# THE WORLD BANK

# TECHNICAL ASSISTANCE TO TANESCO IN FORMATION OF SPP CELL

# TANESCO GRID CODE FOR EMBEDDED GENERATION

**June 2012**

# PREFACE

The **TANESCO Grid Code for Embedded Generation** is the key deliverable of the World Bank's Technical Assistance program to TANESCO to facilitate the implementation of TANESCO's SPP Cell. It has been formulated as a manual for TANESCO to use in the development and implementation of Small Power Projects (SPP) in Tanzania. The manual is divided into two separate but related parts:

**Part 1: SPP Application Approval and Interconnection**

The first part provides a road map that addresses each of the steps necessary to progress from the receipt of an SPP application to the SPP's final approval and interconnection to the power grid. It contains numerous flow charts detailing the different steps to be undertaken by and within TANESCO for the application and interconnection approval process, as well as the various parties involved in and responsible for completing these tasks. The document also includes numerous appendices with standardized templates and internal documents for TANESCO to use in the approval processes and to facilitate communication between TANESCO, SPP applicants and other relevant stakeholders.

**Part 2: TANESCO and SPP Operation**

The second part of the manual provides detailed operational guidelines for TANESCO operation and maintenance staff working on distribution systems connected with SPPs. TANESCO's current Manual on Operation Practices, which was first published in February 1977, does not address SPPs, as there were no SPPs within TANESCO's power grid when the manual was first published. Electric Offices without any grid-connected SPPs should therefore continue using the current Manual on Operation Practices. Electric Offices with one or more SPP interconnections should use the original Manual on Operation Practices as well as this manual on TANESCO and SPP Operation in conjunction with one another.

Special thanks are due to Michael J. Spolum who provided English language copy editing for this volume.

Mr. Prayad Kruangpradit

June 2012

# GLOSSARY OF TERMS

| | |
|---|---|
| CB | Circuit Breaker |
| COD | Commercial Operation Date |
| CPV | Concentrating Photovoltaic |
| CT | Current Transformer |
| DFIG | Doubly-Fed Induction Generator |
| EA | Engineering Assessment |
| EWURA | Energy and Water Utilities Regulatory Authority |
| IBEG | Inverter-based Embedded Generator |
| IG | Induction Generator |
| LOI | Letter of Intent |
| LV | Low Voltage |
| MV | Medium Voltage |
| PCC | Point of Common Coupling |
| PF | Power Factor |
| PFC | Power Factor Control Mode |
| PMSG | Permanent Magnet Synchronous Generator |
| POS | Point of Supply |
| PV | Photovoltaic |
| REA | Rural Energy Agency |
| SCIG | Squirrel Cage Induction Generator |
| SG | Synchronous Generator |
| SER | Sequence of event records |
| SPP | Small Power Project |
| SPPA | Small Power Purchase Agreement |
| TANESCO | Tanzania Electric Supply Company |
| VC | Voltage Control Mode |
| VT | Voltage Transformer |
| WECS | Wind Energy Conversion System |

# Definition of Terms

**BIL**

The BIL or basic lightning impulse insulation level is the electrical strength of insulation expressed in terms of the crest value of the "standard lightning impulse."

**Dead (Cold)**

An object shall be said to be “dead” – or “cold” – when it is at or near zero voltage, disconnected from any live system, and connected solidly to the earth.

**High Voltage (HV)**

Voltage exceeding 33 kV between conductors

**Live (Hot)**

An object shall be said to be “live” – or “Hot” - when a difference of potential voltage exists between the object and the earth, or the object is connected to any part of a supply system any part of which is not permanently and solidly earthed.

**Low Voltage (LV)**

Voltage not exceeding 650 V between conductors

**Medium Voltage (MV)**

Voltage exceeding 650 V but not exceeding 33 kV between conductors

**Person-In-Charge of Work (PICW)**

The approved person who in immediate charge of work on specific apparatus

**Person Issuing Work (PIW)**

The approved person who is tasked with: 1) appointing the Person-In-Charge of Work; 2) allocating work to the PICW; and 3) appointing a coordinator, if required.

