offset some or all of the Customer's own energy usage, both real and reactive energy.

## 4.1 Interconnection Agreement

The Customer is required to sign an **Interconnection Service Agreement with** BEL prior to **Official** commencement of parallel operation. The **Interconnection Service Agreement outlines** the applicable interconnection standards and requirements

## 4.2 Unauthorized Connections

BEL must grant approval in writing before any DER is connected to BEL's Grid. For the Purposes of public and utility personnel safety, BEL reserves the right to disconnect and suspend, as required, the service to any Customer who connects a DER to the electrical installation without written authorization from BEL.BEL reserves the right to conduct inspections at the DER site to ensure compliance with the terms of the interconnection Service Agreement.

## 4.3 Land Interests

The Customer should recognize that the Interconnection requirements for the DER Facilities might require acquisition of land interests, including but not limited to rights of way, which may require individual Agreements between BEL and third party landowners. All concerns or issues as relates to land acquisition and or proof of ownership shall be the sole responsibility of the Customer. BEL reserves the right to draft any and all documents creating land interests that it will receive to effectuate Interconnection service under this Interconnection Policy. In the event the Customer acquires the land, the necessary permits, licenses, franchises or regulatory or other approvals required for the construction and operation of the Distribution Facilities Upgrades, BEL has the right to approve or reject any terms and conditions related to such acquisition prior to the start of service. The Customer will submit adequate proof of availability of land for DER construction along with the Notice of Intent.

## 4.4 Distribution System Upgrade Charges

If Distribution System Upgrades are required to accommodate interconnection of the DER Facility, the customer will be required to pay a Distribution System Upgrades Charge that reimburses BEL for all reasonable costs incurred by BEL in constructing a reliable and safe interconnection that has no adverse impacts on the Distribution System. Any such charges will be reflected in the terms of the Interconnection Service Agreement.

These costs will be provided to the customer based on an Economic Analysis process. In this process, benefits of the project are considered, and cost sharing is completed. The cost considered typically includes - Engineering design, construction costs, taxes and fees, and costs of ancillary facilities (such as, reactive power support).

## 4.5 Access and Control

Properly accredited representatives of BEL or its Affiliate will at all reasonable times need access to the DER Facility to make reasonable inspections and obtain information required in connection with this Interconnection Policy. Representatives will be required to make themselves known to the Customer's personnel and state the objective of their visit. BEL or its Designated Agent will have control such that it may open or close the circuit breaker or disconnect and place safety grounds at the appropriate Interconnection point.

## 4.6 Future Modifications and Expansion of DER System

Prior to modifying, expanding or altering the DER, the Customer must obtain written permission from IRC to alter or extend an existing installation. Thereafter, the Customer must provide a new Application Form, revised single line Diagram, Interconnection Service Agreement and to seek prior written approval from BEL before interconnecting the modified DER to BEL's Grid.

## 4.7 Customer-owned equipment protection

It is the Customer's sole responsibility to protect its facility loads and generation equipment and comply with the requirements of all appropriate and relevant standards, codes and local authorities.

# 5. General Requirements for Parallel Systems

The DG Facility will provide a disconnect switch at the interconnection point with BEL that can be opened for isolation. The switch will be in a location accessible to BEL's personnel at all times. BEL will have the right to open this disconnect switch during emergency conditions and with reasonable notice to the Customer at other times. BEL will exercise such right in accordance with Good Utility Practice. The switch will be gang operated, have a visible break when open, be rated to interrupt the maximum generator output and be capable of being locked open, tagged and grounded on BEL side by Company personnel. The switch will be of a type approved by BEL.

## 5.1 Requirements for Inverter-based installations:

1) The DG Facility is responsible for protecting its equipment from being re-connected out of synchronism with BEL's system by an automatic line recloser operation. To meet these requirements, the DG facility's protection needs to be consistent with the auto-reclosing policies of BEL.

2) The following information must be submitted by the Customer for review and acceptance by BEL prior to BEL approving the Customer's request for interconnection:

1. Electrical single-line diagram or sketch depicting how the inverter will be interconnected relative to the service entrance panel and the electric meter.
2. Make, model and manufacturer's specification sheet for the inverter.

3) For Facilities that utilize photovoltaic technology or other direct current energy sources and employ inverters for production of alternating current, it is required that the system be installed in compliance with IEEE Standard 929-2000, "IEEE Recommended Practice for Utility Interface of Photovoltaic (PV) Systems". The inverter will meet the Underwriters Laboratories Inc. Standard UL 1741, "A Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems" or IEEE 1547. The Customer's request for interconnection will be accompanied with a request to conduct a Distribution Facilities Impact Study or a Distribution Facilities Detailed Study as deemed necessary by BEL. In addition, due to the nature of PV impacts on interconnected distribution systems, BEL reserves the right to request special studies depending on the control technology and the physical characteristics used for the PV converters.

## 5.2 Requirements for Parallel Connected Induction Generator installations:

The Customer for review must submit the following information and acceptance by BEL prior to the Customer finalizing the DG Facility's protection design and BEL is approving the Customer's request for interconnection:

1. Three copies of a three-line drawing for three phase units or a two-line drawing for single phase units showing the AC connections to the relays, if required in this Interconnection Policy, and meters.
2. The generator nameplate information including rated voltage rated current, power factor, HP/kW, rated speed and locked rotor current.
3. Three copies of applicable relay instruction manuals may also be required if BEL does not already possess them.
4. Schematic drawings showing the control circuits for the interconnection breaker(s) or contactor(s).
5. Specifications for CTs and PTs relevant to the interconnection including their make, model, accuracy class, ratio, and available taps.
6. The proposed grounding method for the stator winding of the generator.
7. Other information that may be determined by BEL as required for a specific interconnection.
8. Relay settings for all DG Facility protective relays that affect the interconnection with BEL's system must be submitted for review and acceptance by BEL.
9. As changes occur in the location and size of capacitors, the DG Facility may be required in the future to upgrade its interface to meet the requirements for synchronous machines if self-excitation becomes possible even if not initially possible.
10. BEL will review the relay settings as submitted by the Customer to assure adequate protection for BEL's facilities. BEL will not be responsible for the protection of the DG Facility or Customer is other facilities. The DG Facility will be responsible for protection of its system against possible damage resulting from parallel operation with BEL.

## 5.3 Studies for Utility Acceptance

Without DER, the power flow in a radial system is unidirectional and decreases with increasing distance from the power substation. Since DER can modify the power flow directions, difficulties in maintaining and adjusting voltage regulation may arise. Therefore, the DER interconnection policy requires that studies.

Be performed to assess the impacts of power flows in the system. Two separate analyses that will be performed for an interconnection are:

**a) Distribution Systems Impact Study, and**

**b) Distribution Facilities Detailed Study (if required)**

These studies will evaluate generation interconnection feasibility, the impact of DER on BEL's system along with the impact of the system on DER, and then evaluate options for system upgrade as necessary. The interconnection policy requires that power flow analysis be performed to assess the impact of the interconnecting DER resource on the local system and to identify any known violations in the area based on a contingency set. The contingency set will be established by BEL and will be agreed upon with the Customer or entity making the request for interconnection. Similarly, stability analysis will be performed for resources where existing stability margins are limited. BEL will ensure that operational issues such as availability of spinning reserve are appropriately considered while conducting these studies and while developing the findings and recommendations. BEL reserves the complete right to decline any interconnection request due to any system or operational constraints.

Category 1 facility may generally not be required to do any of the studies except in exceptional circumstances that will be determined by BEL. Interconnection of Category 2 & 3 facilities may require a Distribution Systems Impact Study but may not be required to conduct a Distribution Facilities Detailed Study. For larger facilities such as a Category 4, a Distribution Facilities Detailed Study will be required in addition to Distribution Systems Impact Study in or DER to scope the required distribution facility system additions and/or upgrades necessary due to the addition of the distributed resource. BEL may decide to include all the analyses performed on DER Generation Interconnection Feasibility, System Impact, and Generation Interconnection Facilities Studies under one study. Typically, power flow analysis will be performed to ensure that local contingency criteria are not violated.

Short circuit calculations will be performed to ensure that circuit breaker and protection equipment capabilities are not exceeded. BEL or its designee acting on its behalf will also evaluate the engineering details of the physical attachment of the resource, as well as the relaying and metering

associated with the resource to ensure a safe and reliable interconnection. This may entail a more detailed evaluation in certain cases and configurations.

# 6. Metering for Parallel Systems

When a distributed generation site generates more electric energy than is being consumed, the surplus electric energy will be supplied out of the distributed generation site into BEL's grid. Distributed generation applicants must notify BEL they are becoming a micro-generator. Distributed generation units will be compensated for their electrical energy supplied.

The DER interconnection policy will govern the operation of the DER interconnection to the BEL grid. In compliance with the policy, billing approach will be a net billing configuration.

In compliance with DER interconnection Policy, BEL will be using a net billing approach and associated rates, to compensate for excess energy fed to the grid. Net billing allows DER customers to generate electricity for personal use, and can sell any excess energy they generate back to BEL. Both consumption and generation are recorded and billed separately. As a result, customers get charged their full retail rate per kWh when they use energy from the grid, and are paid a wholesale price by the utility when they sell it back.

Below are configurations for the different types of systems:

## 6.1 Parallel System Configuration

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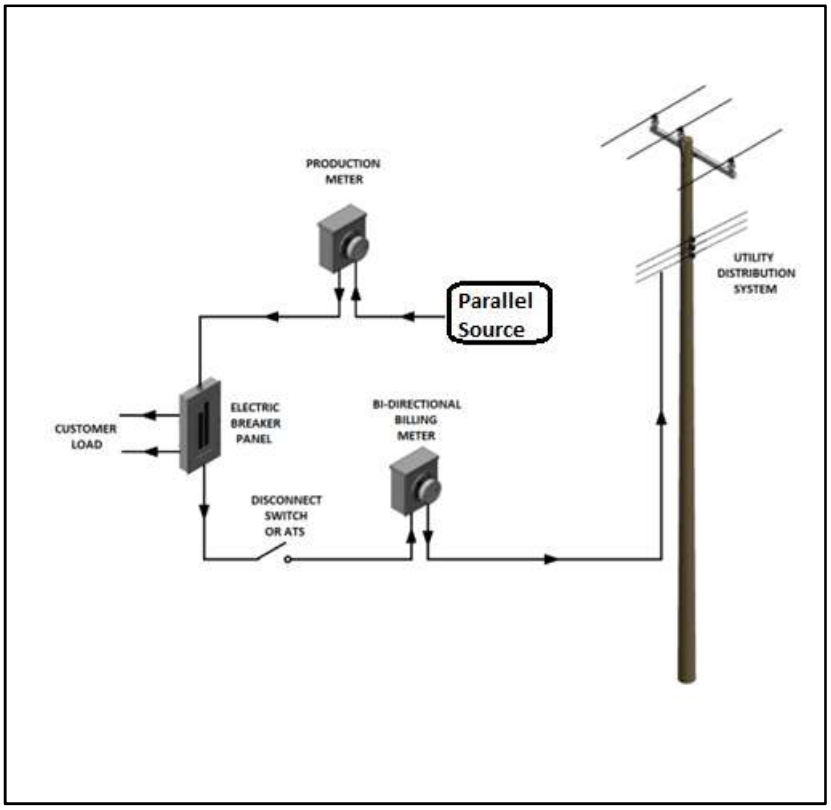
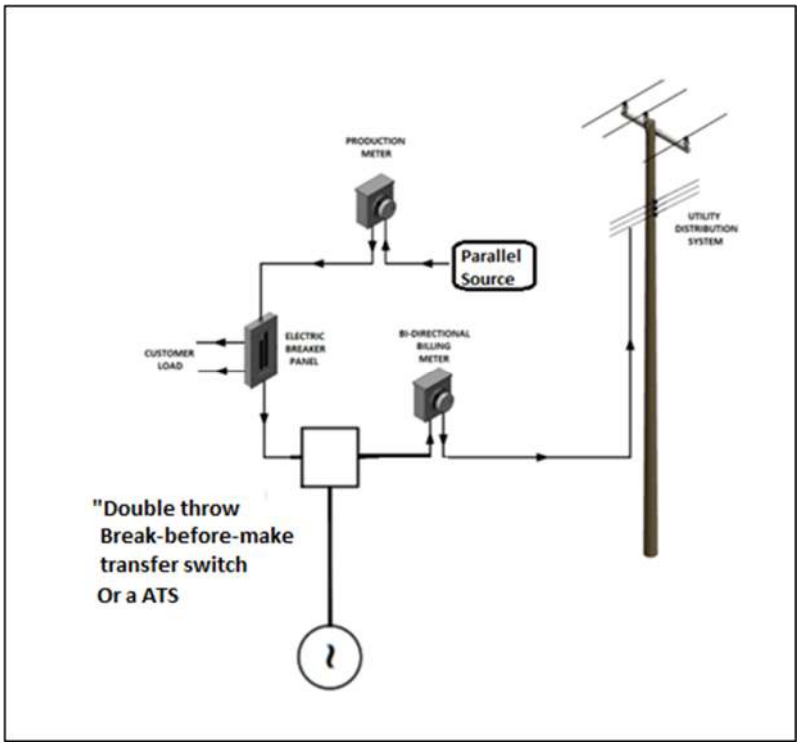


## 6.2 Dual System Configuration



## 6.3 Metering Related Equipment and Billing Options:

BEL will provide meters required for DER interconnection, for which the Customer may be required to pay to BEL a one-time charge to cover expenses associated with the meter. The Customer will provide suitable space within the DER Facility for installation of the metering, at no cost to BEL.

All metering equipment installed pursuant to this Interconnection Policy and associated with the DER Facility will be routinely tested by BEL in accordance with applicable metering criteria, rules and standards. Should the Customer require additional testing outside of this schedule, it shall be provided at a cost to the Customer. If, at any time, any metering equipment is found to be inaccurate by a margin greater than that allowed DER applicable criteria, rules and standards, BEL will cause such metering equipment to be made accurate or replaced.

The type of metering equipment to be installed at a DER Facility is dependent on the Category (size) of the facility.

## 6.4 Meter Sockets

All self-contained meter socket bases are to be supplied and installed by the customer. Self-contained type meters may be used for loads up to but not exceeding 200 amps. For **bi-directional** services in excess of 200 amps, the utility will provide a meter socket base and the required metering current transformers (CTs). For **production meters** in excess of 200 amps, the customer is required to provide a meter socket base and the required metering current transformers (CTs). An agreement of CT and meter socket base required for production meter is to be determined during utility studies and documented in the Interconnection Agreement between utility and customer. Installation greater than 500kW requires primary metering to be installed by utility, at customer's cost.

## 6.5 Location of Socket Base on Building

The **bi-directional meter** should be placed in a location that will be accessible at all times to BEL meter readers. In cases where it can be determined that the customer plans to fence the property, the customer may prefer to have an underground supply and place the meter on a column at the

boundary of the property. In this case, the meter should face outwards towards the roadway. This type of installation is recommended for underground residential distribution. Bi-directional meters must meet the requirements of BEL Service Installation Manual.

The **production meter** should be placed between parallel generation source and load. It is understood that this meter may be in a location on the customer's premises. An agreement of suitable location and accessibility terms is to be determined during utility studies and documented in the Interconnection Agreement between utility and customer.

## 6.6 Single Meter Installation

a) ***Type of Socket Base—*** A 5 jaw socket is required for all three wire services with the fifth jaw connected to the neutral conductor. Note that neutral should be continuous through meter socket.

b) ***Height of Socket***— the meter socket should be at a height of about 1.7m or 5.6ft above finished grade.

c) ***Wiring of Socket Base—*** the wiring in the socket base should be neat, not bulky. Any excess wire in the socket base may prevent the meter from being properly inserted into the socket.

d) ***Security of Socket Base***— the meter socket base should be properly secured to the building or service pedestal.

e) ***Waterproof***— the point at which the conduit enters the meter socket base should be properly sealed to prevent the ingress of water into the socket. **All equipment installed outdoors should be designed and rated for outdoor use, as it will be exposed to changes in weather**.

**Both Bi-directional and Production meter must meet requirements stated above.**

# 7. Summary of Application and Interconnection Process for Parallel Systems

a) Persons desirous of installing the DER are required to be familiar with these requirements for interconnection BEFORE acquiring the DER.

b) The Customer may obtain application forms, Distributed Renewable Energy Generation Interconnection Policy, and information on DER requirements from BEL offices. This information is also available on BEL's website at https://www.bel.com.bz/

c) In order for an interconnection to BEL's Grid to be approved, the Customer is required to do the following:

I. Understand BEL's interconnection requirements before starting the project;

II. Submit to BEL:

i. A Notice of Intent to which shall include:

a) Application to interconnect

b) Three copies of single line diagrams of proposed Renewable Energy (RE) System

c) Relevant proof of ownership of property on which RE system is to be installed and documented Right of Way (ROW) where applicable

ii. A manufacturer specification sheet of the inverter showing the product technical details.

III. Ensure provision of a visible lockable outdoor rated AC disconnect is in an accessible location at or near BEL's meter.

