Renewable Embedded Generation

Interconnection Framework

April 2026

Table of Contents

Acronyms

BESS	battery energy storage system
COD	commercial operations date
DER	distributed energy resources
IEEE	Institute of Electrical and Electronics Engineers
IMG	interconnected minigrid
MVA	megavolt-ampere
MW	megawatt
NEMSA	Nigerian Electricity Management Services Agency
NERC	Nigerian Electricity Regulatory Commission
NESI	Nigerian Electricity Supply Industry
NESIS	Nigerian Electricity Supply and Installation Standards
PCC	point of common coupling
PCS	power conversion system
PoC	point of connection
PPA	power purchase agreement
PV	photovoltaic
REG	renewable embedded generation
SERC	State Electricity Regulatory Commission
SLD	single line diagram
SON	Standard Organization of Nigeria
UK PACT	United Kingdom Partnering for Accelerated Climate Transitions
UL	Underwriters Laboratories

1. Introduction

The development of utility-enabled distributed energy resources (DERs) in Nigeria is accelerating as a critical solution to the weak national grid driven by innovative business models such as renewable embedded generation (REG). However, interconnection remains a major barrier to adoption.[1] Considering that REG deployment is still in its early stages with untested processes and evolving regulatory expectations, both distribution companies (DisCos) and project developers are uncertain about the impact of embedded generation on network stability, power quality, and cost of network upgrades required for DER interconnection.

This framework serves as a guide for the successful interconnection of DER solutions such as REG to the distribution grid, outlining key processes and requirements. It aims to establish a transparent, bankable, and technically robust interconnection process. We recognize that interconnection requirements may vary by DER business models, and the framework outlined in this document focuses exclusively on REG projects with a capacity of up to 20 MW at the distribution network level at or below 33kV. Additionally, the framework seeks to reduce time-to-connection, ensure safety and power quality, and provide predictable cost allocations and operational requirements for both DisCos and developers.

The core principles of this framework are to improve service reliability, security, and safety across the distribution network, while maintaining fair access, flexibility, and scalability for DER developers and DisCos. This guide serves as an accessible reference for DisCos, developers, and stakeholders managing and implementing DER interconnection, providing recommendations through each stage from project initiation and technical screening to network rehabilitation, interconnection, and post-go-live operations.

This framework reflects current best practices and emerging experience in REG interconnection and is expected to evolve over time. As REG deployment scales and regulatory and operational practices mature, further refinements can be incorporated. Feedback from DisCos, developers, and regulators will be critical to strengthening and updating this framework in future iterations.

The interconnection framework is structured as follows:

- Section 1 introduces the REG interconnection framework, including the scope, objectives, and guiding principles, as well as some sectoral background and the REG business model.
- Section 2 outlines the applicable codes, standards, and regulatory context for implementing REG.
- Section 3 details the end-to-end interconnection process, from application and implementation to acceptance, proposing targeted improvements to current practice where applicable. It also defines the roles and responsibilities among DisCos, developers, and other partners in interconnection.

- Section 4 presents the technical requirements for interconnection.
- Section 5 covers operations, performance monitoring, and conflict resolution strategies.

1.1. Background

In Nigeria, grid investment is outpaced by population growth and increasing electrification, leaving the grid infrastructure unable to meet rising energy demand. With more than 13,000 MW of installed generation capacity, however, only a third is delivered to consumers due to distribution constraints.[2] Most DisCos struggle with collections from customers with losses often exceeding half of all energy supplied due to losses in the distribution network.[3]

Similarly, the first wave of interconnected minigrid (IMG) pilot projects experienced significant delays across the design, construction, and commissioning phase largely due to uncertainties in managing interconnections. Key contributing factors include prolonged project agreement negotiations, lengthy equipment procurement, and extended approval processes for construction, commissioning, and certification. These delays are further compounded by the absence of standardized interconnection architecture and undefined roles and responsibilities among stakeholders, which further complicated project execution.[4]

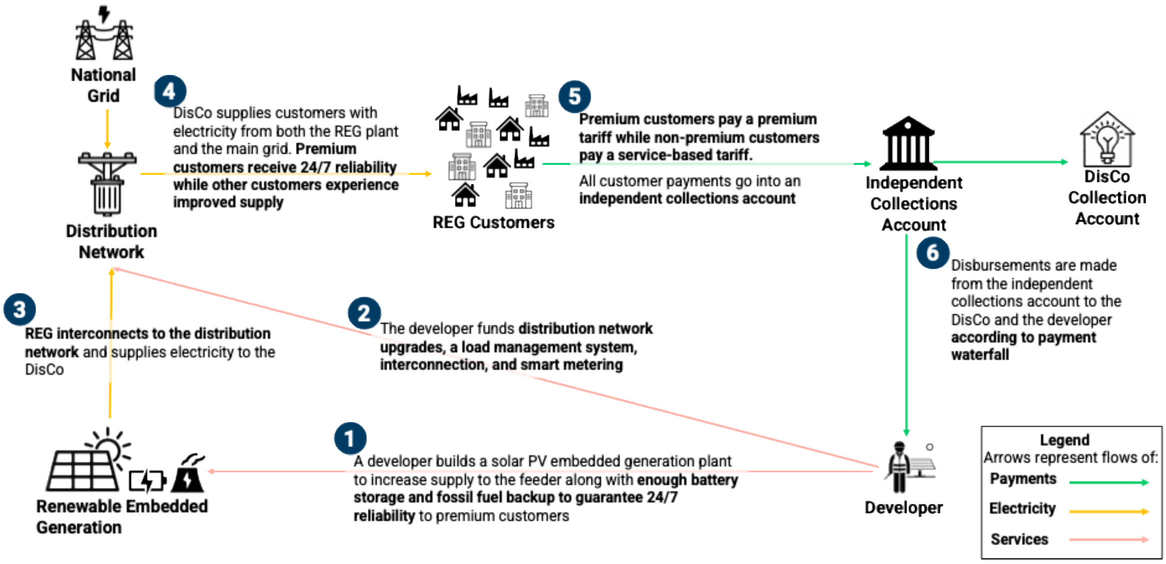
Furthermore, following the signing of the Electricity Act 2023, the Nigerian Electricity Regulatory Commission (NERC) mandated in April 2024 that DisCos operating within the Nigeria Electricity Supply Industry (NESI) procure at least 10% of their allocated capacity from embedded generation sources, of which half must come from renewable sources. This incrementally adds 10% of current capacity to each DisCo's allocated load. With this mandate driving a significant increase in embedded generation development and grid connections, the need for a clear, standardized interconnection framework has never been more critical.