**Point of Supply (POS)**

The location of the connection between a distribution network and an embedded generator

**Request for Isolation**

A written document requesting the isolation of a specific apparatus requiring work/maintenance, and/or an apparatus in close proximity to an apparatus requiring work/maintenance

**SPP Cell**

An operational unit embedded within, and under the authority of, TANESCO's Strategic Planning Department that is tasked with the approval and SPP interconnections.

**TANESCO Controller**

The approved person to oversee operation of the defined distribution system or a portion of the distribution system

**TANESCO Operator**

The approved person to perform the day-to-day operation of the TANESCO's power system, who operates under the supervision of the TANESCO Controller

**The SPP Operator**

The approved person to perform the day-to-day operation of the SPP's system

**TANESCO Line Crew Foreman**

The approved person to supervise a group of Linemen and other workers engaged in the construction, maintenance and/or repair of overhead or underground transmission and distribution power lines.

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## EXECUTIVE SUMMARY

This TANESCO Grid Code for Embedded Generation has been formulated as a manual for TANESCO to use in the development and implementation of SPP projects in Tanzania. The manual is comprised of, and divided into, two parts:

### PART 1: SPP APPLICATION APPROVAL AND INTERCONNECTION

Part 1 describes each step in the process of approving and interconnecting an SPP to TANESCO's main grid, TANESCO mini-grids and SPP mini-grids. It also details coordination processes between: 1) TANESCO and the developer of the SPP project; 2) TANESCO, EWURA and REA; and 3) the TANESCO SPP Cell and the relevant TANESCO departments and/or Regional Office. The document includes detailed flow charts showing the workflow between these entities as well as the day-to-day responsibilities of each department/entity. A number of check-lists have also been developed to support the SPP Cell's project management activities, including the monitoring and evaluation of SPP projects during construction and operation.

The following is a sequential summary of the steps to approve an SPP application and interconnection.

### 1. SPP Connected to TANESCO Main Grid and TANESCO Mini Grid

#### 1.1 Request for LOI

Once a completed application is received from the prospective SPP Developer, the TANESCO SPP Cell will issue a notification letter informing the developer of their specific Site Reference Number to be used for purposes of coordinating with TANESCO.

#### 1.2 Duplication checking of TANESCO rural electrification projects

If an SPP applicant requests a connection to one of TANESCO's mini grids, TANESCO will proceed by determining if there are any rural electrification or distribution extension projects being planned for the project area. If it is determined that projects are being planned for the proposed project area, TANESCO will provide the SPP applicant with an approximate estimate of the date the project area will be connected to TANESCO's main grid. This information is intended to assist the SPP applicant in determining the proposed project's financial feasibility.

#### 1.3 Issuance of LOI

The TANESCO team will be comprised of: one SPP Cell Officer; one Regional Office Engineer; and one Protection Engineer. For a very small SPP, which can be connected to

one of TANESCO's low-tension (230/400 volt) lines, only a Regional Office Engineer will be assigned to collect the required information from the project site. Upon receipt of an SPP application, the appropriate TANESCO team will visit the proposed project site to verify the project's feasibility. Initial criteria that should be used to determine a site's feasibility should include the project's estimated power export capacity as well as any potential conflicts that may exist with other SPP or TANESCO projects. Information will be collected in support of the eventual issuing of an LOI.

### 1.4 Issuance of SPPA

Within 30 days of the LOI's issuance**,** an ***Engineering Assessment (EA)*** will be completed to ensure the project's technical feasibility. This assessment will seek to verify/identify: 1) the anticipated quantity of power to be purchased from the SPP project; 2) the project's proposed location with respect to sites for grid interconnection; and 3) the potential impact of the proposed project on TANESCO's power system. If the Engineering Assessment is satisfactory, TANESCO will issue the SPPA.

There are three options regarding which party (i.e. TANESCO or the SPP Developer) will be responsible for carrying out the EA:

**Option 1:** TANESCO conducts a detailed interconnection study that includes Load Flow and Short Circuit Studies. TANESCO will bill the SPP Developer for the costs of the studies.