DG Interconnection Process Flow.pdf

## 7.1 Application process

The process of interconnecting a DER Facility with BEL's Distribution System is described and
Summarized below:

1. The Customer submits an Application and Notice of Intent to Interconnect ("Notice of Intent") to BEL. The form of the Application and Notice of Intent is provided in Appendix A. The application should be sent to BEL's designee at the address specified by BEL.
2. Receiving the Application and Notice of Intent, BEL's designee will work with the Customer and serve as the point of contact for all future activities until directed otherwise. The Notice of Intent will be reviewed and verified for completeness. If any of the requirements specified in the Interconnection Policy are not met, BEL will inform the Customer in writing and the application process will be delayed until the Customer has addressed the deficiencies in writing.
3. If the Application is for an Inverter-based DER Facility, BEL will determine if the DER Facility complies with UL Standard 1741 or equivalent.
4. Fast Track Interconnection for Small inverter based DER Facilities: For systems that are under 5kW, BEL provides a faster interconnection process. This facilitates and simplifies the interconnection process for smaller DER Facilities by eliminating the Detailed Study as long as the DER Facilities meet the codes and standards stated by BEL, and provided that BEL has reviewed the design and monitored the proposed inverter based DER facility and is satisfied that the installation is safe for operation. Note that the system is "monitored" after the Customer and BEL execute the DER Interconnection Monitoring Agreement.
5. Upon reviewing the Application and Notice of Intent, BEL will determine if the proposed installation meets the capacity limits specific to the Customer's consumption. An evaluation of whether a Distribution Facilities Impact Study (Impact Study) is required will be subsequently conducted. This evaluation will be conducted by BEL.
6. If an Impact Study is required, BEL will prepare a cost estimate to perform the study and will submit such estimate to the Customer.

7. If the Customer elects to proceed with the Impact Study, the Customer and BEL will execute a Distribution Facilities Impact Study Agreement, a sample short form of which is provided in Appendix D. However, note that BEL reserves its right to include additional provisions and use a longer form of agreement to the extent necessary to address any specific circumstances of the project. The Customer will be required to pay BEL for the costs incurred in performing the study.
8. Upon execution of the Distribution Facilities Impact Study Agreement and receipt of payment in full, BEL will conduct the Impact Study and, upon completion of the work, issue a Distribution Facilities Impact Study Report to the Customer. The Report will also indicate whether a Detailed Study is required. If no Detailed Study is required, the Customer may proceed to install said DER.
9. If the Customer elects to proceed with the installation, the Customer and BEL will execute a DER Interconnection Monitoring Agreement. The form is provided in Appendix.
10. If a Detailed Study is required and the Customer elects to proceed with the project, BEL will prepare a cost estimate to perform the study and will submit such estimate to the Customer.
11. If the Customer elects to proceed with the Detailed Study, the Customer and BEL will execute a Distribution Facilities Detailed Study Agreement, a form of which is provided in Appendix D. However, BEL reserves its right to change the terms or include additional provisions to address the specific circumstances of the project. The Customer will be required to pay the costs incurred by BEL in performing the study.
12. Upon execution of the Distribution Facilities Detailed Study Agreement and receipt of payment in full, BEL will conduct the Detailed Study and, upon completion of the work, issue a Distribution Facilities Detailed Study Report to the Customer.
13. This report will contain a detailed cost estimate for any equipment and/or modifications to the Distribution System required to interconnect the DER facility.
14. After reviewing the Distribution Facilities Detailed Study Report, if the Customer elects to proceed with the interconnection of the DER Facility, BEL will require the Customer to execute a DER Interconnection Monitoring Agreement.

15. Upon execution of the DER Interconnection Monitoring Agreement and payment in full for any equipment and/or modifications specified in the Detailed Study, Customer will proceed to construct the required facilities for monitoring.
16. If the monitoring comply with BEL's interconnection requirements, the Customer and BEL shall proceed to execute the Interconnection Service Agreement. The terms of such Agreement will depend upon the size and location of the DER Facility, and other Customer-specific parameters particular to each individual interconnection request. A copy of the said Agreement to be logged with the IRC.
17. DER owner is responsible for the design and calculations of voltage levels of the DER system up to the PCC
18. Owner must obtain formal, written approval by BEL for grid-tied battery systems.

***Table 4 - Application Process***

| # | ACTIVITY STEPS | PARTY RESPONSIBLE |
|---|---|---|
| 1 | Obtain Distributed Renewable Energy Generation Interconnection Policy | Customer |
| 2 | Read and get familiar with the Distributed Renewable Energy Generation Interconnection Policy | Customer |
| 3 | Get information on DER requirements | Customer |
| 4 | Obtain application form | Customer |
| 5 | Submit application along with Notice of Intent | Customer |
| 6 | Review Notice of Intent and give feedback | BEL |
| 7 | Determine whether to conduct an Impact Study | BEL |
| 8 | Execute Distribution Facilities Impact Study Agreement (if yes for # 7) | BEL |
| 9 | Conduct Impact study | BEL |
| 10 | Execute Distribution Facilities Detailed Study Agreement (if yes for # 10) | BEL |
| 11 | Conduct Detailed Study | BEL |
| 12 | Issue Distribution Facilities Detailed Study Report to the Customer. | BEL |
| 13 | Execute DER Interconnection Monitoring Agreement | BEL |
| 14 | Construct the facility for monitoring | Customer |
| 15 | Inspect upon Installation and provide feedback | BEL |
| 16 | Execute the Interconnection Service Agreement | BEL |
| 17 | Forward Copy of agreement to the IRC | BEL |

# 8. Connection Requirements for Parallel Systems ≤150kW

## 8.1 General Requirements

This section covers Parallel DER systems of Category I and II identified in **Error! Reference source not found.** above.

**Category I**

- No production meter is required for customers which meet Category I level.
- All other requirements are to be met by customers of Category I

## 8.2 Isolating Device

The DER Facility will provide a disconnect switch at the interconnection point with BEL that can be opened for isolation. The switch will be in a location accessible to BEL's personnel at all times. BEL will have the right to open this disconnect switch during emergency conditions and with reasonable notice to the Customer at other times. BEL will exercise such right in accordance with Good Utility Practice. The switch will be gang operated, have a visible break when open, be rated to interrupt the maximum generator output and be capable of being locked open, tagged and grounded on BEL side by Company personnel. The switch will be of a type approved by BEL.

## 8.3 Interconnection Grounding

The DER must be grounded as per the equipment manufacturers' recommendations and according to the requirements of the BEL's Service Installation Manual and UL1741 Section 20. Grounding system resistance readings are to be at maximum, 25 ohms. BEL provides a grounded neutral service conductor. In **Table 5** below indicates summarized grounding conductor requirements.

**Table 5 - Grounding Requirements** *(NEC table 250.102 (C)(1))*

| Grounding Requirements | | | | | |
|---|---|---|---|---|---|
| Copper Conductor | | | Aluminium or Copper-Clad Conductor | | |
| Conductor Size | Copper | Aluminium-Copper Clad | Conductor Size | Copper | Aluminium-Copper Clad |
| | Grounding Conductor | Grounding Conductor | | Grounding Conductor | Grounding Conductor |
| 1/0 or smaller | #6 | #4 | 1/0 or smaller | #8 | #6 |
| 2/0 | #4 | #2 | 2/0 | #6 | #2 |
| 4/0 | #2 | 1/0 | 4/0 | #4 | 1/0 |
| 250 | #2 | 1/0 | 250 | #2 | 1/0 |
| 350 | 1/0 | 3/0 | 350 | 1/0 | 3/0 |
| 500 | 1/0 | 4/0 | 500 | 1/0 | 3/0 |
| 750 | 2/0 | 4/0 | 750 | 2/0 | 4/0 |

## 8.4 Power Quality (Technical and Performance Requirements)

### 8.4.1 Voltage

All electricity across the interconnection point will be in the form of single phase or three phase alternating current at a voltage level determined by mutual agreement between BEL and the Customer. A voltage tolerance of +5% / -5 % is applicable to allow for varying load conditions as shown in **Table 3**

### 8.4.2 Voltage Flicker

The DG operation must not result in objectionable flicker on the utility system for other connected customers at the point of common coupling. Objectionable voltage flicker is defined as, causing equipment mis-operation, or the flickering of lamps at levels irritating to humans. Reference IEEE Std. 519-1992, IEEE P1453, IEC/TR3 61000-3-7, IEC 61000-4-15, IEC 61400-21.

### 8.4.3 System Frequency

BEL's Grid operates at 60 Hz. Frequency deviations typically range from 60.6Hz to 59.4HZ

***Table 6 - Frequency Operating Ranges***

| Nominal Frequency (+/- 1%) | Minimum Frequency | Maximum Frequency |
|---|---|---|
| 60Hz | 59.4Hz | 60.6Hz |

### 8.4.4 Harmonics Distortion

DERs are expected to comply with IEEE Standard 519, IEC 61000-3-2, IEC TS 61000-3-4, or IEC 61000-3-12 current distortion limits with regard to harmonic current injection into BEL's Grid. The harmonic current injection arising from the DER shall not exceed the values listed in **Table 7** below (excluding any harmonic currents associated with harmonic voltage distortion present on BEL's Grid without the DER connected). Total current harmonic distortion shall not exceed 5% of rated current.

***Table 7 - Current Harmonic Distortion***

| Maximum Total current harmonic distortion | | 5% |
|---|---|---|
| | Maximum distortion | |
| Harmonic Numbers | Even Harmonics | Odd Harmonics |
| h < 11 | 1.0% | 4.0% |
| 10 < h < 17 | 0.5% | 2.0% |
| 8 < h <23 | 0.4% | 1.5% |
| 24 < h < 35 | 0.2% | 0.6% |
| h > 35 | 0.1% | 0.3% |

### 8.4.5 Voltage Imbalance

When single phase DERs are connected in multiple units and three-phase service is available, then approximately equal amounts of generation capacity should be applied to each phase of a three-phase circuit. Voltage imbalance caused by the DER at the PCC is limited to 3 %.

### 8.4.6 DC Injection

The DER shall not inject a DC current greater than 0.5% of the unit's rated output current at the Point of Common Coupling after a period of 6 cycles following connection to BEL's Grid

### 8.4.7 Voltage Rise

During normal operation, the voltage rise caused by the DER at the PCC shall not exceed by 3% the magnitude of the voltage when the DER is not connected. DER owner is responsible for the design and calculations of voltage levels of the DER system up to the PCC. The expected operating voltage from BEL is normally regulated at 102% of nominal voltage at the PCC but will be at 105% (extreme operating limits). The customer is required to take the extreme operating limits into consideration when performing voltage calculations or sizing the DER system.

The DER owner shall ensure voltage is always maintained within 95~105% at PCC.

The customer must calculate secondary voltage rise and consider potential nuisance tripping caused by overvoltage during the design phase of the DER interconnection. For measurement purposes, in most cases is the metering point, however where site access is restricted, BEL reserves the right to choose an accessible location to measure closest to the service entrance or the metering point.

### 8.4.8 Reactive Power Capability

1) The DER shall be capable of operating at a constant power factor between 0.95 leading and 0.95 lagging.

### 8.4.9 Under-Voltage and Over-Voltage Ride Through

1. The DER Facility interconnection protection scheme shall have the capability of detecting abnormal voltages.

2. Three phase inverter systems shall detect each individual phase to neutral voltage on a grounded Wye system or each individual phase-to-phase voltage on an ungrounded Wye or delta system.

3. Single phase inverter systems shall detect the phase to neutral voltage if connected to the neutral conductor.

4. Single phase inverter systems connected phase to phase (not connected to the neutral conductor) shall detect the phase-to-phase voltage.

5. In the case of under-voltage for synchronous generators, the DER Facility shall not disconnect from the grid if the voltage as a percentage of the nominal voltage value remains above the lower blue line in **Figure** . (in the case of three-phase generators, the voltage refers to the smallest line-to neutral or line-to-line voltage at the generator terminal); the points which define the lower blue line in **Figure** are listed in **Table 8**.

6. In the case of under-voltage for non-synchronous generators, the DER Facility shall not disconnect from the grid if the voltage as a percentage of the nominal voltage value remains above

the lower blue line in **Figure** . (in the case of three-phase generators, the voltage refers to the smallest line to-neutral or line-to-line voltage at the generator terminal); the points which define the lower blue line in **Figure** are listed in **Table 8**.

7. In **Figure** and **Figure** the time t=0 seconds marks the beginning of the voltage drop (where the voltage first falls below 90% of the nominal voltage).

8. In the case of over-voltage, the DER Facility shall not disconnect for 0.92 s if the voltage rises to between 110% and 120% of its nominal value. The upper blue line in **Figure** and **Figure** represents this; in the case of three-phase generators, the voltage refers to the highest line-to-line voltage at the generator terminal.

9. If the active power production is reduced during the fault, it shall be ramped up back to the pre-fault value after fault clearance with a ramp rate of at least 10% of the rated power per second.

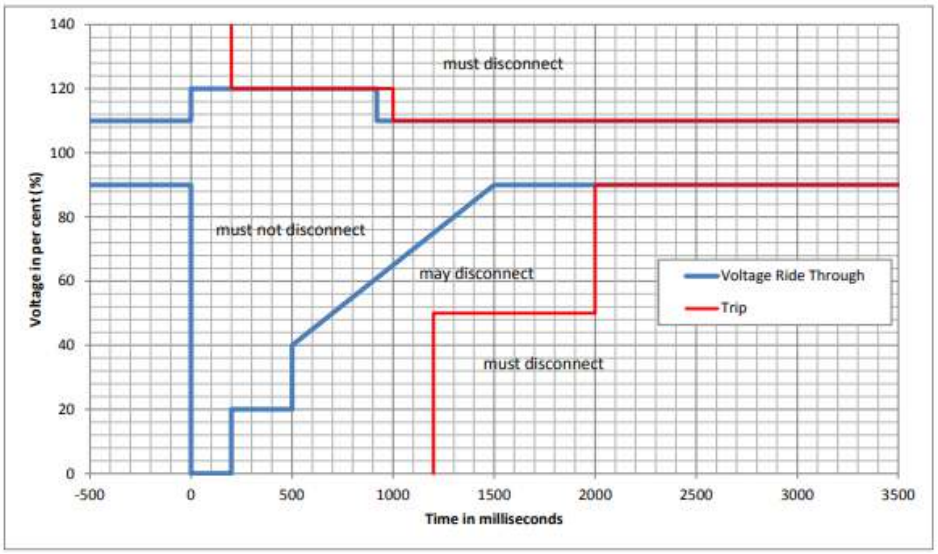



***Figure 5 - Voltage Ride through Curves for synchronous generator ≤150kW.***

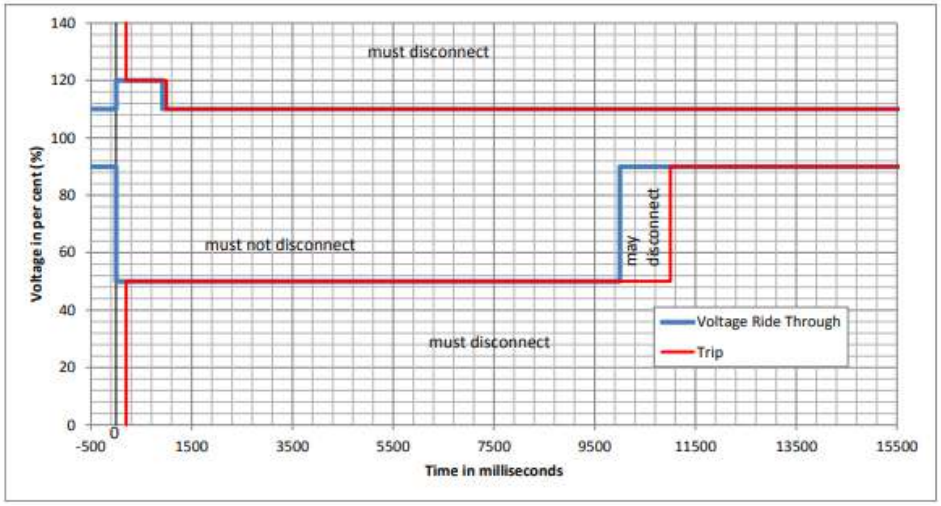



***Figure 6 - Voltage Ride through Curves for non- synchronous generator ≤150kW.***

***Table 8- DER Under- and Over-Voltage Protection Trip Times***

| 0UVRT points for synchronous DER | | UVRT points for non-synchronous DER | |
|---|---|---|---|
| Time (milliseconds) | Voltage (%) | Time (milliseconds) | Voltage (%) |
| 0 | 0 | 0 | 50 |
| 200 | 0 | 10000 | 50 |
| 200 | 20 | 10000 | 90 |
| 500 | 20 | | |
| 500 | 40 | | |
| 1500 | 90 | | |

### 8.4.10 Under Frequency and Over Frequency Ride Through

*1. The DER Facility interconnection protection scheme shall have the capability of detecting abnormal frequencies shown below in*

**Table 9**. It must comply with IEEE STD 1547-208

*2. The DER Facility shall not disconnect due to frequency deviation during abnormal frequencies within the ranges and within the time limits marked "Ride Through" in*