1.2. The REG Business Model

Renewable embedded generation (REG) combines the benefits of renewables and embedded generation. Embedded generation is electricity produced near the load and connected at the distribution network level. It offers clean, flexible, scalable, and cost-effective alternatives by eliminating transmission losses, thus reducing investments required for new bulk generation and transmission infrastructure. It directly supports DisCos in meeting their embedded generation mandates as stipulated by NERC. Similarly, REG is often the least cost of energy generation at the last mile and scale of generation.

The REG business model illustrated in Exhibit 1 shows the key components of the REG business model. A comprehensive description of the REG business model is provided in the UK PACT *REG Implementation Guide*.

Exhibit 1: *The renewable embedded generation business model.*



Given the typical size of an embedded generation project, reliable disconnection and islanding detection are essential for the safety of the generation assets and the network, including the safety of technical personnel of both the DisCo and the developers. The required metering is typically unidirectional, from the plant to the load center. If there is, however, a need to supply the plant auxiliary load to the grid, or battery charging from the grid, a bi-directional metering arrangement can be agreed upon.

The interconnection framework proposed in this document has been tailored to address the specific requirements and characteristics of REG projects.

2. Applicable Codes and Standards

Reliable, safe, flexible, and scalable interconnection — core principles of this framework — are supported by a set of enabling codes and standards. These establish consistent requirements for REG interconnection based on applicable voltages (11kV and 33kV) and the nameplate capacity. Some of these codes are country-specific to Nigeria, while others are technical standards globally applicable across all DER interconnections.

Exhibit 2: *Summary table of applicable codes and standards.*

Codes/standards	Description and the scope	To what extent this applies
Electricity Act (2023)	The Act is the primary law regulating the electricity sector in Nigeria. Signed into law in June 2023, the Act decentralizes the sector by empowering states and other	**Overarching regulatory guidance**: The Act establishes the legal basis for electricity regulation

	entities to generate electricity and establishing sub-national electricity markets, moving beyond the previous model where energy generation was exclusively under federal control.	at both the federal and state level. REG projects must comply with applicable state-level regulatory requirements. In states where electricity markets have devolved, State Electricity Regulatory Commissions (SERCs) may assume roles typically performed by NERC, including aspects of licensing and approvals.
Embedded Generation Regulation (2012)	The Regulation governs embedded generation in Nigeria. Released by NERC in 2012, this is the enabling regulation allowing independent power plants (DERs included) on the grid to use the distribution network at either 11kV or 33kV.	**Licensing:** The Regulation outlines requirements for embedded generation licensing. REG projects must comply to obtain necessary approval for a license.
Distribution Code (2018)	The Distribution Code defines the technical requirements of distribution network and any generation assets connected to it in Nigeria	**Technical requirements**: This code outlines the technical requirements for the distribution network. The interconnection, network rehabilitation, and upgrades of REG projects must comply with this code.
Nigerian Electricity Supply and Installation Standards (NESIS) Regulation (2015)	The NESIS Regulation provides the mandatory technical and safety standards for design, construction, installation, inspection, testing, and certification of electricity supply and installation across the Nigerian Electricity Supply Industry (NESI), formed by NERC, enforced by the Nigerian Electricity Management Services Agency (NEMSA).	**Technical and safety requirement**: This defines the safety and fitness of all electrical installations. REG projects must comply with the NESIS Regulation for certification by NEMSA during testing commissioning.

IEEE 1547	The IEEE 1547 and related guidelines (such as IEEE 1547.1, IEEE 1547.2) are a set of international standards that define the foundational technical requirements for safely interconnecting and operating DERs on distribution networks.	**Technical requirement**: REG interconnection must be guided by these technical requirements.
UL 1741	The UL1741 is a product safety and certification standard for DER equipment, especially inverters and other power conversion systems (PCS). It ensures that DER equipment meets electrical and mechanical safety requirements, performs key functions such as anti-islanding correctly, and is suitable for utility interconnection.	**Safety and quality:** UL 1741 certifies inverter-based equipment to demonstrate compliance with IEEE 1547. REG interconnection equipment should be validated against UL1741.
Standard Organization of Nigeria (SON) Standards and NEMSA Certification	The SON is the statutory body responsible for developing and enforcing national standards, certifying products (both local and imported), and preventing substandard or unsafe electrical equipment from entering the Nigerian market.	**Safety and quality:** REG interconnection equipment must have SON and NEMSA certifications to be approved for use.