**Option 2:** TANESCO provides the SPP Developer with a base case study or studies of a similar TANESCO system. The developer uses the study/studies to conduct its own detailed interconnection study, the results of which are examined by TANESCO. The costs for preparing the base case study/studies are passed through to the SPP Developer.

**Option 3:** The SPP Developer independently conducts detailed interconnection studies. Upon completion, the studies are reviewed by TANESCO for accuracy.

Please refer to section 4 of Part I for the **Guidelines for SPP Engineering Assessments.** The guidelines consist of two main parts: a load flow study and a short-circuit study, both of which are addressed in Section 4.1 of Part I.

### 1.5 Upgrading TANESCO's Distribution Systems

Within 30 days of the SPPA's issuance, the TANESCO Regional Office will complete a detailed design outlining the upgrades required for the TANESCO distribution system to accommodate the proposed SPP project's connection to the grid. This SPP Developer will integrate the TANESCO Regional Office's proposed design into the SPP project's formal design.

Note: *Projects may be constructed by TANESCO or a contractor hired by the SPP Developer, however compliance with all relevant TANESCO standards is mandatory.*

### 1.6 Interconnection Protection and Testing

The SPP Developer is required to submit its application for grid interconnection and electricity after being granted the SPPA and within 12 months of the LOI's issuance. The application must include protective device diagrams and a protection coordination study. A protection engineer from TANESCO's Transmission Department is responsible for: 1) ensuring that the TANESCO and SPP protection systems are coordinated; and 2) approving the SPP Developer's protection coordination study and proposed project design.

The **Guidelines for Design Examination and Interconnection Protection Acceptance (item 5 of Part I)** provides guidance for TANESCO regarding the protection coordination/setting study and the appropriate processes to assess the SPP Developer's proposed project design.

### 1.7 Meter Installation and Commissioning

Following the successful testing and commissioning of the SPP project's interconnection facilities**,** the SPP Developer will be given permission to install a three phase AMR meter for the up-sale of electricity into the grid. The SPP Developer has two options regarding the meter's installation:

1) The SPP Developer may purchase an AMR meter from TANESCO. TANESCO will charge the SPP Developer directly for the meter as well as all costs associated with the meter's installation and commissioning;

2) The SPP Developer may independently purchase an alternative meter that complies with TANESCO specifications. As in Option 1, TANESCO remains responsible for calibrating, installing and commissioning the meter, the costs of which are passed through to the SPP Developer.

Note: *The Large Power Department is responsible for meter installation and commissioning.*

### 1.8 Initial Interconnection and Commercial Operation Date (COD)

Excluding cases where the SPPA requests additional time, the date of a project's formal commissioning shall not exceed two years after the original SPPA is signed by both TANESCO and the SPP Developer.

The initial interconnection - or ***first synchronization*** - can begin once the following conditions are met: 1) the SPP's distribution system is connected to TANESCO's grid;

2) TANESCO's distribution upgrade is complete; 3) the required protective equipment and meter have been installed and tested; and 4) the SPP Developer has obtained a EWURA license. *The first synchronization* process requires the cooperative efforts of the SPP Cell, protection engineer (optional), the TANESCO Regional office and the SPP Developer. The Commercial Operation Date (COD) is formally declared once the conditions outlined above have been met.

**2. SPP MINI GRID**

In instances when the proposed location of the SPP project is isolated (i.e. a considerable distance away from TANESCO's main grid), the SPP Cell is required to check with the Electrification and Projects Divisions regarding: 1) the status of any rural electrification and/or distribution extension projects that would extend the TANESCO distribution system to the target community; and 2) the anticipated date when the target community will be connected to TANESCO's main grid. The SPP Cell will then provide this information to the SPP applicant, EWURA and REA.

**PART 2: TANESCO AND SPP OPERATION**

Part 2 provides operational guidelines for TANESCO operation and maintenance staff working on distribution systems that are interconnected to SPPs. Flow charts depicting the appropriate work flow, the sequence of work to be done, and which parties are responsible for completing the work in each respective step are clearly identified in order to ensure safety and system reliability.