**Table 9**. The same conditions are illustrated in **Figure 7 - Frequency Operating Limits for DER ≤ 150 kW**.

*3. The times in*

**Table 9** shall be measured from the instant when the measured frequency has crossed the respective threshold.

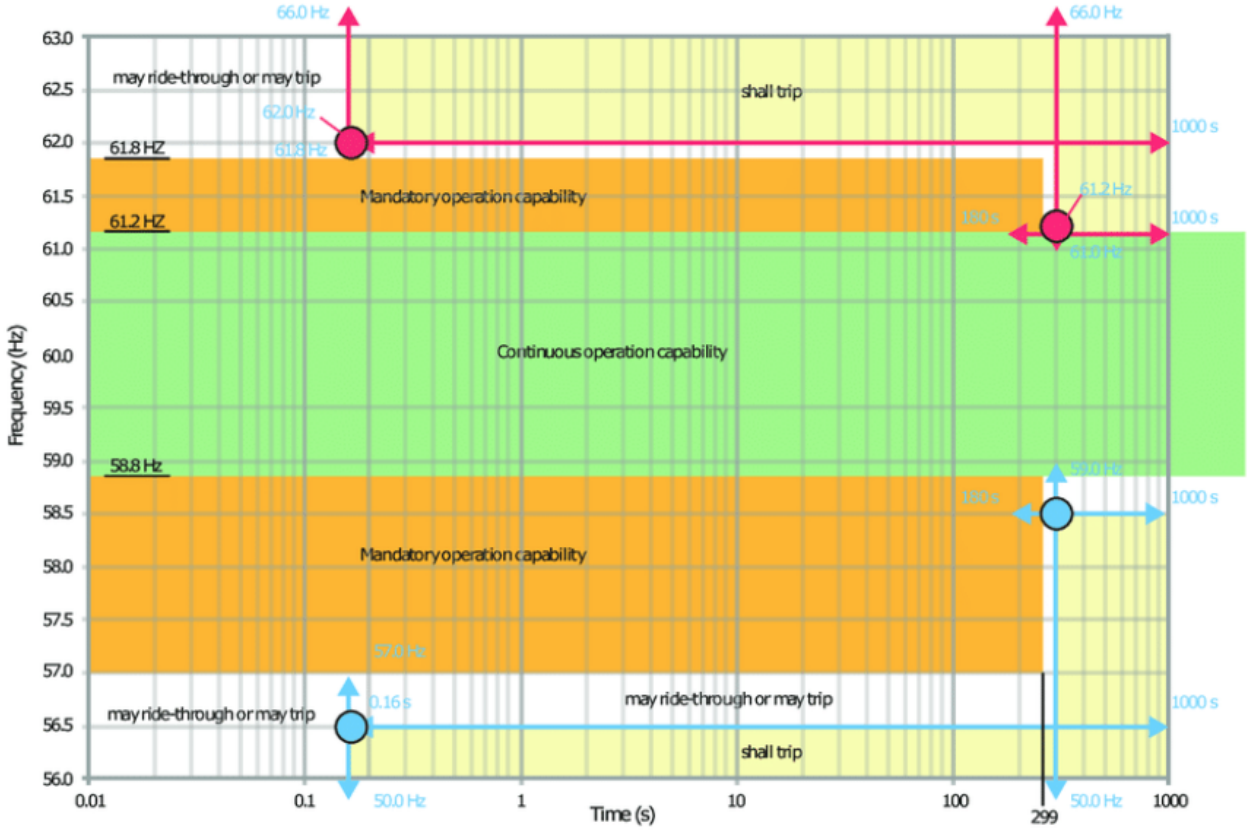



***Figure 7 - Frequency Operating Limits for DER ≤ 150 kW***

***Table 9 - Frequency Ride Through for DER ≤ 150 kW***

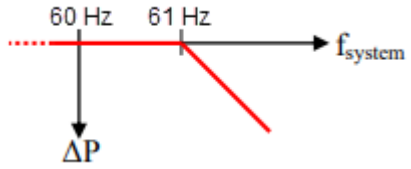
| Range (Hz) | Mode | FRT Duration (s) | |
|---|---|---|---|
| | | Ride Through | Trip |
| f > 63.0 | Trip | None | 0.2 |
| 62.5 < f ≤ 63.0 | Ride Through | 20 | 21 |
| 57.5 < f ≤ 62.5 | Normal Operation | Indefinite | Indefinite |
| 57.0 ≤ f ≤ 57.5 | Ride Through | 20 | 21 |
| f < 57.0 | Trip | None | 0.2 |

### 8.4.11 Over-Frequency Active Power Reduction for Non-Synchronous Generators

1. All non-synchronous DER should reduce their active power output by a frequency-dependent power difference ΔP when the system frequency exceeds a threshold of 61.0 Hz.
2. The active power output at the time when the frequency crosses the threshold is frozen and taken as the reference $P_M$ for the power reduction.
3. Above the threshold, the power reduction per unit of $P_M$ is calculated according to the formula:

$$\Delta P / P_M \text{ (per unit)} = 20 \times (61.0 \text{ Hz} - f_{system})/60 \text{ Hz}$$

Where $f_{system}$ is the system frequency in Hz.




1. This corresponds to a power reduction of 40% of the frozen reference active power per Hz.
2. The frequency measurement shall be accurate within 10 MHz the response time to over-frequency shall be as fast as possible, as and not larger than 0.5 seconds shall.
3. When the system frequency returns to below 61.0 Hz and the DER is then capable of producing more than the previously frozen reference active power, the active power may be ramped up to the maximum with a ramp rate not exceeding 10% of the rated active power output per minute.
4. DER not capable of adjusting their active power output shall disconnect at a randomized frequency threshold between 61.0 Hz and 63.0 Hz. The manufacturer may perform the randomization, such that a fixed threshold may be built into the generation unit.

## 8.5 Protection Requirements

### 8.5.1 Interconnection Protection Function Requirements

The DER shall incorporate the following protective functions: -

(i) AC disconnecting;
(ii) Anti-Islanding;
(iii) Automatic synchronizing (generators with stand-alone capability);
(iv) Under-voltage trip (on each phase for 3-phase equipment);
(v) Over-voltage trip (on each phase for 3-phase equipment);
(vi) Instantaneous over-current trip (on each phase for 3-phase equipment);
(vii) Timed over-current trip (on each phase for 3-phase equipment);
(viii) Under-frequency trip; and
(ix) Over-frequency trip

### 8.5.2 Over-Current Protection

The DER must detect and promptly cease to energize for over-current fault conditions within its system.

### 8.5.3 Under-Voltage and Over-Voltage Protection

1. Every grid-tied DER shall have under/over-voltage protection and, on detection of such voltage, shall cease to energize within the timeframe indicated in **Table 10**.
2. Three phase inverter systems shall detect each individual phase to neutral voltage on a grounded Wye system or each individual phase-to-phase voltage on an ungrounded Wye or delta system for the purposes of **Table 10**.
3. Single phase inverter systems shall detect the phase to neutral voltage if connected to the neutral conductor.
4. Single phase inverter systems connected phase to phase (not connected to the neutral conductor) shall detect the phase-to-phase voltage.
5. The DER shall not attempt to regulate the voltage or adversely affect the voltage at the Point of Connection.
6. The DER Facility shall reconnect once the conditions in section **8.5.6** are met.

*Table 10- DER ≤ 150 kW Under- and Over-Voltage Protection Trip Times*

| Range (% of nominal Voltage) | Trip Time (seconds) | |
|---|---|---|
| | Synchronous DER | Non- Synchronous DER |
| V> 120 | 0.20 | 0.20 |
| 110 < V ≤ 120 | 1.0 | 1.0 |
| 50 < V ≤ 90 | 2.0 | 11.0 |
| V < 50.0 | 1.2 | 0.2 |

### 8.5.4 Under Frequency and Over Frequency Protection

1) The DER Facility interconnection protection scheme shall have the capability of detecting abnormal frequencies shown in **Table 9**.
2) The DER Facility shall disconnect from BEL's Distribution System in the clearing times specified in **Table 9** under "Trip".
3) The times in **Table 9** shall be measured from the instant when the measured frequency has crossed the respective threshold.
4) If the DER has ceased to energize due to over/under frequency conditions, the DER Facility shall reconnect only once the conditions in section **8.5.6** are met.

### 8.5.5 Short-Time Contingency

1) Network faults that
   i. Lead to the disconnection of the DER
   ii. And where the violation of the normal operating ranges of voltage (between 90% and 110% of its nominal value) and frequency (between 57.5 Hz and 62.5 Hz) is shorter than 3 seconds shall be called short-time contingencies.
2) After short-time contingencies, the DER may reconnect to the grid if voltage and frequency continuously remain within the normal operating ranges for at least 5 seconds.
3) The active power ramp of the DER reconnecting after short-time contingencies shall be at least 10% of rated power per second.

4) If the conditions stated under (1) and (2) are not fulfilled, the normal reconnection procedure applies as outlined in Section 8.5.6 - Reconnection after Protection Tripping.

### 8.5.6 Reconnection after Protection Tripping

1) After disconnection due to protection tripping, the DER shall reconnect to the grid when
   i. The voltage continuously remains within 95% to 105% of its nominal value and, at the same time,
   ii. The frequency continuously remains between 57.5 Hz and 62.5 Hz for at least 60 seconds.
2) The active power ramp of the reconnected DER shall not exceed 10% of rated power per second until
   i. The momentary maximum active power output or dispatched active power output is reached (uncontrollable DER)
   ii. The dispatched active power output is reached (controllable DER)
3) If the active power ramp cannot be limited, reconnection shall be delayed by a random time (specific to each DER unit) interval between 1 and 10 minutes.

### 8.5.7 Anti-Islanding

For an unintentional island condition, where the DER energizes a portion of BEL's Grid, the DER shall detect the island condition and cease to energize BEL's Grid within a maximum of three (3) seconds after the formation of the island.

## 8.6 Interrupting Device Ratings

The design of the DER must consider the fault current contributions from all generation sources to ensure that all circuit fault interrupters are adequately sized.

# 9. Operating Requirements of Parallel Systems ≤150kw

## 9.1 Synchronization

The DER that can generate an AC Voltage Waveform independent of BEL's Grid shall be connected in parallel only in combination with the DER's synchronizing capabilities. The DER shall synchronize to BEL's Grid while meeting the Flicker requirements of **8.4.2**. Synchronization may occur only if BEL's Grid is stabilized, and normal operating ranges have been attained for both the voltage (between 90% and 110% of its nominal value) and the frequency (between 57.5 Hz and 62.5 Hz). The synchronization or interconnection process for any DER system shall not create a voltage drop greater than 5%.

## 9.2 Grid-Tied Inverters

Grid-tied inverters are required to produce a true sine wave with an output frequency of 60 Hz. It must be synchronous with BEL's Grid and comply with the requirements of this document. Note that systems comprising grid-tied inverters with battery backup are configured differently and are more complex than battery-less grid-tied systems. In the interest of safety, the designs of interconnection and meter configurations for battery back-up grid-tied systems must be approved by BEL prior to installation. The Owner must obtain formal, written approval by BEL for grid-tied battery systems.

## 9.3 DER Autonomous Functions and Capabilities

The DER system shall be capable of PCC voltage control provision via the following DER system autonomous functions/modes:

- Constant power factor.
- Voltage – reactive power (volt-var).
- Active power – reactive power (watt-var).
- Constant reactive power.
- Voltage – active power (volt-watt).

## 9.4 Control And Monitoring Requirements

DER Facility shall have the provision for monitoring the isolation device at the PoC.

A SCADA link and modem to BEL's network is not required at the initial interconnection but may be requested later. Monitoring data requirements shall comply with IEEE 1547-2018 for all

available data points. Minimum required data points which BEL may request are currently the following:

***Table 11 - Minimum Data Points***

| Minimum Required Data Points | |
|---|---|
| Active Power (W) | Reactive Power (Var) |
| Voltage (V) | Frequency (Hz) |
| Operational State (Generation ON or OFF, Operational Mode) | Connection Status |
| Alarm Status | Operational State of Charge (if Applicable) |

## 9.5 Communication Requirements

The DER system shall be capable of providing real-time operating information to BEL from an intelligent electronic device (microprocessor relay, inverter, etc.). When deemed applicable by BEL, a communication interface module may be supplied by BEL for real-time control and/or monitoring.

***Table 12- Eligible Communication Protocols***

| **Eligible Protocols (IEEE 1547)** | | |
|---|---|---|
| **Protocol** | **Transport** | **Physical layer** |
| IEEE Std 1815 (DNP3) | TCP/IP | Ethernet |
| | Serial | RS-485 |

# 10. Connection Requirements for Parallel Systems >150kw

## 10.1 General Requirements

**For Parallel Systems greater than 500kW, the system must be connected directly to BEL's primary lines.**

## 10.2 Measurement Point

The measurement point is the location where the DER system measures power system quantities for the purpose of implementing the protection and control functions required by this standard.

### 10.2.1 DER System 151 kW – 249 kW

Measurement point may be between the point of common coupling (PCC) and the point of connection (PoC). Where zero sequence continuity can't be maintained between the PoC and PCC the measurement point shall be located at the PCC.

### 10.2.2 DER System 250 kW and Over

Measurement point must be at the point of common coupling (PCC)

## 10.3 Equipment Ratings

The DER system equipment standards shall align with BEL equipment standards and shall not cause the equipment in the distribution system to exceed its equipment ratings. This includes but not limited to the following:

- Maximum Voltage
- Basic Impulse Limit
- Short Circuit Ratings / Limits
- Capacity

Where reverse power flow is possible, all existing voltage regulating and metering devices shall be suitable for bi-directional flow.

## 10.4 Isolation Device

1. A means of electrically isolating the DER Facility from BEL's Distribution System, whilst creating a visible air gap, must be provided.

2. The isolation device shall:
   a) Be capable of being energized from both sides.
   b) Be capable of indicating its status whether in the open or closed position locally.
   c) Be capable of being opened at rated load (Load Break Switch).
   d) Be located between the BEL's system and the DER Facility.
   e) Be readily accessible by BEL.
   f) Not be in a locked or enclosed facility, unless an arrangement is in place with BEL.
   g) Not be located in a hazardous or obstructed location.
   h) Have provision for being locked whilst in the open position.
   i) Have a manual override.
   j) Not have any form of keyed interlocks.
   k) Have contact operation verifiable by direct visible.
   l) Be capable of being closed with safety to the operator if there is a fault on the system.
   m) Be capable of being operated without exposing the operator to any live parts.
   n) Bear a warning to the effect that inside parts can be energized from sources on both sides when the disconnecting means is open.

3. In addition to the requirements above, all DER Facilities of Category 4, the isolation device shall:

a. Be gang operated and disconnect all ungrounded conductors of the circuit simultaneously.
b. Be motorized.
c. Have a protection interface for tripping if used as a backup for interrupting device failure (HVI Breaker Failure or LVI Breaker Failure).
d. Switching, tagging and lockout procedures shall be coordinated with BEL.
e. The DER Owner and BEL shall mutually agree to the exact location of the disconnect switch.

## 10.5 Interrupting Device Rating

- All fault current interrupting devices shall be sized appropriately using present and anticipated future fault levels.
- The interrupting device used to disconnect generation from BEL's Distribution System shall:
  - Be coordinated to meet the timing requirement of the quickest protection operation as specified by BEL.

## 10.6 Grounding

The DER must be grounded as per the equipment manufacturers' recommendations, in accordance with the requirements of the BEL's Service Installation Manual, and UL1741 Section 20. Grounding system resistance readings are to be at maximum, 25 ohms. BEL provides a neutral service conductor that is bonded to a grounding electrode. **Table 5** below indicates required grounding conductor requirements.

**Table 5 - Grounding Requirements** *(NEC table 250.102 (C)(1))*

| Copper Conductor | | | Aluminium or Copper-Clad Conductor | | |
|---|---|---|---|---|---|
| Conductor Size | Copper | Aluminium-Copper Clad | Conductor Size | Copper | Aluminium-Copper Clad |
| | Grounding Conductor | Grounding Conductor | | Grounding Conductor | Grounding Conductor |
| 1/0 or smaller | #6 | #4 | 1/0 or smaller | #8 | #6 |
| 2/0 | #4 | #2 | 2/0 | #6 | #2 |

| | | | | | |
|---|---|---|---|---|---|
| 4/0 | #2 | 1/0 | 4/0 | #4 | 1/0 |
| 250 | #2 | 1/0 | 250 | #2 | 1/0 |
| 350 | 1/0 | 3/0 | 350 | 1/0 | 3/0 |
| 500 | 1/0 | 4/0 | 500 | 1/0 | 3/0 |
| 750 | 2/0 | 4/0 | 750 | 2/0 | 4/0 |

2. For interconnections to BEL's Distribution System, TOV (Temporary over voltage) is a major concern and the neutral reactor, Xn or grounding transformer, shall be sized by the DER Owner and reviewed during the Impact Assessment, based on a Thevenin Equivalent of the Positive ($X_{DG1}$) and Zero Sequence ($X_{DG0}$) Reactance of the DER Facility (example: at the Point of Connection with the Point of Connection OPEN) that will result in:

    a) For Conventional (Rotating) Generators:

    $1.5<=X_{DG0}/X_{DG1}<=2.5$

    This will achieve an overall Thevenin Equivalent Positive and Zero Sequence impedance at any point on the feeder with any or all DER sources and BEL sources In-Service of:

    $2<X_0/X_1<3$ or $R_0/X_1<0.4$ or

    b) For DER Facilities with an Inverter Interface:

    $X_{DG0}=0.6+10\%$ p.u. and $X_{DG0}/ R_{DG0} >=4$

and where 1 p.u. is based on:

1) The total MVA rating of the DER Facility (sum of DG Interconnection Transformers' MVA ratings) and the high side kV rating of the DGIT(s) for Grounding Transformer sizing.