2.1. REG-Specific Provisions in Applicable Codes and Standards

This section outlines the key codes and standards relevant to REG interconnection, providing a consolidated reference for the enabling legislative, technical, safety, and product quality requirements in Nigeria. It highlights the provisions most pertinent to REG deployment and equips developers and DisCos with the regulatory and technical context needed for compliant and efficient project execution.

The Electricity Act 2023

Section 80 of the Electricity Act 2023 mandates NERC, in the issuance of licenses, to promote embedded generation, and the generation of electricity from renewable sources like solar, wind, hydro, and biomass. Section 230 of the Act includes a provision for a more liberalized market permitting states to participate in electricity generation, transmission, and distribution. It also empowers states to set up state-level electricity regulatory agencies, similar to NERC, to oversee and regulate their electricity sectors.

Embedded Generation Regulation 2012

The regulation sets out key requirements for embedded generation projects. Chapter III defines connection requirements, including voltage levels and classification based on their installed nameplate capacity. Chapter IV describes the commissioning procedures and required documentation. Chapter V covers commercial agreements, and Chapter VII specifies licensing application requirements and timelines for approval.

***Exhibit 3**: Embedded generation capacity and connection voltages*

Technical Definition	Connection Voltage Level
Small size units having a nameplate rating greater than 1 MW and not more than 6 MW	11kV Medium Distribution
Large size units having a nameplate rating greater than 6 MW and not more than 20 MW	33kV Medium Distribution
Greater than 20 MW	33kV Medium Distribution for every 20 MW being evacuated

Distribution Code 2018

Section 4, Part II of the Distribution Code describes the technical requirements at the interconnection point. It details the power supply quality, applicable and allowable frequency, and voltage variations. Additionally, it addresses protection and grounding schemes for users and distribution network assets. Voltage requirements for generators connecting at the distribution network are also provided in Section 4 of the Distribution Code. Developers are DisCos must ensure that all default settings and metrics in their interconnection terms are based on the nominal values in the distribution code.

***Exhibit 4:** Applicable code based on DER nameplate capacity*

S/N	DER Nameplate Capacity	Applicable Code
1	1 kW–5 MW	Distribution Code
2	5 MW–20 MW	Distribution Code and The Nigerian Grid Code

NESIS Regulation 2015

Chapter 4 of the NESIS Regulation highlights the key considerations of the injection substation including design, construction, and safety requirements. Chapter 5 focuses on the distribution network including line conductors, right of ways, and their design and construction. It is important to note that the commissioning, testing, and certification of the rehabilitated and upgraded distribution network must comply with the NESIS Regulation, which is a prerequisite for certification and approval by NEMSA.

The IEEE 1547 and related guidelines on interconnection

Clause 4 of the IEEE 1547 describes the applicable voltage and frequency as well as the definition of the point of common coupling (PCC). Clause 5 specifies requirements for reactive power and voltage control. Requirements during faults and abnormal operating conditions are addressed in Clause 6. Finally, Clause 7 focuses on islanding requirements that ensure the DER and its interconnection operates safely with the rest of the distribution network.

Local standards and certifications

SON and NEMSA align with international product standards in certifying DER components. Certification type depends on the country of manufacture, where imported products require a "SONCAP" certificate, while locally manufactured components are issued a "MANCAP" certificate.

3. REG Interconnection Process

This interconnection framework focuses on the REG business model. As such, some regulatory requirements described might not apply to other DER models in Nigeria.

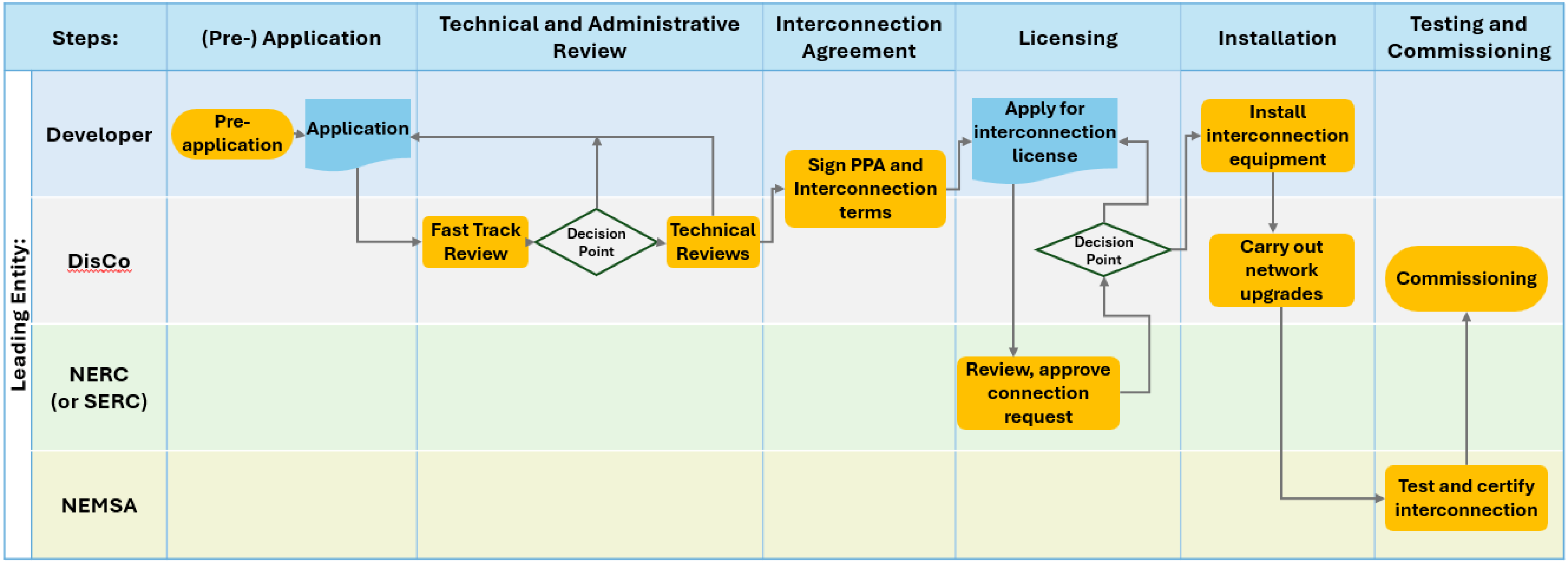
The interconnection process comprises the following six steps:

1. Pre-application and application
2. Technical and administrative reviews
3. Execution of interconnection terms and complementary agreements
4. Regulatory approval and licensing
5. Installation and construction
6. Testing, commissioning, and certification

The process begins with the pre-application stage, involving initial exchange of distribution network data and information between the developer and the DisCo. This is followed by formal application submission by the developer to the DisCo, including technical details such as REG system specifications, layout, and single-line diagrams (SLDs).

The host DisCo reviews the application through administrative and technical assessments. Upon application approval, both parties proceed to the negotiation and execution of the interconnection terms and any required complementary agreements. Regulatory approval and licensing must be obtained before construction, commissioning, and operation can commence. Exhibit 5 below illustrates the key steps, inputs, and output of the interconnection process.

Exhibit 5: *Overview of interconnection process, developer-led DER interconnection*



Depending on the REG development approach adopted — developer-led or DisCo-led — the pre-application and application steps may differ. For developer-led interconnection, feeder and network information is typically not readily accessible, making an initial exchange with the DisCo necessary to obtain relevant network data. For DisCo-led REG projects, on the other hand, pre-qualified developers are usually provided with detailed feeder and network information up-front, then a separate pre-application step may not be required.

A new requirement by NERC will mandate all DisCos to publish up-to-date hosting capacity information (HCI) of all feeders within their franchise area. This will further streamline the interconnection process by eliminating the pre-application data request and exchange phase. This requirement is expected to come into effect in the third quarter of 2026.

Prior to formal application submission, DisCos should make information on the application process, including fees, timelines, required forms, and documentation, publicly available. This can typically be via the DisCo's webpage and at no cost to prospective applicants.

3.1. Interconnection Application to the Host DisCo

The interconnection process begins with pre-application, where DisCos share relevant network data, including the feeder capacity, substation conditions, hosting capacity and protection schemes to inform REG system designs and applications.

Pre-application documentation to be submitted to the host DisCo may include:

- Expression of interest or a letter of intent
- Memorandum of understanding or non-disclosure agreement
- Pre-application request form

Annex 1 provides a template of the pre-application request form, and Annex 2 offers a template for the pre-application report.

Following the pre-application, the developer submits a formal interconnection application (application form template provided in Annex 3) to the host DisCo, along with any applicable fees, for technical and administrative review. The application should include all relevant REG project information, including:

- SLD
- Site layout
- Protection and metering schemes, metering
- Monitoring and control
- Inverter and battery energy storage system (BESS) specifications and certifications

The application form (Annex 3) and supporting documents are submitted through the DisCo's application portal or directly to the DisCo's DER unit, as applicable.

3.2. Technical and Administrative Reviews

An administrative review will be conducted to determine the completeness of the interconnection application. The DisCo will notify any applicant with an incomplete application form **no more than a week** after submission. Applications that pass the administrative review proceed to the technical review stage.

To streamline the application, we propose two tracks for reviewing the interconnection application of REG projects: a **fast-track screening** and a **detailed study** track.

REG projects with a total nameplate capacity of up to 4 MW and an interconnection voltage of 11kV or lower may qualify for the fast-track screening, provided they meet the applicable technical and network stability criteria. This approach allows the DisCo to prioritize detailed technical review for projects with potential greater impact on its networks. However, where a feeder or distribution substation already hosts multiple DERs, the cumulative installed capacity must be carefully assessed. Even smaller projects may require detailed study if the new DER addition could exceed hosting capacity limits or impact network performance.

Exhibit 6: *DER Category by system capacity and interconnection voltage*

	Category	System Size	Connection Voltage
1	Fast-track screening	< 4 MW	0.3kV, 11kV, and 33kV
2	Detailed study	4 MW - 20 MW	11kV and 33kV

The above classification is based on the potential impact of REG on the distribution network, including thermal loading of the line and the overall loading of the substation power transformers. A typical substation in Nigeria comprises of two units of 15 MVA, 33kV/11kV step-down transformers. A DER penetration level of around 15% of feeder or transformer capacity is considered safe, based on industry studies on DER integration in distribution networks.[5] While DERs with a total nameplate capacity below 4MW[i] may qualify for fast-track screening, projects should be assessed on a case-by-case basis to ensure that the cumulative DER penetration at the point of interconnection does not exceed 15% of the hosting distribution substation's rated capacity. If a REG project fails the fast-track screening after two attempts, it will be required to proceed to the detailed study track.

Fast-track screening

The fast-track screening process provides a streamlined technical assessment to determine whether a proposed REG system can be safely interconnected without requiring detailed studies. It evaluates key aspects such as anti-islanding, disturbance

[i] Based on a typical configuration of two 15 MVA transformers, 15% hosting capacity is approximately 4.5 MW; a conservative threshold of 4 MW is recommended.

recovery, and overall network stability. Screening criteria are informed by established industry methodologies and tools like the Sandia Screening Guide,[6] which typically include:

- Rated nameplate capacity of DER against the feeder's minimum load
- Reactive capability
- DER type and inverter certification if the DER is an inverter-based resource
- Compliance with the voltage limits and trip settings
- Feeder characteristics and state of health

The DisCo DER team will assess the application by comparing the submitted design data with feeder and substation parameters to identify any potential safety or network stability concerns. Examples of such concerns include thermal limit of distribution conductor, adequacy of earthing arrangement and protection mechanisms, and the need for additional controllers or external accessories at the point of interconnection.