# PART I

## SPP APPLICATION APPROVAL AND INTERCONNECTION

# PART I: SPP APPLICATION APPROVAL AND INTERCONNECTION

## 1. Introduction

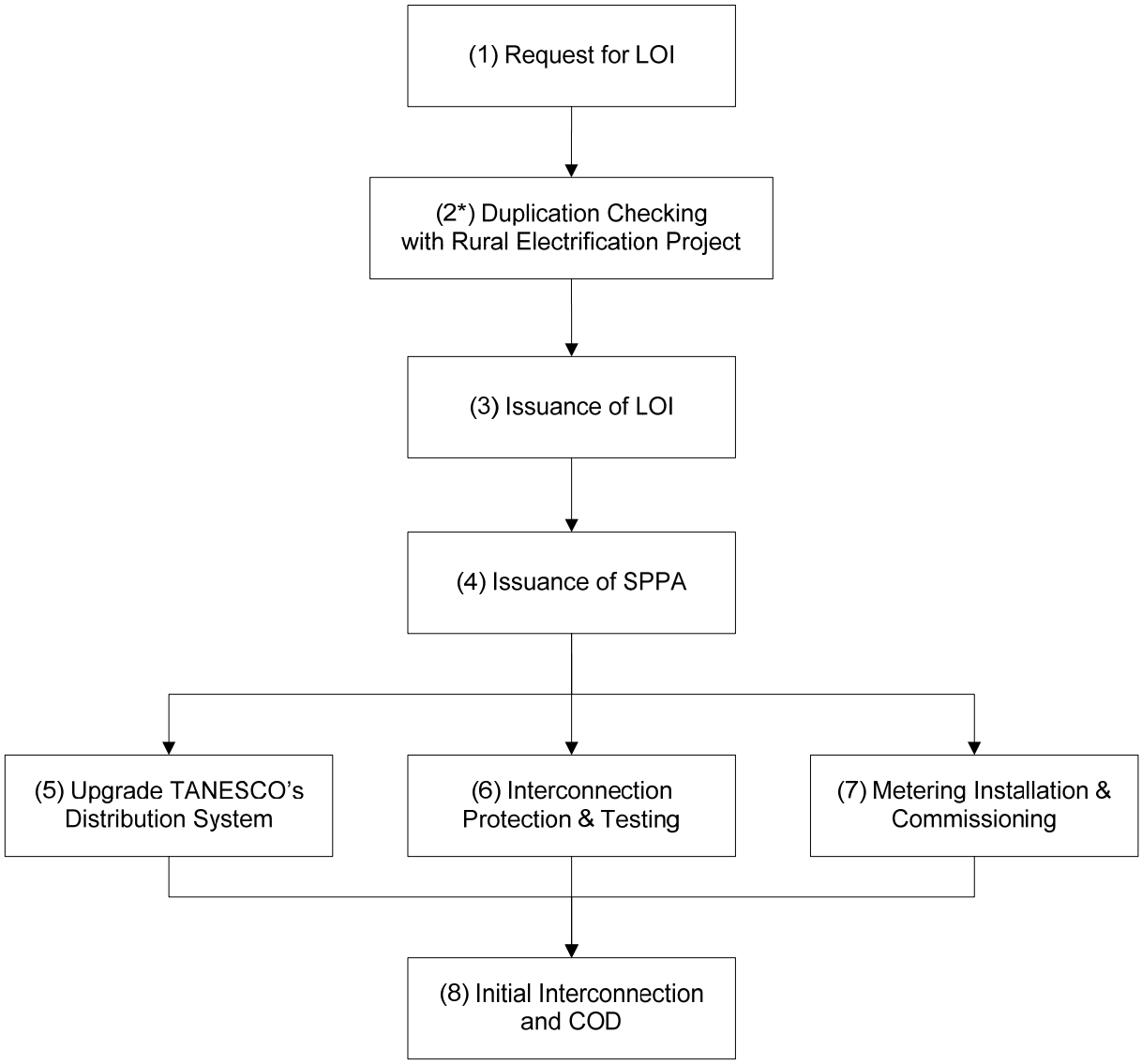
This part of the manual provides the SPP Cell with guidelines on each step of the application approval and interconnection processes for a Small Power Project (SPP) in Tanzania. The SPP Application Approval and Interconnection details the coordination processes between TANESCO's departments/divisions and the SPP Developer, and has been harmonized with:

1) Related guidelines issued by the Tanzanian Government, and;

2) Established TANESCO practices and project approval process.