## 10.7 Interconnection Transformer Configuration.

### 10.7.1 DER greater than 500kW

A **delta (primary)/wye** transformer winding configuration is preferred for DER interconnections. Refer to BEL's transformer specification.

- The DER Interconnection Transformer (DGIT) shall not cause voltage disturbances or disrupt co-ordination of distribution system ground fault protection.
- The DER Owner shall ensure that there is no back feed from the DGIT when the generator is out of service and shall be responsible for all consequences resulting from such back-feeds.

## 10.8 Insulation Coordination

1. The DER Facility shall be protected against lightning and switching surges.
2. Surge arresters shall be located as close as possible to the equipment they protect.
3. Insulation coordination shall conform to ISO/ IEC 71-1 Standard.

Category 4 facilities shall protect against lightning & switching surges at PCC.

***Table 13 - BEL's Distribution System Voltage Arrester MCOV Rating***

| System Phase Voltage (kV) | Arrester MCOV (kV) |
|---|---|
| 6.6 | 5.5 |
| 22 | 17 |

# 11. Power Quality (Technical & Performance Requirement) for Parallel Systems >150kW

## 11.1 Voltage

The DER Facility shall ensure that the operation of the DER(s) does(do) not have an objectionable impact on voltage at the PCC or the interconnected feeder and shall not cause any violation of IEEE Standard 1547.

1. PCC voltage shall be maintained within 0.95~1.05 p.u. and shall not be lower than pre-connection voltage.

2. The DER shall not actively regulate the voltage at the PCC unless agreed with BEL.
3. Variations at the PCC shall be limited in accordance with the
    a. —Voltage Fluctuations (Flicker) Requirements in Section **11.3**
4. At the feeder level, DER shall not contribute to short-term voltage fluctuation anywhere on the feeder by more than 1%.

5. The reactive power provision of the DER Facility at the PCC shall be as required in Section **11.7**

6. During normal operation, the DER shall be loaded and unloaded gradually to allow adequate time for regulating devices on BEL's Distribution System to respond and avoid excessive voltage fluctuations.

7. Insulation levels and protective equipment at the DER Facility shall be capable of withstanding abnormal voltages from BEL's Transmission and Distribution System.

## 11.2 Voltage And Current Unbalance

1. The DER Facility shall be capable of operating under existing unbalance conditions.
2. The DER Facility shall not cause deterioration of existing imbalance voltage and current conditions at the PCC and in the Distribution System.

3. A single-phase generator shall not negatively affect the unbalance of the nearest three-phase section of the Distribution System.
4. The DER and its interconnection transformer‘s design shall take into consideration the unbalanced current it may supply to the unbalanced load on the feeder.
5. Single-phase generators shall not cause a steady-state voltage unbalance of greater than 3% when connected alone.
6. If multiple single-phase generators are installed, they shall be connected so that an equal amount of generation is applied to each single phase of the distribution line, and this balance shall be maintained if one or more of the generating units go offline.

## 11.3 Voltage Fluctuations (Flicker)

1. The DER Facility shall not create objectionable flicker for other customers on BEL’s Distribution System.

2. The voltage dip at the PCC should not be more than 3% on connecting the single largest generation unit in the facility and should remain within 10% of nominal voltage when the entire DER Facility and all other DER Facilities on the interconnected feeder trip.

3. Item (1) above, shall include flicker caused by energization inrush.

4. The DER Owner shall take steps to make sure that flicker requirements in Item (1) and (2) are met. For example by adding loss of synchronism protection, stagger generator energization, etc.

5. The DER Facility shall conform to the flicker requirements in IECC610004-15.

6. Flicker measurements shall be conducted by the DER Owner using a device that conforms to IEEE Standard 1547 /IEC C61000-4-15 if requested by BEL. BEL

shall request this measurement if flicker complaints are received in the surrounding area.

7. Induction generators and inverter-based generators that do not produce fundamental voltage before the paralleling device is closed, and double-fed generators whose excitation is precisely controlled by power electronics to produce a voltage with magnitude, phase angle, and frequency that match those of the Distribution System shall be tested to determine the maximum start-up current. The results shall be used, along with the Distribution System source impedance for the proposed location, to estimate the starting voltage magnitude change and verify that the unit will not cause a voltage fluctuation at the PCC greater than ± 5% of the prevailing voltage level of the Distribution System at the PCC.
8. Induction generators may be connected and brought up to synchronous speed by direct application of rated voltage if they meet the requirement of voltage drop given above and/or they do not exceed flicker limits at the PCC. Otherwise, other methods such as reduced voltage starting or speed matching, using the prime mover prior to connection, must be used to respect this voltage drop and flicker limits.
9. Large DER Facilities, with multiple generator units, shall stagger the generator reconnections to BEL's Distribution System to meet the above requirements.

## 11.4 Voltage And Current Harmonics

1. The DER Facility shall not inject harmonic current that causes unacceptable voltage distortion on BEL's Transmission and Distribution System.

2. The DER Facility shall follow the requirements of IEEE Standard IEC C61000-3-06.

3. The DER Facility shall operate within the voltage distortion limits as indicated in Table 14 and Table 15 below.

*Table 14 - Voltage Distortion limits for Odd Harmonics*

| Odd Harmonics Non Multiples of 3 | | Odd Harmonics Multiples of 3 | |
|---|---|---|---|
| | Harmonic Voltage (%) | | Harmonic Voltage (%) |
| 5 | 5 | 3 | 4 |
| 7 | 4 | 9 | 12 |
| 11 | 3 | 15 | 0.3 |
| 13 | 2.5 | 21 | 0.2 |
| 17 | 1.6 | >21 | 0.2 |
| 19 | 1.2 | | |
| 23 | 1.2 | | |
| 25 | 1.2 | | |
| >25 | 0.2+0.5(25/h) | | |

*Table 15 - Voltage Distortion limits for Even Harmonics*

| Even Harmonics | |
|---|---|
| | Harmonic Voltage (%) |
| 2 | 1.6 |
| 4 | 1 |
| 6 | 0.5 |
| 8 | 0.4 |
| 10 | 0.4 |
| 12 | 0.2 |
| >12 | 0.2 |

4. Total Harmonic Distortion (THD) shall be a maximum of 5% on 22 kV systems and below 5.0% on all other systems.

5. The DER Facility shall operate within the current harmonic limits as listed in Table 16.

*Table 16 - Harmonic Current Limits*

| Harmonic Number h | 5 | 7 | 11 | 13 |
|---|---|---|---|---|
| Admissible harmonic current $i_h=I_{hi}/I_i$ (%) | 5-6 | 3-4 | 1.5-3 | 1-2.5 |

6. The DER Owner and/or BEL may be required to implement measures that will mitigate the harmonic distortion caused by the DER Facility, such as by adding harmonic filters, at the DER Owners cost.
7. The limits presented in Items (3), (4) and (5) above exclude the harmonic distortion present on BEL's Transmission and Distribution System when the DER Facility is disconnected from the Transmission and Distribution System.
8. This document does not impose design limits to limit harmonic-related telephone interference problems, as it is almost impossible to predict. However, the DER Owner shall make sure that the design complies with all applicable standards and shall not cause telephone interference.

## 11.5 Frequency

1. The generators at the DER Facility shall operate at a nominal frequency of 60Hz.

2. The generators at the DER Facility shall remain synchronously connected over the frequency range presented in **Section 11.11** in **Table 18**.

3. The generators shall trip in the time required in accordance with Section for any frequencies beyond what is presented in **Section 11.11** in **Table 18**

## 11.6 Limitation of DC Injection

1. The DC current injection by the DER Facility shall not be greater than 0.5% of the full rated output current at the PCC after a period of five cycles following the energization of BEL's Distribution System.

## 11.7 Reactive Power and Voltage Control

1. DER Facilities > 150 kW shall be capable of operating with a power factor anywhere between 0.95 leading and 0.95 lagging, as measured at the PCC.

2. If warranted by local distribution system conditions, this range may be narrower or wider and shall be specified by BEL in the CIA-L.

3. The DER Facility shall be capable of operating within lagging and leading power factor ranges with, or without, other DER Facilities in service on the feeder.

4. The DER Facility shall be capable of providing reactive power according to any of the following four reactive power control schemes:
   a) At a fixed power factor 0.95 lagging ≤ cos φ ≤ 0.95 leading;
   b) At a power factor dependent on the active power feed-in cos φ (P);
   c) At a fixed level of reactive power in KVar;
   d) At a level of reactive power dependent on the voltage Q (U).

5. BEL shall determine the required reactive power control scheme of the DER Facility during the impact study and shall specify this to the DER Owner.

6. Upon request by BEL, the reactive power control scheme of the DER Facility shall be adjusted within one month if deemed necessary by BEL.

7. Power factor correction or reactive power compensation techniques may be required, if determined by BEL in the impact study.

8. Induction generators consume reactive power and the DER Owner shall be required to provide reactive power compensation to correct the power factor at the PCC, if determined by BEL in the impact study.

## 11.8 Disturbances

1. The DER Facility shall be designed, built and maintained in accordance with all applicable codes, regulations and standards, along with the requirements of this document. The design shall minimize the impact of:

a) Over-voltages during ground faults;

b) Electric disturbances, which can cause irregular power flows

c) Interference – radio, television and telephone;

d) Audible noise and

e) Other disturbances, which may reduce the reliability of BEL's Distribution system.

## 11.9 Self-Excitation Analysis

1. DER Facilities with induction generators must have the capability to Self-Excite.

## 11.10 Under-Voltage and Over-Voltage Ride Through

1. The DER Facility interconnection protection scheme shall have the capability of detecting abnormal voltages.

2. Three phase inverter systems shall detect each individual phase to neutral voltage on a grounded Wye system or each individual phase-to-phase voltage on an ungrounded Wye or delta system.

3. Single phase inverter systems shall detect the phase to neutral voltage if connected to the neutral conductor.
4. Single phase inverter systems connected phase to phase (not connected to the neutral conductor) shall detect the phase-to-phase voltage.

5. If the requirement in Item (4) above is not practical or feasible, estimated values may be used, if approved by BEL.

7. In the case of under-voltage for synchronous generators, the DER Facility shall not disconnect from the grid if the voltage as a percentage of the nominal voltage value remains above the lower blue line in **Figure 8**. (in the case of three-phase generators, the voltage refers to the smallest line-to- neutral or line-to-line voltage at the

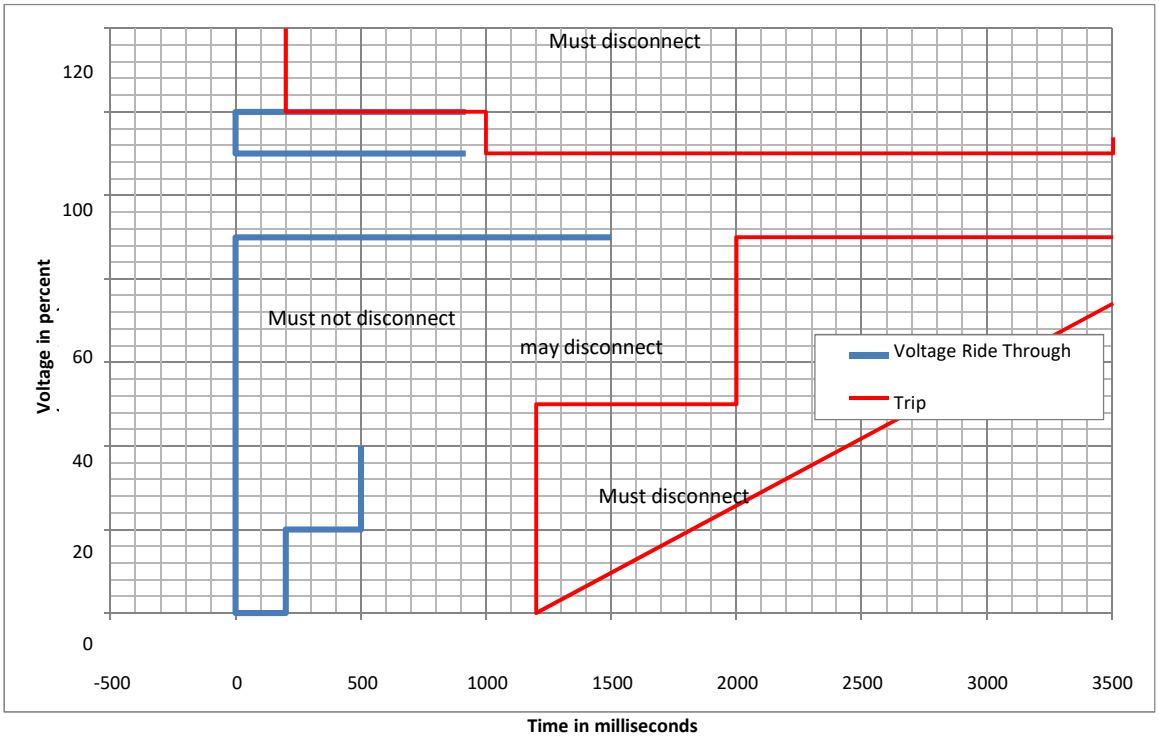
generator terminal); the points which define the lower blue line in **Figure 8** are listed in **Table 17**.

8. In the case of under-voltage for non-synchronous generators, the DER Facility shall not disconnect from the grid if the voltage as a percentage of the nominal voltage value remains above the lower blue line in **Figure 9**. (In the case of three-phase generators, the voltage refers to the smallest line- to-neutral or line-to-line voltage at the generator terminal); the points which define the lower blue line in **Figure 9 - Voltage Ride Through curve for non-synchronous generators > 150 kW, and trip curves** and are listed in **Table 17**.

9. In Figure 9 and Figure 10 the time t=0 seconds marks the beginning of the voltage drop (where the voltage first falls below 90% of the nominal voltage).

10. In the case of over-voltage, the DER Facility shall not disconnect for 0.92 s if the voltage rises to between 110% and 120% of its nominal value. The upper blue line in Figure 9 and Figure 10 illustrates this.

11. If the active power production is reduced during the fault, it shall be ramped up back to the pre-fault value after fault clearance with a ramp rate of at least 10% of the rated power per second.


Must disconnect
Must not disconnect
may disconnect
Must disconnect
Voltage Ride Through
Trip
Voltage in percent
120
100
60
40
20
0
-500
0
500
1000
1500
2000
2500
3000
3500
Time in milliseconds

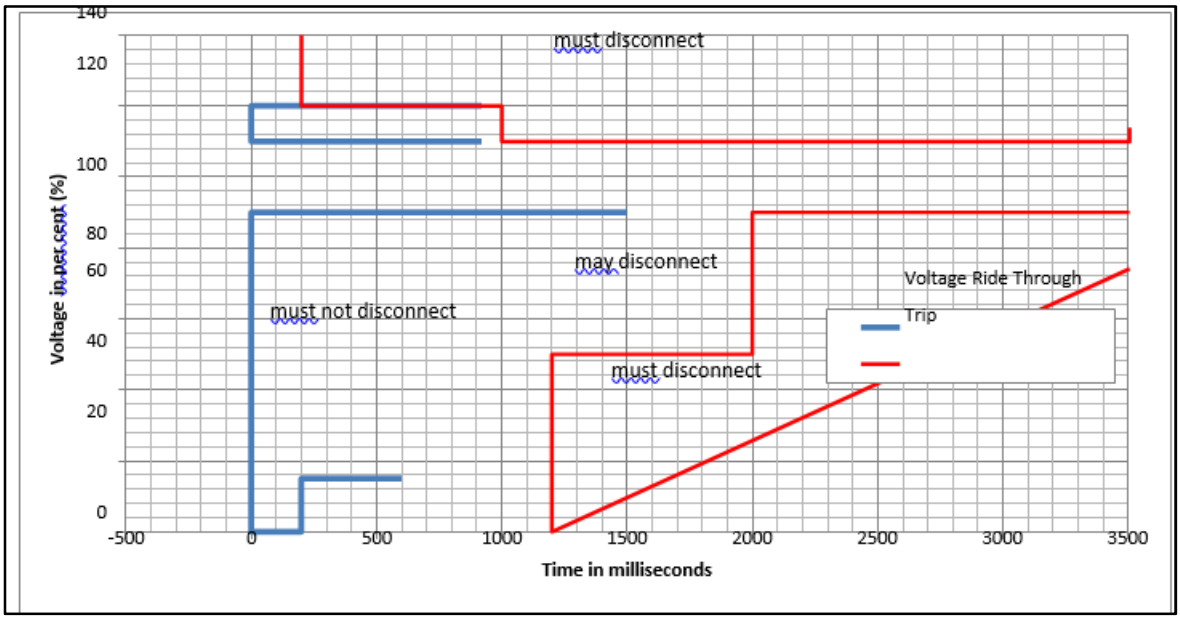



*Figure 9 - Voltage Ride Through curve for non-synchronous generators > 150 kW, and trip curves*

*Table 17 - Under-Voltage Ride Through curve point definitions for DER*

| UVRT points for synchronous DER | | UVRT points for non-synchronous DER | |
|---|---|---|---|
| Time (milliseconds) | Voltage (%) | Time (milliseconds) | Voltage (%) |
| 0 | 0 | 0 | 0 |
| 200 | 0 | 1000 | 0 |
| 200 | 15 | 1000 | 48 |
| 600 | 15 | 1500 | 90 |
| 1500 | 90 | | |

## 11.11 Under-Frequency and Over-Frequency Ride Through

1. The DER Facility interconnection protection scheme shall have the capability of detecting abnormal frequencies shown below in **Table 18**
2. The DER Facility shall not disconnect during abnormal frequencies within the ranges and within the time limits marked "Ride Through" in Table 13. The same conditions are illustrated in **Figure 10**.
3. The times in **Table 18** shall be measured from the instant when the measured frequency has crossed the respective threshold.