When an interconnection application meets all the fast-track screening criteria and remains within the applicable threshold (see Exhibit 6 above), the application is considered to have passed the technical reviews and can proceed to the signing of the interconnection terms and complementary agreements.

The fast-track screening process should be completed with results communicated to the applicants **within 10 business days**. An Excel-based screening tool aligned with this approach is provided in Annex 4, to support the DisCos in conducting these assessments efficiently.

Detailed study

REG projects that do not meet the fast-track screening criteria, as well as those with a nameplate capacity above 4 MW are required to go through a detailed study as part of the technical review. The detailed assessment will evaluate the following:

- **Hosting capacity analysis:** This will evaluate whether the REG system will cross the thermal limit (maximum current capacity) of the line at the PCC or anywhere along the feeder, including potential voltage rise or drop issues from adding too much DER capacity.
- **Transformer and network protection requirement:** Assessment of protection schemes, including transformer and feeder protections, relay coordination, anti-islanding, and reverse power protection.
- **Network impact and stability studies:** For REG projects larger than 4 MW, a stability study is required in coordination with the system dispatching operator.
- **Metering and telemetry requirements:** Verification of metering, monitoring, and communication requirements, including provision for physical and remote access to the REG facility by the DisCo.

These detailed studies may require specialized expertise and tools that are not always readily available within DisCos, particularly those at their early stages of DER integration or facing financial and human constraints. In such cases, the DisCo can engage qualified external consultants to conduct the required studies on its behalf. Note that the associated cost should be borne by the applicant.

The detailed studies should be completed **within 15 business days,** from the date of submission of the application or re-entry into the application pool. Evaluation results should be communicated to applicants **within one week** after its completion and confirmation by the DisCo. After successfully passing the technical review, developers will proceed to the interconnection agreement step. Where requirements are not met, applicants may either:

- Submit a ***revised application*** that complies with ***network requirements; or***
- Agree to undertake necessary ***network upgrades*** to accommodate the project. It is important to note that in this case, all network upgrade costs shall be borne by the applicants based on the cost-causer principle as defined in the relevant regulation.[ii]

Important documents that are required for technical review in addition to the application form include:

- DER project design document, including SLD
- Network diagram showing the boundary of the ring-fenced REG network
- Specifications of inverter, BESS, and other REG components

3.3. Interconnection Terms and Complementary Agreements

Once the interconnection application is approved by the DisCo, the next step is the negotiation and execution of the interconnection terms and any complementary agreements. For REG projects, complementary agreements may include the power purchase agreement (PPA) and the revenue agreements following the agreed payment waterfall.

The interconnection terms define the technical and commercial process governing the interface between the REG facility and the distribution network. Key components typically include:

- Network boundary and point of connection (PoC)
- Applicable voltage and frequency (and their limits)
- Interconnection and metering points
- Energy and billing accounting
- Power quality requirements and allowable deviation
- Contracted capacity
- Deemed energy delivery
- Availability requirements

[ii] The Distribution Code, the Net-Billing Regulation, and the Embedded Generation Regulation all specify that the generator owner shall be responsible for all network upgrades required to interconnect to the grid.

- Technical specifications of the interconnection equipment

Negotiating and execution of these agreements can be time-consuming, as observed during the first wave of the IMG pilots that RMI supported, often leading to additional delays. While standard contract templates can accelerate the process, project-specific adjustments are still strongly encouraged and sometimes required. A balanced approach is recommended, where the DisCo and the developer agree on a set of core terms through a term sheet, while allowing flexibility for project-specific conditions.

As a guideline, contract execution should be reached **within 6 weeks** after interconnection application approval. The interconnection terms sheet, signed between the DisCo and the developer, represents a key milestone in the interconnection process and a prerequisite for subsequent regulatory approval and licensing. A template interconnection agreement is provided in Annex 5.

3.4. Regulatory Approval and Licensing

Following execution of the relevant agreements, the DisCo notifies NERC and NEMSA of the interconnection process through the applicable submission process (e.g., a single-window portal if or when available). The developer is required to submit the necessary documentation and pay applicable processing fees for the regulatory review. Upon successful review and payment of licensing fees, the project is issued the required approvals to proceed to implementation.

Depending on the state regulatory framework, licensing and approval processes may fall under the jurisdiction of SERC and associated state-level agencies.

Key documents required for regulatory approval and licensing:[iii]

- Executed interconnection term sheet
- Executed PPA
- Environmental impact assessment approval for projects above 10 MW, or an environment management plan (e.g., with policy for managing effluents and discharges) for projects below 10 MW
- Evidence of land rights (e.g., registered title deed)
- Corporate documents (e.g., certificate of incorporation, memorandum and articles of association, etc.)

BOX 1: A web portal is critical for tracking and accelerating DER interconnection

A single-window application portal that integrates the interconnection application process across DisCos, NERC, and NEMSA can significantly improve transparency and efficiency. By enabling back-to-back tracking of all DER applications including REG, from submission through commissioning, the portal offers a centralized source of DER project data and progress.

[iii] Following the Embedded Generation Regulation, 2012

Such a system can help identify administrative bottlenecks, monitor timelines (including from application to commercial operation), and support more efficient processing of REG and other DER projects.