## 2. SPP Application Approval and Interconnection Steps for Main Grid and TANESCO Mini Grid Connection

The commissioning of an SPP project consists of 8 separate but related steps (ref. Figure 1). Each step can be separated into a series of unique steps and processes that are explained in detail below:




**Note:** *: This step is only for SPP connected to TANESCO Mini Grid

Fig.1: SPP Application Approval and Interconnection Flowchart

## 2.1 STEP 1: Request for Letter of Intent

2.1.1 The SPP applicants will submit a request for a Letter of Intent (LOI) to TANESCO's Head Office in Dar Es Salaam, which will then forward the request to the Manager of the Strategic Planning Department and then to the SPP Cell. The SPP Cell officer will issue an Acknowledgement of Receipt of SPP Application for Electricity Sales letter (ref. Form 1A) within 7 days of receiving the SPP Developer's request for LOI.

2.1.2 The SPP Cell officer will verify that the request for LOI is complete within 14 days of its receipt. If the request is incomplete, the SPP Cell officer should notify the applicant within 14 days. Notifications of an incomplete request for LOI should be accompanied with a brief list of the contents that are missing.

Complete applications will include the following documents:

(1) Request for LOI to sell electricity to TANESCO signed by authorized person from the entity backing the project accompanied by supporting documents of the signer's position/authority within the entity;

(2) Name and address of the SPP Developer;

(3) The proposed location (longitude and latitude) of the project. In the case of a hydropower project, information regarding the project location should also include the river/stream/canal where the plant will be sited. Head and flow rate measurements should also be included;

(4) Fuel type (hydro, biomass, wind, etc);

(5) Generating capacity (MW), anticipated quantity of power exports (MW), and expected annual energy generation (GWh);

(6) A copy of the land title, deed, lease agreement or any other documentation proving ownership of the land upon which the project will be located; and

(7) Evidence of the right to resource, (e.g. water rights for a hydropower project).

2.1.3 Within 14 days of receipt and verification of a complete request for LOI, the SPP Cell will issue a notification letter to the SPP Developer that will include a Site Reference Number using Form 1B.

The overall procedures for requesting a letter of intent are shown in Fig.2.