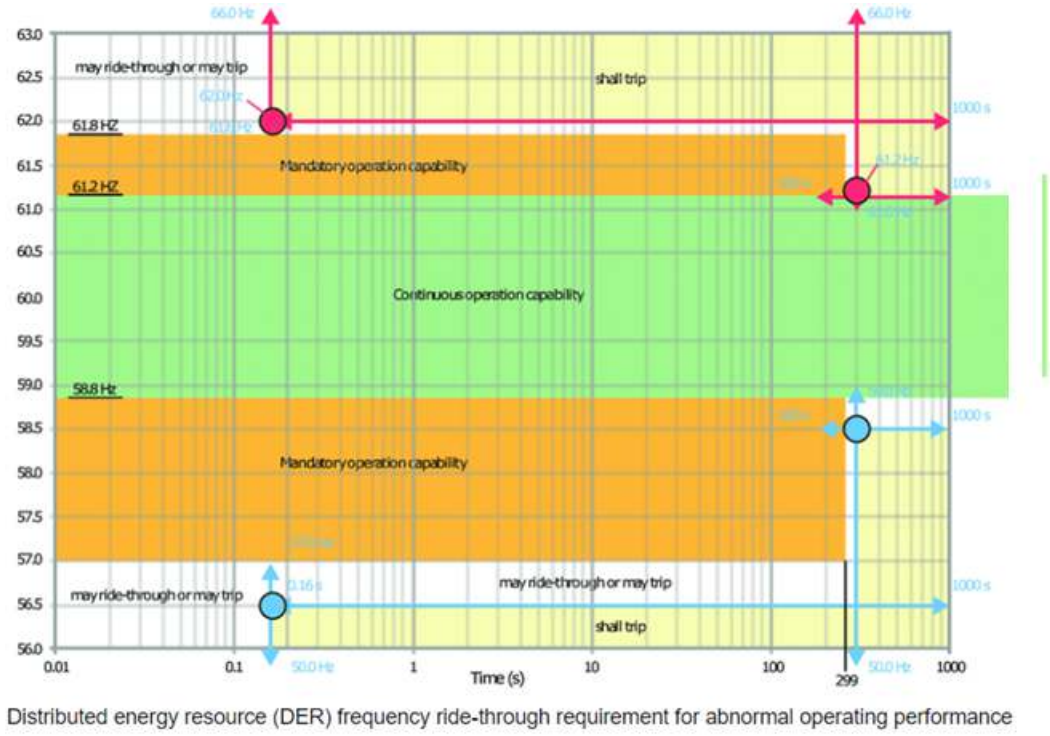



**Figure 10 - Illustration of Frequency Operating Limits for DER**

***Table 18 - DER > 150 kW Frequency Operating Limits***

| Range (Hz) | Mode | FRT Duration (s) | |
|---|---|---|---|
| | | Ride Through | Trip |
| f > 63.0 | Trip | None | 0.20 |
| 62.5 < f ≤ 63.0 | Ride Through | 20 | 21 |
| 57.5 < f ≤ 62.5 | Normal Operation | Indefinite | Indefinite |
| 57.0 ≤ f ≤ 57.5 | Ride Through | 20 | 21 |
| f < 57.0 | Trip | None | 0.20 |

## 11.12 Over-Frequency Active Power Reduction for Non- Synchronous Generators

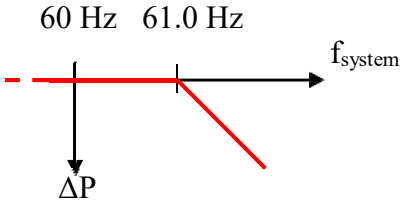
1. All non-synchronous DER Facilities shall reduce their active power output by a frequency-dependent power difference ΔP when the system frequency exceeds a threshold of 61.0 Hz.

2. The active power output at the time when the frequency crosses the threshold is frozen and taken as the reference $P_M$ for the power reduction.

3. Above the threshold, the power reduction per unit of $P_M$ is calculated according to the formula:

   $\Delta P / P_M$ (per unit) = 20 × (61.0 Hz – $f_{system}$)/60 Hz

   where $f_{system}$ is the system frequency in Hz.




4. This corresponds to a power reduction of 40% of the frozen reference active power per Hz.

5. The frequency measurement shall be accurate within 10 MHz the response time to over-frequency shall be as fast as possible, as and not larger than 0.5 seconds stall.

6. When the system frequency returns to below 61.0 Hz and the DER Facility is then capable of producing more than the previously frozen reference active power, the active power may be ramped up to the maximum with a ramp rate not exceeding 10% of the rated active power output per minute.

7. DER Facilities not capable of adjusting their active power output shall disconnect at a randomized frequency threshold between 61.0 Hz and 63.0

Hz. The manufacturer may perform the randomization, such that a fixed threshold may be built into the generation units.

# 12. Protection Requirements

## 12.1 Sensitivity and Coordination

1. The DER Facilities protection shall provide adequate sensitivity to detect abnormal conditions and isolate its generator(s) and if present, its HV ground fault source from BEL's Distribution System.

2. The design of the DER Facility protection system shall coordinate with other BEL protection system devices.

## 12.2 Protection Operating Times

1. The DER Facility's interconnection protection shall disconnect the DER Facility`s generation and, if present, its HV ground fault sources from BEL's Transmission and Distribution System within the required time as specified in the individual requirements throughout this document.

## 12.3 Breaker Fail (Bf)

- DER facilities with an aggregate output > 500 kW shall provide breaker failure protection for the primary interrupting device that is responsible for disconnecting the generator and/or the HV ground sources from BEL's distribution system. This device must be able to interrupt on a fault.
- In the event of a breaker fail condition at the primary interrupting device, the DER facility shall be capable of the following:
    - Full isolation of the DER facility upstream from the breaker failure condition. This may include trips to multiple upstream protection devices or isolation of the prime mover / excitations system.
    - Failsafe protection relay configuration if the protection relay fails to trip the isolation device. This may include redundant relays and/or failsafe contacts.
- The breaker failure protection shall have a maximum pickup time delay of 0.3 seconds after initiation. Full isolation shall take less than 2 seconds after breaker failure detection.
- DER facilities ≤ 500 kW shall have an alternate means of disconnecting the DER energy source from the distribution system when a breaker fail condition is triggered. This can be achieved by opening of the isolation device, disabling an inverter, or removing the prime mover and excitation system as needed.

## 12.4 Reclose Coordination

The DER system shall coordinate with BEL's protective devices to ensure distribution customers are not exposed to disturbances due to out-of-phase reclosing, or mis-coordinated tripping.

## 12.5 Three-Phase Generators Protection greater than 150kW

1. Three-Phase DER Facilities shall have the minimum protection requirements as shown below in **Table 19** and are mandatory for all generators to which this document is applicable.
2. Inverter type generators shall be compliant with IEEE Standard 1547 **and** UL 1741 and for connections at LV and MV.
3. The final design of the protection system shall be submitted to BEL for approval.

## 12.6 Minimum Protections Required for Category 3 and 4 Three-Phase DER Facilities

***Table 19 - Minimum Protections Required for Category 3 and 4 Three-Phase DER Facilities***

| Function Requirement | Protection Element function | Device # | Synchronous | Induction | Inverter |
|---|---|---|---|---|---|
| Basic Anti-Islanding | Over voltage trip | 59 | Required | Required | Required |
| | Under voltage trip | 27 | Required | Required | Required |
| | Over frequency trip | 81O | Required | Required | Required |
| | Under frequency | 81U | Required | Required | Required |
| Tele-protections | Transfer trip received | TTR | Section 5.4.14 | Section 5.4.14 | Section 5.4.14 |
| | DGEO/LSBS | DGEO | Section 5.4.15 | Section 5.4.15 | Section 5.4.15 |
| Other passive Anti-islanding | Rate of change of frequency | 81R | < 1000 kW | < 1000 kW | Not required |
| | Vector Surge | 78 | < 1000 kW | < 1000 kW | Not required |
| | Directional Reactive Power Relay | 32R | < 1000 kW | < 1000 kW | Not Required |
| Phase Fault Protection | Phase Overcurrent | 50 | Required | Required | Required |
| | Phase inverse timed Overcurrent | 51 | See Note 1 | See note 1 | See note 1 |
| | Voltage Controlled Overcurrent | 51V | See note1 | See note1 | See note 1 |
| | Directional Phase Overcurrent | 67 | Required | Required | Required |

**Note 1 -** An alternative or complement to Over-current (50, 50N). Special caution is needed for selection of inverse-time characteristics that meet time constraints.

## 12.7 Phase and Ground Fault Protection

1. The DER Facility's protection system shall ensure that the DER Facility will detect and isolate itself and any HV ground sources from BEL's Transmission and Distribution System for:
    a. All internal faults within the DER Facility
    b. All external faults on the interconnected BEL Distribution Feeder including single phase lateral spurs. This applies to all phase-phase and phase-ground faults and should be coordinated with BELs protection devices.
2. Phase and ground protection shall always be operational whenever phase and ground current can be sourced from the DER Facility.

3. The protective device selectivity and sensitivity shall be maintained over the full range of minimum to maximum fault currents (present and anticipated future levels) with the DER's infeed.
4. The DER Facility shall be capable of selectively detecting faults on the DER side of the HVI, and shall disable the HVI auto-reclosure scheme in **Section 12.11**
5. The total clearing time for faults on BEL's Distribution System or for faults in the DER Facility shall be no more than:

    a) 500 ms for DER Facilities equipped with fast Transfer Trip (for DERs of Class 3 and above); or

    b) 200 ms for DER Facilities not equipped with fast Transfer Trip. This can be relaxed to 500 ms if the DER Owner can demonstrate that the DER Facility fault contributions will not encroach on BEL's Distribution System minimum fuse melt characteristic.

## 12.8 Open Phase Protection

1. The DER Facility's protections must be capable of detecting the loss of any phase to which the DER Facility is connected which occurs within the DER Facility or the Transmission and Distribution System.
2. Upon the detection of the open-phase condition, the DER protection shall:
    a. Disconnect the DER from the Distribution System within 900ms
    b. Disconnect the DGIT (Interconnection Transformer) from the Distribution System via a HVI or a HV Motorized Disconnect Switch whenever the DGIT is three-phase with a common (shared) magnetic core (for DERs of Class 2 and above).

## 12.9 Over Voltage/Under Voltage Protection for DER > 150kW

1. Every grid-tied DER shall have under/over-voltage protection and, on detection of such voltage, shall cease to energize within the timeframe indicated in **Table 20**.
2. Three phase inverter systems shall detect each individual phase to neutral voltage on a grounded Wye system or each individual phase-to-phase voltage on an ungrounded Wye or delta system for the purposes of **Table 20**.
3. Single phase inverter systems shall detect the phase to neutral voltage if connected to the neutral conductor.
4. Single phase inverter systems connected phase to phase (not connected to the neutral conductor) shall detect the phase-to-phase voltage.
5. The DER shall not attempt to regulate the voltage or adversely affect the voltage at the Point of Connection.

***Table 20 - DER >150 kW Under- and Over-Voltage Protection Trip Times***

| Range (% of nominal Voltage) | Trip Time (seconds) | |
|---|---|---|
| | Synchronous DER | Non- Synchronous DER |
| V> 120 | 0.20 | 0.20 |
| 110 < V ≤ 120 | 1.0 | 1.0 |
| 50 < V ≤ 90 | 2.0 | 11.0 |
| V < 50.0 | 1.2 | 0.2 |

## 12.10 Short-Time Contingency

1. Network faults that

    (a) Lead to the disconnection of the DER

    (b) And where the violation of the normal operating ranges of voltage (between 90% and 110% of its nominal value) and frequency (between 57.5 Hz and 62.5 Hz) is shorter than 3 seconds shall be called short-time contingencies.

2. After short-time contingencies, the DER may reconnect to the grid if voltage and frequency continuously remain within the normal operating ranges for at least 5 seconds.
3. The active power ramp of the DER reconnecting after short-time contingencies shall be at least 10% of rated power per second.

4. If the conditions stated under (1) and (2) are not fulfilled, the normal reconnection procedure applies as outlined in Section RECONNECTION AFTER PROTECTION TRIPPING.

## 12.11 Reconnection After Protection Tripping for DER > 150kW

1) After disconnection due to protection tripping, the DER shall reconnect to the grid when:
   a) The voltage continuously remains within 95% to 105% of its nominal value and, at the same time,
   b) The frequency continuously remains between 57.5 Hz and 62.5 Hz for at least 60 seconds.
2) The active power ramp of the reconnected DER shall not exceed 10% of rated power per second until
   a) The momentary maximum active power output or dispatched active power output is reached (uncontrollable DER)
   b) The dispatched active power output is reached (controllable DER)
3) If the active power ramp cannot be limited, reconnection shall be delayed by a random time (specific to each DER unit) interval between 1 and 10 minutes.

## 12.12 Anti-Islanding for DER > 150kW

- All types of generation shall cease to energize and trip within 2 seconds of an island formation.
- DER facilities shall meet the anti-islanding requirements listed below in

| Generation Type | Category | Direct Transfer Trip (DTT) | Anti-Islanding Method |
|---|---|---|---|
| Synchronous | 3 | BEL to review | Passive - 1 |
| | 4 | Required | DTT |
| Inverter Base | All | Not Required - 4 | Active - 2 |
| Induction | 3 | Not Required | Passive - 1 |
| | 4 | Required | DTT - 3 |

- **Table 21**.
- Required anti-islanding studies shall be submitted to BEL for review. Based off the review BEL may require a transfer trip. Failure to provide the required studies will initiate a mandatory direct transfer trip requirement.

***Table 21 - DER Facility Anti-Islanding Requirements***

| Generation Type | Category | Direct Transfer Trip (DTT) | Anti-Islanding Method |
|---|---|---|---|
| Synchronous | 3 | BEL to review | Passive - 1 |
| | 4 | Required | DTT |
| Inverter Base | All | Not Required - 4 | Active - 2 |
| Induction | 3 | Not Required | Passive - 1 |
| | 4 | Required | DTT - 3 |

1. Anti-Islanding method must be reviewed and accepted by BEL. Direct transfer trip may be required upon review.
2. Inverter-based generation shall meet the anti-islanding requirements of CSA C22.2 No. 107.1 and UL 1741 SA
3. Self-Excitation study may be accepted to remove a DTT requirement.
4. In some cases, non-reclose on live line and sync checks may be used on the distribution system to mitigate islanding concerns.

## 12.13 Transfer Trip (TT) for Category 4 DER Systems

1. A TT signal from the station feeder breaker(s) to the BEL Facility shall be required for all Category 4 DER Systems greater than 150kW.
2. A TT signal from the feeder breaker(s) and/or upstream recloser(s) (where the recloser is located between the BEL Facility and feeder breaker) to the BEL Facility shall be required for any or all of the following conditions:

    a. When the aggregate BEL Facility capacity is greater than 50% of the minimum feeder load or the minimum load downstream of recloser(s); or

    b. When the aggregate generation, comprising of existing generation, other earlier proposed BEL Facilities, and the concerned BEL Facility is greater than 50% of the minimum feeder load or minimum load downstream of the recloser; or

    c. If the existing reclosing interval of the feeder breaker(s) and/or upstream recloser(s) is less than 1.0s.

3. A TT signal from upstream feeder breaker(s) and/or recloser(s) to the DER Facility connected at downstream of Distribution substation (DS) supplied by that feeder shall be required. This is required when the aggregate generation, comprising of existing generation, other earlier proposed DER Facilities at the feeder or at the DS, including concerned DER Facility, is greater than 50% of minimum feeder load or the minimum load downstream of breaker/recloser respectively.

5. The DER Facility shall cease to energize BEL's Distribution System with no intentional time delay and isolate all generation and HV ground sources upon receipt of a Transfer Trip signal.