RMI is supporting **NERC, NEMSA, and** DisCos to **develop and adopt a streamlined interconnection application web portal.**

3.5. Installation and Construction

The installation and construction step includes two key workstreams that must be completed before the REG project is ready for interconnection. These are:

- Network upgrades and rehabilitation
- Installation of the interconnection interface equipment

Network rehabilitation and upgrades are a shared responsibility between the developer and the DisCo. While the developer usually finances the required network upgrades, the DisCo leads or supervises these activities — such as reconductoring of lines, pole replacements, and transformer substation rehabilitation and retrofits — given its familiarity with network standards and operations. Where DisCo capacity is limited, the DisCo can recommend its approved contractors or vendors to the developer, who will carry out the upgrades. The DisCo is still expected to provide on-site oversight to ensure compliance with specifications and standards.

During the interconnection agreement step, the DisCo and the developer will have agreed on the type, ratings, and other specifications of the interconnection equipment. The developer or its representative will install interconnection equipment accordingly at the PCC. The interconnection equipment and devices may include:

- Recloser and circuit breakers
- Relays and controllers
- Energy meters (including bi-directional and revenue meters)
- Interconnection disconnect switches
- Power quality equipment
- Communication gateways

The interconnection interface performs critical functions, including protection of both the DER and the distribution network from faults caused by one another. Additionally, the interface synchronizes the REG system with the rest of the network, monitors and measures energy flow, and enables switching and control while managing power quality. These components ensure the REG system is operating safely, reliably, and in compliance with the relevant codes and regulations.

3.6. Testing, Commissioning, and Certification

Once all installation and construction are completed, the REG interconnection proceeds to testing and commissioning. The REG solution will be tested based on the generation technologies deployed at the site to verify that the designed specifications and key performance parameters are met.

The DisCo's representatives will test and verify all aspects of the distribution network upgrades and retrofits through line tracing and pole and transformer parameter tests (insulation resistance, open and short-circuit tests), and to confirm the fitness for operations.

Interconnection testing is conducted jointly by the developer and the DisCo to ensure safe and reliable operation of the interface, mainly the closing and reclosing functionality. This ensures that system does not go into islanding mode unintentionally. Additional tests may include:

- Demonstrating the monitoring and control interface (for the DisCo)
- Verifying protection settings for both the network and REG
- Validating responses to frequency and voltage disturbance

Following the initial testing, NEMSA is invited to conduct an independent inspection to identify issues and non-compliance before the final testing, commissioning, and certification. When deficiencies are noted by NEMSA, the developer is required to promptly address all issues in cooperation with NEMSA, who may schedule another inspection as deemed necessary.

Once the site and the interconnection have been certified by NEMSA, the DisCo is then authorized to energize and start sending and receiving power across the interconnection interface.

3.7. Roles and Responsibilities Among Stakeholders in Interconnection

Clear delineation of roles across stakeholders is critical to ensure an efficient and well-coordinated interconnection process. Exhibit 7 summarizes the key responsibilities of regulators, DisCos, and project developers across the REG interconnection steps.

Exhibit 7: *Roles and responsibilities between stakeholders in REG interconnection.*

Actor		Roles and Responsibilities
Regulator	NERC (or SERC where applicable)	▪ Sets regulations and monitors compliance ▪ Approves all interconnection requests
	NEMSA	▪ Ensures compliance with the NESIS requirements ▪ Tests, commissions, and certifies DER interconnections for safe operations

Utility (DisCo)	▪ Leads project initiation (for DisCo-led projects) ▪ Publishes interconnection procedures ▪ Manages and administers the interconnection process ▪ Conducts screening and technical reviews ▪ Maintains network asset data and identifies network rehabilitation and upgrade needs ▪ Communicates technical requirements, costs, and timelines of interconnection to the developers ▪ Installs, owns, and maintains utility-side interconnection assets ▪ Oversees the quality of distribution network assets and provides guidance on applicable specifications and standards ▪ Coordinates regular inspections and commissioning of interconnection equipment ▪ Manages outages, curtailment, or disconnection when system safety is at risk
Project developer	▪ Leads project initiation (for developer-led projects) ▪ Submits complete and accurate interconnection applications and supporting technical studies ▪ Finances, installs, owns, and maintains REG and customer-side interconnection assets ▪ Funds and coordinates required network studies, upgrades, and tests ▪ Ensures compliance with protection, power quality, and anti-islanding requirements

To complement the roles above, Exhibit 8 below provides a suggested timeline for the interconnection process, highlighting key steps, responsible parties, and expected outputs. We recognize that the timelines may vary depending on project complexity, data availability, and regulatory processing.

Exhibit 8: *Proposed interconnection process timeline overview.*

Process	Timeline (Weeks)	Leading Entity	Outputs
Pre-application	2	DisCo, Developer	Submit pre-application
Application	1	Developer	Complete application form
Technical and administrative review	4	DisCo	Results of technical review/studies
Execute interconnection terms and complementary agreement	4	DisCo, Developer	Interconnection agreement

Regulatory approval and licensing (NERC & NEMSA)	4	DisCo	DER and interconnection license
Installation and construction	N/A	Developer	Complete DER and interconnection interface installed
Inspect and certify interconnection and DER	4	NEMSA	DER and interconnection certification
Commissioning	1	DisCo	Energize interconnection point
Duration of interconnection process	**20**		

3.8. Cost Allocation

Cost allocation for REG interconnection follows the cost-causer principle. The party whose action or project decisions drive additional costs would be responsible for bearing those costs. In practice, interconnection may require:

- Network studies (e.g., feeder data and model, load flows and impact studies)
- Network upgrades and rehabilitation (e.g., to lines, transformers, feeder protection equipment, etc.)
- Metering, monitoring, and communication equipment

In general, the developer bears the costs associated with project-specific upgrades and interconnection requirements, while the DisCo is responsible for core network infrastructure outside the defined project boundary. Exhibit 9 below shows the high-level cost allocation between a developer and DisCo deploying a REG project.