6. TT communications shall meet the timing requirements in

**Table 22**. The maximum TT time shall depend on the operational speed of the DER Facilities interrupting device.

| Maximum TT Communication Time (ms) | Speed of DER Facility`s Interrupting Device (cycles) |
|---|---|
| 83 | 3 |
| 67 | 4 |
| 50 | 5 |
| 33 | 6 |
| 17 | 7 |

***Table 22 - TT Timing Requirements for Category 4 DER***

| Maximum TT Communication Time (ms) | Speed of DER Facility`s Interrupting Device (cycles) |
|---|---|
| 83 | 3 |
| 67 | 4 |
| 50 | 5 |
| 33 | 6 |
| 17 | 7 |

## 12.14 Directional Protection

- Non-Export DER systems shall have directional protection through utilization of a 67/67N/32R capable protective relay.

- The 32R relay shall be set to trip within 1 second if the import power (flowing from BEL to the DER site) falls below 10% of the load demand.
- The 67/67N relay shall be set to trip within 1 second if more than 1% rated current flows from the DER site to the BEL network more than the export limit.

- Directional protection may also be required on the distribution system to prevent mis-operation due to sympathetic tripping. This may be located at a substation breaker or an upstream recloser. BEL will assess this requirement during the detailed level study.
- DERs rated higher than the export limit
  - DER sites that have a nameplate rating higher than their export limit shall install additional protective elements to prevent excess power delivery. For example, a site with a 20 MW DER with a 20 MW export limit that adds a 20 MW Battery Energy Storage System: the site is only allowed to export 20 MW at any time.
- For DER sites that have an export limit that is less than their name plate rating, the following is required at the PCC relay:
  - A 32R relay shall be set to trip within 1 second if the export power (flowing from the DER site to BEL) raises above the export limit.
  - The 67/67N relay shall be set to trip within 1 second if more than 1% rate

## 12.15 Automatic Disconnection of Generation and HV Ground Sources

1. All BEL Facility generation and sources of ground current shall be automatically disconnected from the Distribution System whenever the BEL Facility Interconnection Protection or TT operates, as required by the other sections in this document. The timing requirements for automatic disconnection are detailed below in Items (2), (3), (5), (6), and (7).
2. For those DER Facilities that require TT, all generation shall be disconnected immediately (without any intentional delay) upon the receipt of a TT signal from BEL.
3. For those DER Facilities that require TT, all generation shall be disconnected within 500 ms of when external faults are detected on the Distribution System by the DER Facility Interconnection Protection.
4. For those self-clearing DER Facilities that do not require TT, all generation shall be disconnected within 200 ms of the start of the abnormal condition on the Distribution System by the DER Facility Interconnection Protection.
5. All sources of BEL Facility generation shall be disconnected within 500 ms when the BEL Facility Anti-islanding Protection operates.
6. All three-phase DER Facility ground sources shall be disconnected within

500 ms if any of the above items (2) to (5) above operates.

7. A back-up means shall be provided for disconnecting the DER Facility generation and all grounded DGIT or HV grounding transformers that provide a ground return path for ground faults on the HV side of the DGIT, should the interrupting device fail.

## 12.16 Interconnection Protection Acceptance

1. The DER Owner shall provide BEL with complete documentation on the proposed DER Facility interconnection protection scheme to ensure compliance with the requirements of this document and all applicable standards. Depending on applicability to the Class, documentation shall include, but is not limited to:
   a) A detailed Single Line Diagram;
   b) An overall description on how the protection will function;
   c) A description on failure modes;
   d) Detailed engineering drawings that include design details on protection and control.
   e) The protection element settings (pickup, timers, etc.);
   f) Details on monitoring for the protection system performance (DFR, SER, and telemetry);
   g) Details on backup supply to any critical loads;
   **h)** Details on the Breaker Failure protection if required in **Section 12.3**
   i) Details on the disconnecting and interrupting device.
2. If BEL proposes any changes from the review in Item (1), the DER Owner shall revise and re-submit the protection information to BEL.
3. All documentation must be submitted together.
4. The latest submissions will be filed by BEL and MUST MATCH the documentation retained by the DER Owner.

### 12.17 Synchronization

1. Any DER Facility that is capable of generating its own voltage, while disconnected from BEL's Transmission and Distribution System, shall require proper synchronization facilities before connection is permitted.
2. Interconnection shall be prevented if the DER and BEL's Transmission and Distribution System is operating outside the limits specified in Item (3) below.
3. Synchronous generators, self-excited induction generators or inverter- based generators, that produce fundamental voltage before the paralleling device is closed, shall only parallel with BEL's Transmission and Distribution System when the frequency, voltage and phase angle differences are within the ranges given below in **Table 23** now of synchronization.

***Table 23 - Resynchronization Requirement for DER > 150kW***

| Aggregate Rating of Generators (kVA) | Frequency Difference (Δ f, Hz) | Voltage Difference (Δ V, %) | Phase Angle Difference (Δ Φ, ) |
|---|---|---|---|
| **0-500** | 0.3 | 10 | 20 |
| **>500 – 1000** | 0.2 | 5 | 15 |

## 13. Monitoring and Control Requirements:

Provisions for real-time operating are required at DER facilities connected to BEL's distribution system.

## 13.1 Monitoring Data Requirements

Real-time data to be provided to BEL by the DER owner is dependent on the output rating of the DER Facility as listed below:

### 13.1.1 Total DER System Generation < 500 kW

DER facilities shall have the provision for monitoring the disconnecting device at the PCC/PoC.

- SCADA connection is not required unless otherwise specified by BEL. Provisions for other data points may be required if determined by BEL.

### 13.1.2 Total DER System Generation ≥ 500 kW

- A SCADA connection to BEL's shall be required.
- All communication and parameter mapping requirements outlined in **Section 13.2.1**
- Provisions for additional data points may be required if determined by BEL.

## 13.2 Control Requirements

- Subject to the agreement between the DER Owner and BEL, the following controls shall be provided to BEL:
  - Main interconnection recolser ;
  - Dynamic generator output control;

***Table 24 - Minimum Data Points for DER >150kW***

| Minimum Required Data Points | |
|---|---|
| Active Power (W) | Reactive Power (Var) |
| Voltage (V) | Frequency (Hz) |
| Operational State (Generation On or Off, Operational Mode) | Connection Status |
| Alarm Status | Operational State of Charge (if Applicable) |

### 13.2.1 Communication Requirements

The DER system shall be capable of providing real-time operating information to BEL from an intelligent electronic device (microprocessor relay, inverter, etc.). When deemed applicable by BEL, a communication interface module may be supplied by BEL for real-time control and/or monitoring.

| **Table 12- Eligible Communication Protocols** | | |
|---|---|---|
| Protocol | Transport | Physical layer |
| IEEE Std 1815 (DNP3) | TCP/IP | Ethernet |
| Modbus | TCP/IP | Ethernet |
| | N/A | RS-485 |

# 14. Review Panel

## 14.1 Composition of Review Panel

The IRC shall establish and maintain the Distributed Renewable Energy Interconnection Review Panel, which shall consist of the following five members with adequate knowledge of technical matters related

To electricity supply by Licensees and DER:

a) Chairperson nominated by the IRC

b) One member from each category (Domestic or Commercial) Licensee or Generator

c) One member from the Grid Operator

d) From above the Member-Secretary will be nominated by the IRC from among the representatives of Distribution, and Generation Licensees. A Licensee whose representative is Member-Secretary shall provide the required administrative and other logistic support to the Review Panel. The Member-Secretary shall be fully responsible for rending needed secretarial assistance to the Review panel.

e) One member to represent all the Consumers directly connected to the Licensee's Distribution System. On completion of tenure, the member shall be replaced by a person from other Consumers by rotation as decided by the IRC.

All the members of the Review Panel shall normally have tenure of three years. The new member in Replacement shall be from the same category and for the unexpired period of term.

The Review Panel shall decide the procedures for transaction of its business.

The Functions of the Review Panel:

- Review of the Interconnection Policy as and when necessary.
- Consideration of requests for review and making recommendations along with reasons to the IRC
- Ensuring the consistency of the changes/modifications proposed to the Interconnection Policy with other Codes, Laws, Act, Rules and Regulations in force at that point of time.
- Undertaking detailed studies of matters concerning the Interconnection Policy and circulate
- Findings and recommendations of such studies among the members of the Review Panel and other concerned entities.
- (Holding of regular meetings as required and at least once in six months.
- (Holding of meeting by any sub-committee of the Review Panel for discussing specific issues
- Raised by any group of stakeholders

## 14.2 Review and Revisions

Persons/users seeking any amendment to the Interconnection Policy shall send written requests to the Secretary of the Review Panel with a copy to the IRC.

- If the request is sent to the IRC directly, it shall be forwarded to the Secretary of Review Panel who shall, in consultation with the concerned entities and such other persons as the IRC may direct, review the provisions of Interconnection Policy.
- The Secretary shall circulate the proposed changes/modifications to all the panel members for their written comments within a reasonable time.

- The Chairperson shall convene a meeting of the Panel for discussing the proposed amendments and shall forward its recommendations to IRC.
- The Member - Secretary shall send the following reports to the IRC after each review meeting of the panel.

## 14.3 Role of the IRC

The IRC shall convey to the Review Panel its decision on any proposed amendment to the Interconnection Policy.

All amendments made to the Interconnection Policy shall be duly incorporated in a standard copy.

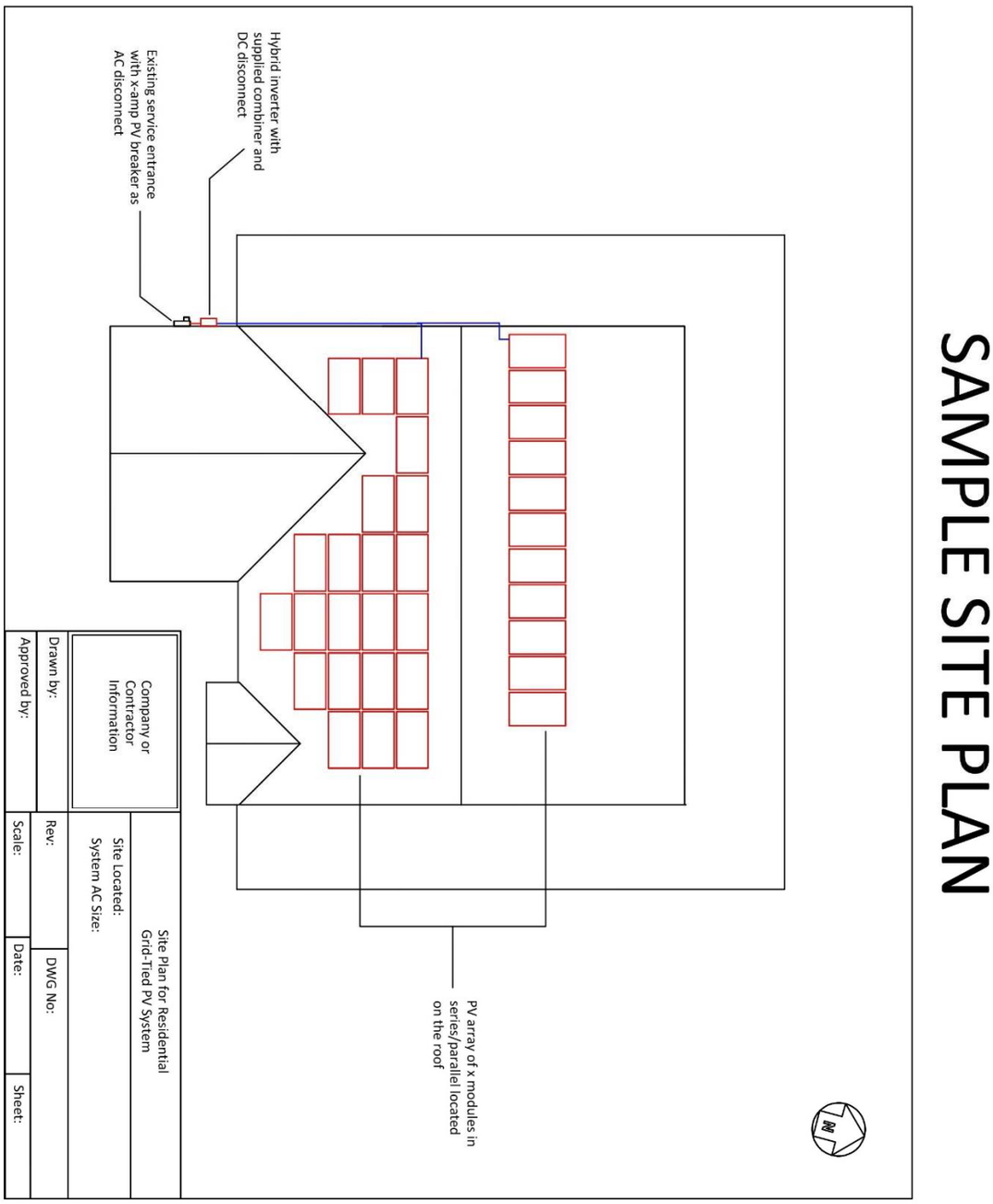
The standard copy shall also contain a sheet showing chronology of all the amendments.

# 15. Appendix

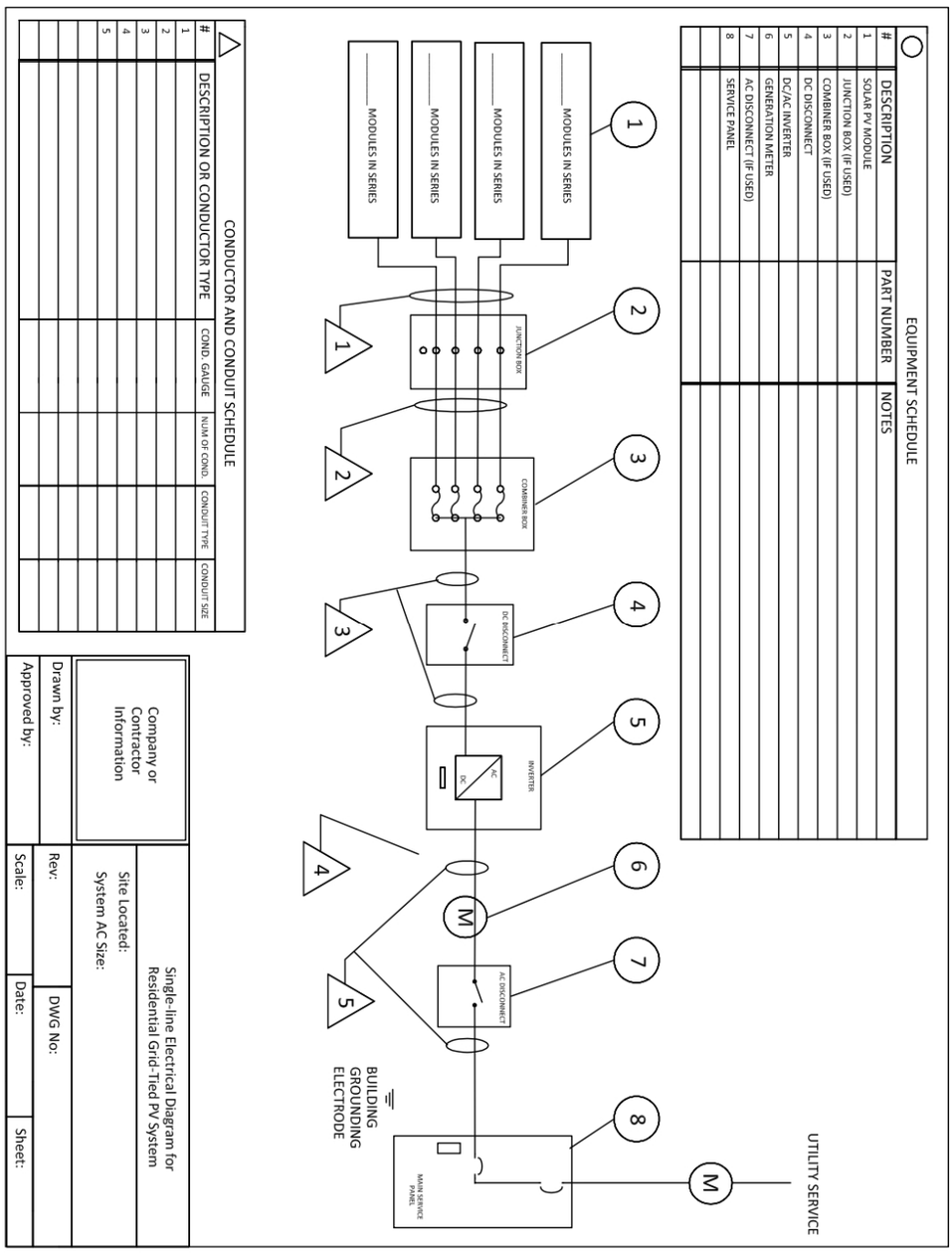
## 15.1 Distributed Generation Application Form

Distributed
Generation Notice A

## 15.2 Appendix 1 - Site Plan Example



## 15.3 Appendix 2 - Single Line Diagram



# MEETING THE CODE:

## YOUR GUIDE TO GRID INTERCONNECTION

A TECHNICAL GUIDE TO GRID INTERCONNECTION REQUIREMENTS


## CONNECT YOUR DG RESOURCE TO THE BEL GRID

This guide explains how to safely connect your **Distributed Generation (DG)** renewable energy system (solar, wind, etc.) or standby (generator) to the BEL grid at 22 kV or below. A qualified professional can help you ensure your system meets BEL's technical requirements for grid interconnection.