Exhibit 9: *Cost allocation for REG interconnection.*

Cost Center	Developer	DisCo
Network Rehabilitation	Finances all network rehabilitation with the ring-fenced distribution network for REG. This also includes meters for individual customers within this network.	Funds network rehabilitation outside of REG boundary.
Network Upgrade	Finances and implements all required network upgrades at the PCC, including substation component upgrades.	N/A
Metering & Telemetry	Provides export meter and remote monitoring and control interface for the DisCo. Maintains metering records and energy transaction log in line with the Embedded Generation Regulation.	Maintains metering records and energy transaction log in line with the Embedded Generation Regulation.
Interconnection	Procures and installs interconnection equipment with	Reviews, validates and certifies compatibility and

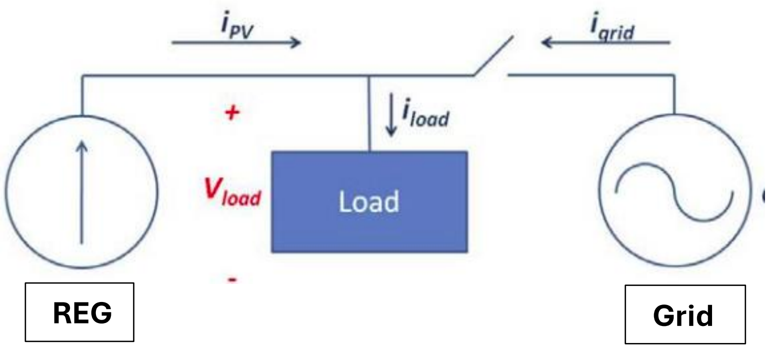
	guidance from the DisCo network management team.	fitness for interconnection equipment. Conducts testing to ensure network safety.
Code Compliance	Ensures compliance and pays inspections and commission fees. Bears penalty costs due to non-compliance or negligence.	N/A

4. Technical Requirements for Interconnection

While the focus of this framework is on the REG business model, the following technical requirements apply to all DERs connected to and operating in parallel to the DisCo's distribution network with the capability of exchanging energy between the DER and the utility network. These requirements shall apply only at the agreed interconnection point between the DisCo and the developer. The interconnection point, depending on the technology and the point of interconnection, could be at the PCC or the PoC of the DER.

A simplified schematic is shown in Exhibit 10, where the load receives energy both from the grid and the DER unit connected in parallel to the grid. The PCC is the point where the DER connects to the grid through a set of interconnection equipment such as meters, relays, reclosers, interlocks and manual high voltage switches.

Exhibit 10: *Schematic of a typical REG interconnection showing the DER, load, and the grid.*



Legend
i = current/power
i_{pv} = current/power from REG DER
i_{grid} = current/power from grid
i_{load} = current/power drawn by the load
V_{load} = voltage of the load

4.1. General Interconnection Specification

Applicable voltage and frequency

Applicable voltage and frequency standards including their allowable variations will meet the requirements of the distribution code for the respective voltage levels. The nominal system frequency is **50 Hz**.

A table of applicable voltage and frequency ranges is provided in Annex 6, which sets out the technical requirements for interconnection.

Power limit

The DER must have the capability to limit its active power (in kW) as a percentage of its nameplate power rating. When requested by the host DisCo, a DER such as REG might be requested to supply power lower than the demand from the REG ring-fenced distribution network for network stability. Guidance on the required power limit requirement can be accessed in the technical requirements in Annex 6 of this interconnection framework.

Isolation device

A visible-break isolation device that is visible and accessible to the host DisCo maintenance team and that is lockable to prevent unauthorized access is required at the PCC in addition to any automatic isolation device.

Reactive power and voltage control requirements

The DER must support the following reactive control models, which can be selected at any given time:

- Constant power mode
- Voltage-reactive power mode
- Active power-reactive power mode
- Constant reactive power mode

Annex 7 provides recommended settings for active power-reactive power and voltage-reactive power for operating DER during normal operating conditions.

4.2. Response to Abnormal Conditions

The DER must have the capability during faults and disturbances to remain in service and disconnect when the allowable threshold has been exceeded. Performance requirements during disturbances include:

- Voltage ride-through
- Frequency ride-through
- Dynamic voltage support

Additional technical requirements and recommended settings during abnormal and fault conditions including voltage and frequency ride-through conditions can be accessed in Annexes 6 and 7 respectively of this framework.

4.3. Islanding Requirements

DERs including REG must support intentional islands, and while interconnected to a distribution network, must meet to all requirements for interconnection of DER to a distribution network. This includes mechanisms for the detection of islanding upstream of the REG distribution network.

An intentional island may disconnect from the distribution network and transition to intentional island mode for any of the following conditions:

- Whenever there is voltage and frequency disturbance event where the limits for disconnecting the DER from the distribution network is reached occur.
- If there is a mandatory tripping event during an abnormal condition
- If the conditions for intentional islanding are met

For an unintentional islanding event in which the DER energizes a portion of the distribution network through the PCC, the DER shall detect the island, cease to energize the distribution network, and trip within two seconds of the formation of an island. False detection of an unintentional islanding event that does not actually exist shall not justify non-compliance.