## TURN YOUR HOME INTO A POWERHOUSE:

INVESTIGATE GRID INTERCONNECTION

## WHAT YOU'LL NEED

Thinking about connecting your generator or renewable energy system to the BEL grid? Here's what you'll need to get started:

### Your Contact Info:

Name, address, phone number, and email.

### Project Details:

Briefly describe your system (e.g., backup generator, solar panels) and its estimated capacity (kW).

### System Layout:

Show where your equipment (generator, inverter, etc.) will be located and how it connects to the grid (diagram).

### Equipment Specs:

Provide datasheets for your generator or inverter and other major equipment (model, capacity, safety certifications).

*FOR SPECIFIC REQUIREMENTS, CONTACT BEL DIRECTLY.*


**BELIZE ELECTRICITY LIMITED**

**2 ½ MILES PHILIP GOLDSON HIGHWAY**
**BELIZE CITY, BELIZE ELECTRICITY LIMITED**

**PHONE:** (501) - 227-0954

**EMAIL:**


## INTERCONNECTION SAFETY

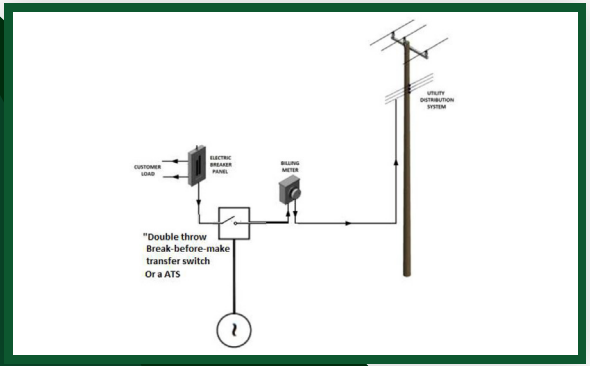
When it comes to grid intercon-nection, safety is never an option.

### SAFETY TIPS FOR GRID INTERCONNECTION

- Label all equipment
- Do not touch energized apparatus
- Get support from qualified electrical workers

# SEPARATE SYSTEM

This system provides complete backup power during loss of power from the grid. It uses a transfer switch that manually or automatically disconnects your home from BEL's grid before switching to your generator, and vice versa. This ensures the safety of both electrical workers and your equipment during power interruptions.




## MAIN REQUIREMENTS

### SAFETY DISCONNECT SWITCH

Safety Disconnect Switch To ensure safety for both you and electrical workers, a separate system must completely disconnect you from BEL's power before switching to your generator and vice versa. This requires one of two transfer mechanisms:

- **Manual Transfer Switch:** This switch must be a ***"break-before-make"*** design, which means it completely disconnects from BEL's power before connecting to your generator, and vice versa. ***Required for installations below 25kW.***
- **Automatic Transfer Switch:** For generators 25kW and above, an automatic transfer switch is required. This ensures a smooth and safe transition between BEL's grid and your generator during outages, meeting all necessary safety standards (like UL 1008).

**In either case, BEL will need to inspect your setup to ensure it meets their safety requirements.**

# PARALLEL SYSTEM

This system lets your DG source work directly with BEL's grid, offering more flexibility for your power needs. Because safety is our top priority for both electrical workers and your equipment, some additional steps are required. This includes a disconnect switch for safe operation, safe grid tied equipment, inspections by BEL to ensure everything meets standards, and an agreement outlining how your system interacts with the grid.

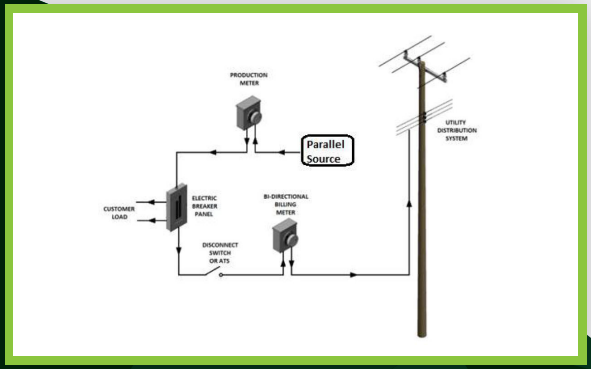
## MAIN REQUIREMENTS

### SAFETY DISCONNECT SWITCH

- A special switch must be installed at the connection point between your system and BEL's grid.
- This switch allows BEL to isolate your system for emergencies or maintenance.
- The switch must be accessible to BEL and meet specific safety standards such as UL.

### SAFETY DISCONNECT SWITCH

- Your system needs protection to prevent it from reconnection to the BEL grid after a loss of power.
- Anti-islanding prevents your system from accidentally supplying power to the grid while utility workers are performing maintenance or repairs.
- This ensures smooth operation and protects BEL's equipment.



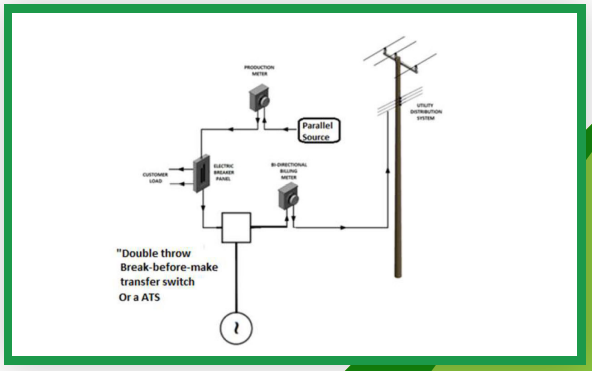

### STANDARDS

- Your inverter must meet specific safety standards for grid interconnection such as UL1741, IEEE 1547, CAN/CSA C22, etc.
- Inverters with these standards are acceptable.

# DUAL SYSTEM

This system combines the benefits of both grid interconnection and a backup generator. You can use the grid power for everyday needs, and this allows for seamless switching between BEL's grid and backup generators. While it offers the most flexibility, it also involves the most steps to ensure safety. This includes safety switch for both systems, additional safety equipment, inspections by BEL, and an agreement outlining how everything works together.

## MAIN REQUIREMENTS




### GENERATOR COMPONENT

- Safety disconnect switch specifications for generators must comply with the conditions outlined in the Separate System section.

### GRID-TIED COMPONENT

- Inverter and other equipment specifications must comply with the requirements outlined for a Parallel System section.

# Belize Electricity Limited

## *Distributed Generation Interconnection Standards*

**2 ½ Miles Philip Goldson Highway | Belize City, Belize**

**Tel: 0-800-235-2273 | 227-0954**

**Email: belcare@bel.com.bz**

## Purpose

To safeguard the reliability and integrity of Belize Electricity Limited's (BEL) distribution network, interconnection applications are required for all distributed generation (DG) projects intending to operate as backup power or grid-tied systems. DG encompasses generators, inverters, battery storage solutions, and similar equipment.

This authorization process, facilitated by the Public Utilities Commission (PUC), ensures the safe integration of these systems into the grid. Failure to obtain prior written approval from the PUC may compromise system stability and pose potential safety hazards to personnel and equipment. Any resulting damage or injuries incurred due to unauthorized interconnection will be the sole responsibility of the customer.

## Process

1. ***Implement Energy Efficiency Measures.*** Employing energy-efficient appliances within your home will optimize the utilization of your distributed generation system.
2. ***Secure the Services of a Qualified Installer.*** A qualified and reputable installation company is essential for a successful project. These professionals possess the expertise to guide you through the entire process, from system sizing and design to commissioning and ongoing maintenance. Selecting a company that prioritizes customer education will ensure you possess a comprehensive understanding of your system and its operation.
3. **Familiarize Yourself with BEL Grid Code and Interconnection Requirements.** A thorough understanding of Belize Electricity Limited's (BEL) Grid Code and Interconnection Requirements is crucial for a compliant application. These documents outline the technical specifications and safety standards for interconnecting distributed generation (DG) systems with the BEL distribution network [BEL Grid Code and Interconnection Requirements] Non-compliance with these requirements may lead to application delays.

   The BEL Grid Code defines the interconnection protocols for various DG system configurations, including:

   - **Separate System**: Provides complete backup power during grid outages, utilizing generators or battery storage.
   - **Parallel System**: Operates alongside the grid, but automatically isolates itself during power outages.
   - **Dual System**: Combines the functionalities of both separate and parallel systems.

**2 ½ Miles Philip Goldson Highway | Belize City, Belize**

**Tel: 0-800-235-2273 | 227-0954**

**Email: belcare@bel.com.bz**

4. **Secure a License from the Public Utilities Commission (PUC).** BEL regulations mandate that all distributed generation (DG) systems obtain a permit from the PUC before operation. The PUC will determine the appropriate permit category for your specific DG system configuration. We recommend visiting the PUC website (https://www.puc.bz/new-si-no-39-of-2024-electricity-licensing-and-consent-regulations/) to access Statutory Instrument (SI) 30 of 2024, which outlines the electricity licensing and consent regulations. This resource will provide valuable information for initiating your permit application with the PUC.
5. **Compile a Complete Application Package.** A comprehensive application package is essential for a streamlined review process. This package should include a completed application form along with all required documentation outlined in the **Application Requirements Checklist**. BEL will review your application within XX business days. Upon successful review, you will receive a formal Interconnection Approval Letter.
6. **Proceed with System Installation Upon Approval.** Receipt of a formal Interconnection Approval Letter from BEL authorizes you to proceed with the construction and installation of your distributed generation (DG) system.
7. **Schedule Interconnection Inspection and Meter Change.** Following successful system installation, contact Belize Electricity Limited (BEL) to arrange a site inspection. This inspection verifies that your distributed generation (DG) system adheres to interconnection standards and ensures safe and proper integration with the BEL network.

   **Note: System operation is prohibited until successful completion of the inspection.**

   Upon successful inspection, BEL will replace your existing meter with a bi-directional meter capable of tracking both energies imported from the grid and exported by your DG system. This ensures accurate billing for your electricity consumption and export to the grid.

8. **Receive Permission to Operate (PTO).** The successful completion of the interconnection inspection by BEL signifies the final stage of the process. Following this inspection, BEL will issue a formal Permission to Operate (PTO) document. This PTO serves as your official authorization to interconnect your distributed generation (DG) system with the BEL network and commence electricity production.

   The PTO signifies that your DG system has undergone careful evaluation and meets all required safety, technical, and legal standards. Furthermore, it confirms that your system will not adversely impact grid stability or pose any safety hazards to utility personnel or the general public.

# Belize Electricity Limited

## *Distributed Generation Interconnection Standards*

**2 ½ Miles Philip Goldson Highway | Belize City, Belize**

**Tel: 0-800-235-2273 | 227-0954**

**Email: belcare@bel.com.bz**

## Application Requirements

☐ **Application Form**

To ensure a smooth and efficient review process, please complete all relevant sections of the application form with accurate information corresponding to the supporting documentation you provide.

☐ **Site Plan**

A detailed site plan is required, clearly illustrating the precise location and orientation of the solar panel array relative to the building structure. The plan should also depict the designated placement of all relevant electrical equipment, including the main panel, utility disconnect, transfer switch (if applicable), existing service entrance, production meter, and any other pertinent electrical components to be installed.

☐ **Single-Line Drawing**

A single-line electrical schematic is required, depicting the complete electrical path from the main distributed generation (DG) source (e.g., solar panels, wind turbine, generator) to the utility meter. This schematic should illustrate all pertinent electrical components, including the DG equipment, inverter(s), main electrical panel, battery (if applicable), utility disconnect switch, and both the existing and production meters.

☐ **Technical Data Sheets for Equipment**

The application package must include technical data sheets for all major electrical equipment intended for use in the distributed generation (DG) system. This includes, but is not limited to:

- Solar Panels
- Wind Turbine
- Inverter(s)
- Utility Disconnect Switch
- Battery Storage System (if applicable)
- Generator (if applicable)

These data sheets should provide detailed specifications for each piece of equipment.

# Belize Electricity Limited

## *Distributed Generation Interconnection Standards*

**2 ½ Miles Philip Goldson Highway | Belize City, Belize**

**Tel: 0-800-235-2273 | 227-0954**

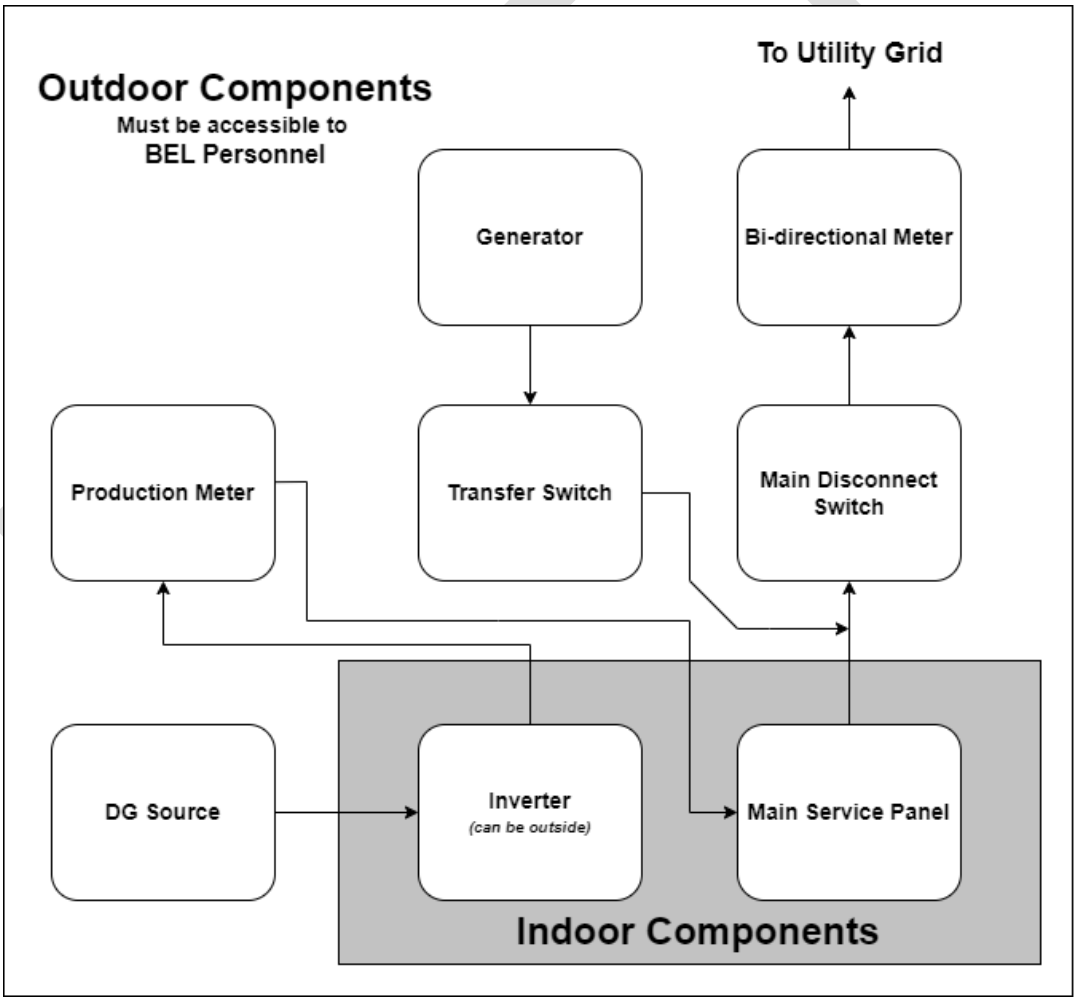
**Email: belcare@bel.com.bz**

☐ **Public Utilities Commission (PUC) License**

As outlined in the Belize Electricity Limited (BEL) regulations, a valid permit issued by the PUC is mandatory for all distributed generation (DG) systems before operation. The application package should include this permit. The PUC will determine the appropriate permit category based on the specific type and size of your DG system.

Note: You can access Statutory Instrument 30 of 2024, which details the electricity licensing and consent regulations, by visiting the PUC website: https://www.puc.bz/.

## Distributed Generation Interconnection Equipment Siting



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**Tel: 0-800-235-2273 | 227-0954**

**Email: belcare@bel.com.bz**

- **Compliance with NEMA Enclosure Ratings.**
  All outdoor electrical enclosures utilized within the distributed generation (DG) system must adhere to NEMA rating standards. These standards ensure the enclosures provide adequate protection against environmental factors that could compromise equipment functionality and safety.
- **Interconnection Standards Compliance**
  A critical aspect of a successful interconnection application is ensuring your system adheres to all relevant Belize Electricity Limited (BEL) interconnection standards. Non-compliance may result in the revocation of your interconnection approval. Should this occur, modifications to your system will be necessary to achieve compliance with BEL's established standards.

# Belize Electricity Limited

## *Distributed Generation Application Form*

**2 ½ Miles Philip Goldson Highway | Belize City, Belize**

**Tel: 0-800-235-2273 | 227-0954**

**Email: belcare@bel.com.bz**



## Customer

Customer Name: _____ BEL Account: _____

Street Address: _____ Phone Number: _____

City/Village, District: _____ Email: _____

## Primary Installer

Company: _____ Primary Contact: _____

PUC License #: _____ Role/Title: _____

Street Address: _____ Phone Number: _____

City/Village, District: _____ Email: _____

## System Information

*Project/System Name:* _____

### PV Modules

Manufacturer: _____ Quantity of Modules: _____

Model #: _____ Rated Output per Module (DC-W): _____

Efficiency of Module: _____

Array Location: ☐ Rooftop ☐ Pole or Ground Mount

### Inverter (s)

Manufacturer: _____ Quantity of inverters: _____

Model #: _____ Rated Output per Inverter (AC-W): _____

Efficiency of Inverter (s): _____ Inverter (s) Location: _____

### Monitoring

Provider/Platform: _____ Access to Historic Data (Y/N): _____

Internet Connected (Y/N) _____ Willingness to Grant Access to BEL: _____

### Storage

Manufacturer: _____ Type (Li-Ion, Lead-acid, etc.): _____

Model #: _____ Total Installed Capacity: _____

## Signatures:

By signing your name below, you certify you have read and agree to the terms outlines in BEL Distributed Energy Resource Technical Interconnection Requirements. You also certify that the above application is complete and accurate to the best of your knowledge.

*Customer Signature:* _____ *Date:* _____

**DISTRIBUTION INTERCONNECTION AGREEMENT BETWEEN*:***

***(1) BELIZE ELECTRICITY LIMITED***

***AND***

**(2)**

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**B E L I Z E**

This **DISTRIBUTION INTERCONNECTION AGREEMENT** is made on the [ ] day of

[ ] 20[ ].

**Parties**

Belize Electricity Limited ("BEL"), a company duly incorporated under and by virtue of the Companies Act of Belize whose office is at 2 ½ Miles Philip Goldson Highway, Belize City, Belize; and

**[Customer Name]**, an individual/company incorporated under the laws of Belize with his/her/its principal office/residence located at [Insert Address] (hereinafter referred to as "Customer-Generator" or "C-G").

**Recitals**

**WHEREAS**, BEL is a licensed utility company responsible for the transmission, distribution, and supply of electricity within Belize;

**WHEREAS**, the C-G is licensed and authorized by the Commission to generate electricity for self-use and has the excess capacity available for sale;

**WHEREAS**, BEL desires to purchase and the C-G agrees to sell the excess electricity generated by the C-G.

**NOW, THEREFORE,** in consideration of the mutual covenants and agreements herein contained, the parties hereby agree as follows:

**3. Definitions and Interpretation**

3.1 **"BEL"** means Belize Electricity Limited.

3.2 **"Commission"** means the Public Utilities Commission of Belize.

3.3 **"Customer"** or **"Customer-Generator"** or **"C-G"** means [Customer-Generator Name], an individual or entity with his/her/its residence/principal office at [Customer Address], who owns and operates a Facility for generating electricity primarily for his/her/its own use and desires to interconnect and sell excess electricity to BEL.

3.4 “**Dual Interconnection Design Standards”** means a power generation system that combines the functionalities of a parallel system and a separate system. The system integrates a distributed generation source, a power inverter, a grid-tie inverter, a backup generator, and an advanced transfer switch. This configuration enables seamless power supply from either the utility grid (BEL) or the backup generator, optimizing power utilization and reliability. To ensure safe operation and grid compliance, the system requires multiple safety devices, including dedicated disconnect switches for both the grid and generator, as well as additional safety equipment. Comprehensive inspections by the utility provider (BEL) and a detailed interconnection agreement are essential for system integration and adherence to grid standards.

3.5 **"Electricity"** means electrical power generated by the C-G and supplied to BEL.

3.6 **"Facility"** means the Customer-Generator's system and all equipment necessary for generating electricity, including but not limited to, solar panels, wind turbines, inverters, and all related electrical equipment and infrastructure.

3.7 **“Force Majeure”** means any cause or event not reasonably within the control of the Party claiming Force Majeure.

3.8 **"Interconnection Facilities"** means all the equipment and infrastructure required to connect the C-G's generation system to BEL’s distribution network.

3.9 “**Parallel Interconnection Design Standard”** means a power generation system that operates in parallel with the utility grid (BEL). The system incorporates a distributed generation (DG) source (e.g., solar panels, wind turbine), a power inverter, and a grid-tie inverter to interface with the utility grid. To ensure safe operation and compliance with grid standards, the system requires a dedicated disconnect switch, grid-compliant equipment, and prior inspection and approval by the utility provider (BEL). A grid interconnection agreement outlines the technical and operational requirements for the DG system's interaction with the utility grid.

3.10 “**Separate Interconnection Design Standard”** means a standalone electrical power generation and distribution system designed to provide uninterrupted power supply to a load in the event of grid power failure. The system comprises a primary power source (e.g., generator), a transfer switch capable of manual or automatic operation, and associated electrical components. The transfer switch isolates the load from the utility grid (BEL) during power outages and redirects power from the generator, ensuring continuous operation of critical equipment.

This configuration enhances safety by preventing electrical hazards for utility workers and safeguarding sensitive loads from power fluctuations and surges.

## 4. Purchase and Sale of Electricity

4.1 BEL agrees to purchase and the Customer agrees to sell any excess electricity generated by the C-G at the agreed price and terms specified in Schedule A

4.2 BEL reserves the right to unilaterally adjust these rates in accordance with any determinations or directives resulting from the Full Tariff Review Proceedings conducted by the Commission

4.3 The Customer shall generate electricity in compliance with the applicable license conditions, the technical standards as set by the Commission and the terms of this agreement.

## 5. Construction and Maintenance of the Facility and Interconnection Facilities

5.1 The C-G shall, at its own expense, design, install, operate and maintain the Facility and Interconnection Facilities in accordance with the consent and license granted by the Commission and in a manner that ensures their normal and safe operation, consistent with the standards required for the electrical distribution system owned and operated by BEL.

5.2 The Facility shall conform to all applicable National Electric Code (NEC) standards and applicable building codes.

## 6. Compliance with Laws and Regulations

6.1 The C-G shall at all times comply with all applicable laws, regulations, and standards, including the Electricity Licensing and Consent Regulations, 2024.

6.2 The C-G shall, at its own expense, obtain all necessary licenses and consents from the Commission before commencing any activities related to the generation, transmission, distribution, or supply of electricity.

6.3 The C-G shall reimburse BEL for any and all losses, damages, claims, penalties, or liability BEL incurs as a result of the C-G's failure to obtain or maintain any governmental authorizations and permits required for construction and operation of the Facility.

## 7. Interconnection And Operation

7.1 The C-G shall deliver energy from the Facility to BEL at BEL's meter.

7.2. BEL shall furnish and install one or more standard watt-hour meters to read energy generated by the C-G's Facility. The C-G shall provide and install a meter socket in accordance with BEL's metering standards.

7.3 The C-G shall not connect the Facility, or any portion of it, to BEL's distribution system until written approval of the Facility has been given to the C-G by BEL. Such approval shall not be unreasonably withheld.

7.4 The C-G may reconnect its Facility to the BEL system following normal operational outages and interruptions without notifying BEL unless BEL has disconnected service, or BEL notifies the customer that a reasonable possibility exists that reconnection would pose a safety hazard.

7.5 If BEL has disconnected service to the Facility, or BEL has notified the C-G that a reasonable possibility exists that reconnection would pose a safety hazard, the C-G may call BEL at 0-800-235-2273 to request authorization to reconnect the Facility.

## 8. Interconnection Design Standards

8.1 *General Requirements*

8.1.1 The C-G Facility and all portions used to provide or distribute electrical power, whether for separate or parallel interconnection with BEL's distribution system, shall be designed, installed, constructed, operated, and maintained in compliance with this Agreement. Compliance is mandatory unless prior written approval from BEL is obtained for specific items not in compliance. Such exemptions must be in writing, signed by BEL, and attached to this Agreement. The C-G shall conform to applicable National Electric Code (NEC) standards and applicable building codes.

8.2 *Separate Interconnection Design Standards*

8.2.1 For separate interconnections:

8.2.1.1 The C-G shall have a dedicated transfer mechanism from the utility to the separate generation source.

8.2.1.2 The C-G's separate source shall automatically or manually disconnect from BEL's source upon loss of BEL voltage and shall not reconnect until BEL voltage has been restored by BEL.

8.3 *Parallel Interconnection Design Standards*

8.3.1 For parallel interconnections:

8.3.1.1 The C-G shall have a dedicated circuit from the inverter to the electrical service panel with a circuit breaker or fuse.

8.3.1.2 The C-G must have a disconnect that is accessible to the utility in case of an emergency.

8.3.1.3 The C-G's over-current protection device at the service panel shall be marked to indicate the distributed generation power source.

8.3.1.4 The C-G's inverter output shall automatically disconnect from BEL's source upon loss of BEL voltage and not reconnect until BEL voltage has been restored by BEL.

8.4 *Dual Interconnection Design Standards*

8.4.1 For dual interconnections: The Facility must comply with all requirements outlined in Sections 8.2 (Separate Interconnection Design Standards) and 8.3 (Parallel Interconnection Design Standards).

## 9. Access to Premises

9.1 BEL may enter C-G's premises, without prior notice, to:

9.1.1 inspect, at all reasonable hours, C-G's protective devices and read or test any meter for the Facility;

9.1.2 disconnect, at any time and without notice, the Facility if, in BEL's sole opinion, a hazardous condition exists and that immediate action is necessary to protect persons, or BEL's facilities, or property of others from damage or interference caused by CG's Facility or failure to comply with the requirements of the Interconnection Agreement;

9.1.3 read the bi-directional digital meter for billing purposes.

## 10. Environmental and Safety Standards

10.1 The C-G shall comply with all environmental laws and regulations, including obtaining necessary environmental permits and conducting regular environmental impact assessments.

10.2 The C-G shall implement and maintain safety protocols and procedures in accordance with BEL's safety standards and applicable laws.

## 11. Indemnity and Liability by Customer

11.1 The C-G shall indemnify and hold BEL, its directors, officers, agents, and employees harmless against all loss, damages, expenses, and liability to third persons for injury to or death of persons or damage to property caused by the C-G's engineering, design, construction, installation, ownership, maintenance, or operations of, or the making of replacements, additions, or betterment to, or by failure of, the Facility.

11.2 The C-G shall, on BEL's request, defend any suit asserting the claim covered by this indemnity. The C-G shall pay all costs that may be incurred by BEL in enforcing this indemnity.

## 12. Right to Disconnect

12.1 BEL shall have the right to disconnect the Facility under the following circumstances:

12.1.1 BEL may disconnect the Facility without prior notice if an emergency situation arises that, in BEL's sole opinion, requires such action to protect the safety of persons, BEL's facilities, or the property of others.

12.1.2 If the C-G fails to comply with any term of this Agreement or any applicable laws, regulations, and standards, BEL may disconnect the Facility after providing the C-G with written notice and a reasonable opportunity to cure the non-compliance.

12.1.3 BEL may disconnect the Facility to perform maintenance, repairs, or upgrades to BEL's distribution system as provided for at clause 5.2.

12.1.4 If the Facility, in BEL's sole opinion, is being operated in a manner that poses a risk to the reliability or safety of BEL's distribution system, BEL may disconnect the Facility immediately and without prior notice.

12.1.5 BEL may disconnect the Facility in the event of a Force Majeure that affects the ability of BEL to maintain the safety and reliability of its distribution system.

## 13. Force Majeure

13.1 If either Party is rendered wholly or partly unable to perform its obligations under this Agreement because of a Force Majeure event, that Party shall be excused from whatever performance is affected by the Force Majeure event to the extent so affected, provided that:

13.1.1 The non-performing Party, within two (2) weeks after the occurrence of the Force Majeure event, gives the other Party written notice describing the particulars of the occurrence.

13.1.2 The suspension of performance is of no greater scope and of no longer duration than is required by the Force Majeure.

13.1.3 The non-performing Party uses all reasonable efforts to remedy its inability to perform.

## 14. Dispute Resolution Clause

14.1 This Agreement shall be governed by and construed in accordance with the laws of Belize.

14.2 In the event of any dispute, controversy, or claim arising out of or relating to this Agreement, including the validity, invalidity, breach, or termination thereof (hereinafter "Dispute"), the Parties shall seek to resolve the Dispute through amicable negotiation. If the Parties are unable to resolve the Dispute through negotiation within thirty (30) days, the Dispute shall be submitted to mediation.

14.3 The Parties agree to mediate any Dispute through the Belize Mediation Centre or any other recognized mediation body in Belize. The mediation shall be conducted in accordance with the mediation rules in effect at the time the Dispute is submitted for mediation. Each Party shall bear its own costs and expenses incurred in connection with the mediation, and the Parties shall share equally the fees and expenses of the mediator.

14.4 If the Dispute is not resolved through mediation within sixty (60) days from the date of the mediator's appointment, or such longer period as the Parties may agree

in writing, either Party may submit the Dispute to the courts of Belize for final resolution.

14.5 The Parties hereby irrevocably submit to the exclusive jurisdiction of the courts of Belize for the purpose of any judicial proceeding arising out of or relating to this Agreement and waive any objections to the laying of venue in, and the jurisdiction of, such courts.

## 15. Amendments, Modifications or Waiver

15.1 Any amendments or modifications to this Interconnection Agreement shall be in writing and agreed to by both Parties.

15.2 The failure of any Party at any time to require performance of any provision hereof shall in no manner affect the right at a later time to enforce the same.

15.3 No waiver by any Party of the breach of any term or covenant contained in this Interconnection Agreement, whether by conduct or otherwise, shall be deemed to be construed as a further or continuing waiver of any such breach or a waiver of the breach of any other term or covenant unless such waiver is in writing.

## 16. Termination

16.1 This Agreement may be terminated by either Party giving sixty (60) days' written notice.

16.2 This Agreement may be terminated by BEL, without notice, if any of the following occurs:

16.2.1 If the C-G commits a material breach of this Agreement;

16.2.2 If the C-G fails to comply with applicable governmental statutes, regulations, and codes;

16.2.3 If the C-G fails to make payment when due; or

16.2.4 If the C-G becomes insolvent.

## 17. Notices

17.1 Any notice or correspondence authorized or required to be given under this Agreement shall be in writing and deemed to be validly and sufficiently served if either:

17.1.1 addressed to either Party and delivered to or left at their usual business office/residence at their physical addressed below; or

17.1.2 delivered by electronic correspondence to either of them at their email addresses below. Notices by email shall be taken to be received two clear days after being sent.

| | **CUSTOMER** | **BEL** |
|---|---|---|
| **Name:** | | Belize Electricity Limited<br>Attention: [insert name] |
| **Address:** | | 2 ½ Miles Philip Goldson Highway, Belize City, Belize |
| **Email:** | | belcare@bel.com.bz |
| **Phone Number:** | | +501-[227-0954] |

## 18. Entire Agreement

18.1 This Agreement constitutes the entire agreement between the Parties and supersedes any prior agreements, understandings, negotiations, or representations, whether oral or written, concerning the subject matter hereof.

## 19. Severability

**19.1** If any provision of this Agreement is held to be invalid, illegal, or unenforceable, the remaining provisions shall continue in full force and effect.

## 20. Execution of Agreement

20.1 This Agreement may be executed in counterparts; each of which when so executed and delivered shall be an original, but such counterparts shall together constitute one and the same Agreement. Signature pages exchanged electronically by email, facsimile or PDF shall be fully binding.

## 21. No Agency or Partnership

21.1 Nothing in this Agreement shall be construed to create a partnership, joint venture, or agency relationship between the parties. Neither party shall have the authority to act as an agent or representative of the other party, nor shall either party have the authority to bind or obligate the other party in any manner whatsoever. Each party shall act as an independent contractor in the performance of its duties under this Agreement.

## 22. Successors and Assigns

22.1 This Interconnection Agreement is and shall be binding on all successors and assigns of each of the Parties hereto without the necessity of any further documentation.

**IN WITNESS WHEREOF,** THE PARTIES HERETO HAVE CAUSED THIS AGREEMENT TO BE EXECUTED.

**Executed for and on behalf of Belize Electricity Limited:**

Name: _____

Title: _____

Date: _____

**Executed for and on behalf of [Customer]**

Name: _____

Title: _____

Date: _____

## SCHEDULE A-PAYMENT RATES

### Belize Electricity Limited (BEL)
**Approved Tariffs for Full Tariff Period (FTP)**
**September 1, 2024, to June 30, 2028**

| Demand Rate | | |
|---|---|---|
| **All Classes** | Demand (KVA)<br>Energy: Peak<br>Energy: Off-Peak | 30.00<br>0.35<br>0.30 |
| **FEED-IN TARIFFS** | | |
| **All Classes** | Energy | 0.13 |

Note: All customers (Prosumers) operating under SI No. 39 of 2024 ELECTRICITY LICENSING AND CONSENT REGULATION, will be billed by Belize Electricity Limited using this Schedule (6B).

Any regular customer can voluntarily apply switch from Schedule 6A to Schedule 6B

This Demand Rate is being considered a "Regulatory Sand-Box" and will be running for the ATP 2024|2025. That is form 1st September 2024 to 30 June 2025.

***Source:*** *https://www.puc.bz/initial-decision-on-bels-2024-2028-ftrp/*