4.4. Monitoring and Control

A REG site will have provisions for a local DER interface capable of communicating to support the information exchange requirements specified in this standard for all applicable functions that are supported in the DER.

Under mutual agreement between the distribution network operator and DER operator, additional communication capabilities may be allowed.

Monitoring and controlling requirements

The DER must be capable of providing real-time monitoring data through a communication interface at the point of interconnection. At a minimum, this should include information specified in Annex 6 on technical requirements for monitoring and control, with data updates within the required response time.

In addition, plant control parameters must be accessible for both reading and writing through the communication interface. These often include:

- Power factor mode parameters
- Voltage-reactive power mode parameters
- Active power-reactive power mode parameters
- Constant reactive power mode parameters
- Voltage-active power mode parameters
- Voltage trip and momentary cessation parameters
- Frequency trip parameters
- Frequency drop parameters

- Maximum active power limits
- Cease to energize and trip (the DER can be directed to cease to energize and trip by changing the permit service setting to "disabled")

Recommended settings and applicable technical requirements have been included in Annexes 6 and 7 of this framework.

5. Operations, Monitoring, and Issues Resolution

This section outlines the operational requirements and coordination between the REG plant operator and the host DisCo to ensure reliable, continuous power supply, and efficient operation. It also defines key considerations for daily operations of REG facilities, performance monitoring, non-compliance, and issue resolution.

5.1. Operations

The project developer, or its appointed third-party operator, is responsible for the day-to-day operations and maintenance of the REG facility, ensuring optimal performance and compliance with agreed technical and commercial requirements.

The REG system supplies power on demand by the DisCo: all energy generated by the REG system is injected into the DisCo's network for distribution to customers. To maintain network reliability and operational efficiency, the REG operator and the DisCo's network planning team must agree on the amount of expected energy and dispatch arrangements, as defined in the interconnection terms and commercial agreements.

5.2. Performance Monitoring

The REG developer should provide the host DisCo with access to a monitoring interface where the REG plant's performance data can be viewed, queried, stored, and retrieved. The data should also include both the generation data and energy import/export data at the PoC to support accurate monthly energy accounting and reconciliation between the developer and the DisCo.

The developer should prepare periodic reports summarizing REG plant performance to the DisCo, on a monthly or quarterly basis, as agreed by both parties. The DisCo can then incorporate these reports into their performance reporting to the regulators (NERC or state regulatory agencies).

Important performance metrics to track include, at a minimum:

- Plant hourly availability
- Energy import/export
- Faults and incident logs summary

Non-compliance and operation out of approved limits

Any DER operator found to be non-compliant with the applicable codes, standards, and regulatory requirements may be subject to enforcement actions by NERC or the relevant state electricity regulators. These actions may include fines, disconnection, or license revocation, typically following filing of such complaints and escalation by the DisCo.

Non-compliance poses significant operational and safety risks to the distribution network, DisCo personnel, and the public. the DER operator must document any non-compliance incident and submit a report to the DisCo detailing the issue(s), root cause, corrective actions taken, and mitigation steps to prevent reoccurrence.

One of the most common yet dangerous cases of non-compliance is unintentional islanding. This occurs when the DER continues to export power/current to a portion of the distribution network even though the system has been de-energized by the operator. This presents serious safety risks and must be prevented through appropriate protection and control systems.

5.3. Issues Resolution

The DisCo and the developer will, in the case of any issues or conflicts, address the conflicts amicably within 30 days using the conflict resolution mechanisms specified in the governing agreements for the interconnection. If after 30 days both parties are unable to come to an agreement, they can approach NERC to mediate on the issue.

Annexes

Annex 1	REG Interconnection Pre-Application Form
Annex 2	REG Interconnection Pre-Application Report
Annex 3	REG Interconnection Application Form
Annex 4	REG Interconnection Fast-Track Screening Tool
Annex 5	Interconnection Terms Template
Annex 6	Interconnection Technical Requirement
Annex 7	Recommended Power Settings

Endnotes

[1] Osa Imoukhuede, Wayne Omonuwa, Ola Okeowo, Sakhi Shah, Olamide Edun, and Ighosime Oyofo, *Unlocking Renewable Embedded Generation in Nigeria*, RMI, 2022, https://rmi.org/insight/unlockingrenewable-embedded-generation-in-nigeria/.

[2] NERC Quarterly Report Q3 2025, Nigerian Electricity Regulatory Commission, 2025, https://nerc.gov.ng/wp-content/uploads/2026/01/2025_Q3-Report.pdf.
[3] Collins Dadzie, Olatunde Okeowo, Alberto Rodríguez, Sakhi Shah, and James Sherwood*, Scaling Utility-Enabled Distributed Energy Resources in Nigeria: A Roadmap to Boost Distribution Company Revenues and Improve Power Availability and Reliability*, RMI, June 2024, https://rmi.org/insight/scaling-utility-enabled-distributed-energy-resources-in-nigeria/.
[4] Folawiyo Aminu, Alberto Rodríguez, and Ridwan Zubair, *Partnerships for Power: Unlocking Scale for Interconnected Minigrids in Nigeria*, RMI, 2025, https://rmi.org/insight/partnerships-for-power/.
[5] Duong, Minh Quan, et al., "The impacts of distributed generation penetration into the power system," *2017 International Conference on Electromechanical and Power Systems (SIELMEN)*, IEEE, 2017.
[6] Abraham Ellis and Michael Ropp, *Suggested guidelines for anti-islanding screening*, US Department of Energy Office of Scientific and Technical Information, 2012, https://doi.org/10.2172/1039001.