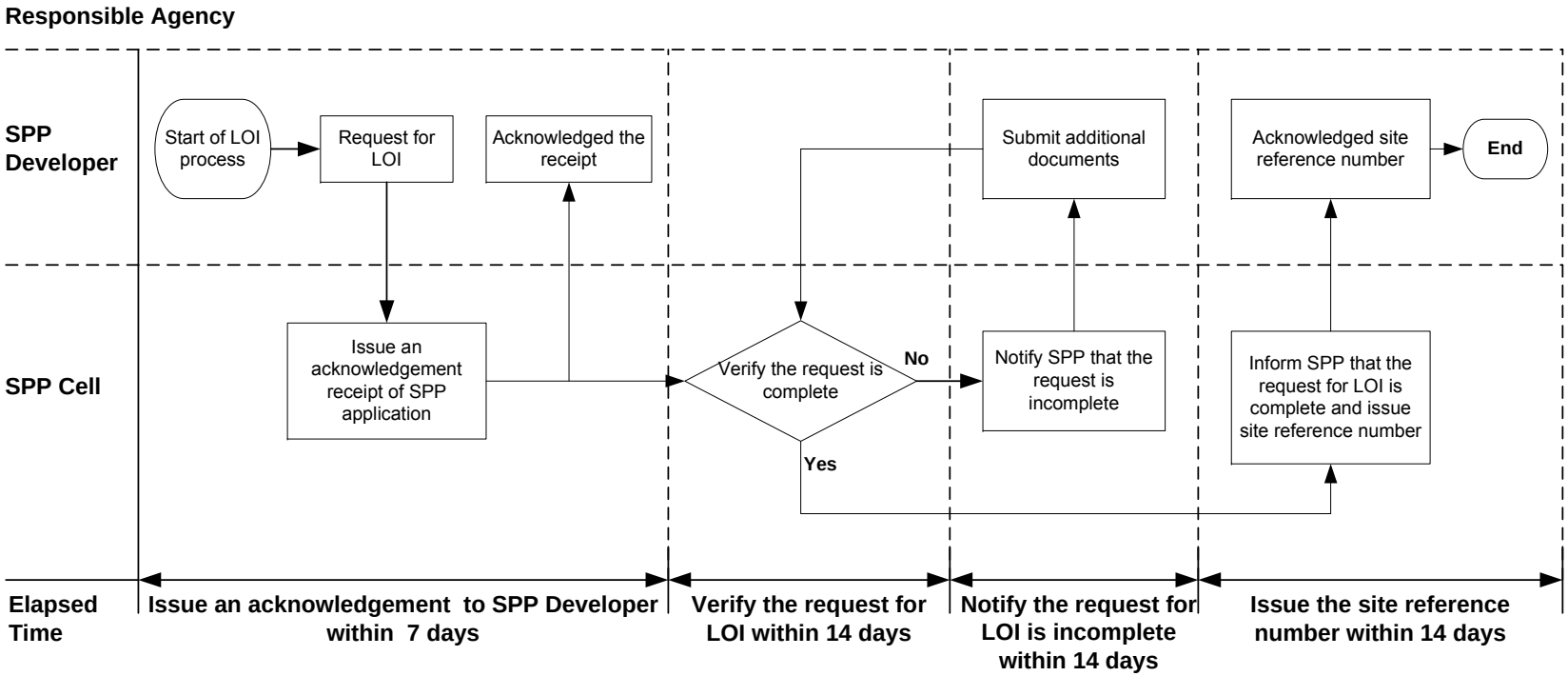



Fig.2: Request for Letter of Intent procedure flowchart

## 2.2 STEP 2: Checking for Duplication of Rural Electrification Projects

Several additional steps are required when an SPP Developer requests a connection to one of TANESCO's Mini Grids. In such instances, TANESCO will review internal plans regarding the national grid's expansion and connection to the mini-grid in the proposed project area. Relevant procedures for this process include:

2.2.1 The SPP Cell submits all relevant information from the SPP Developer's application to TANESCO's Electrification Division and Strategic Planning Department, which are responsible for inspecting the information in accordance with Form 2A.

2.2.2 The Electrification Division and Strategic Planning Department will verify if and when the proposed project area will have access to the national grid in the future. If there are plans to expand the national grid into the project area, the expansion schedule and any other relevant information will be provided to the SPP Cell accordingly.

2.2.3 The SPP Cell will proceed by using Form 2B to inform the SPP Developer of any pre-existing plans to expand and interconnect TANESCO's distribution system to the TANESCO Mini Grid in the proposed project area. Upon receipt of Form 2B, the SPP Developer will have 30 days to inform the SPP Cell of their "go or no go" decision regarding the proposed project.

2.2.4 In the event that plans exist to connect the TANESCO Mini Grid in the project area to TANESCO's Main Grid, any pre-existing SPPA between TANESCO and the SPP Developer will be terminated when the Mini Grid is connected to TANESCO's Main Grid. The concerned parties will thereafter enter into a new Main Grid SPPA with a new tariff rate that will become active upon the Main Grid's connection with the Mini Grid.

2.2.5 The TANESCO Electrification Division and Strategic Planning Department will inform the SPP Cell when the TANESCO Mini Grid in the project area will be interconnected with TANESCO's Main Grid at least 6 months before the interconnection takes place.

2.2.6 Within 14 days of receiving notification of a Mini Grids scheduled interconnection with TANESCO's Main Grid from the Electrification Division and Strategic Planning Department, the SPP Cell will inform the SPP owner of the existing SPPA's termination. The SPP owner will thereafter be required to submit a request for new SPPA for Main Grid interconnection using Form 2C. TANESCO will then inform EWURA of the new SPPA's signing as well as the new COD.

The overall procedures for checking for the duplication of rural electrification projects are shown in Fig.3.

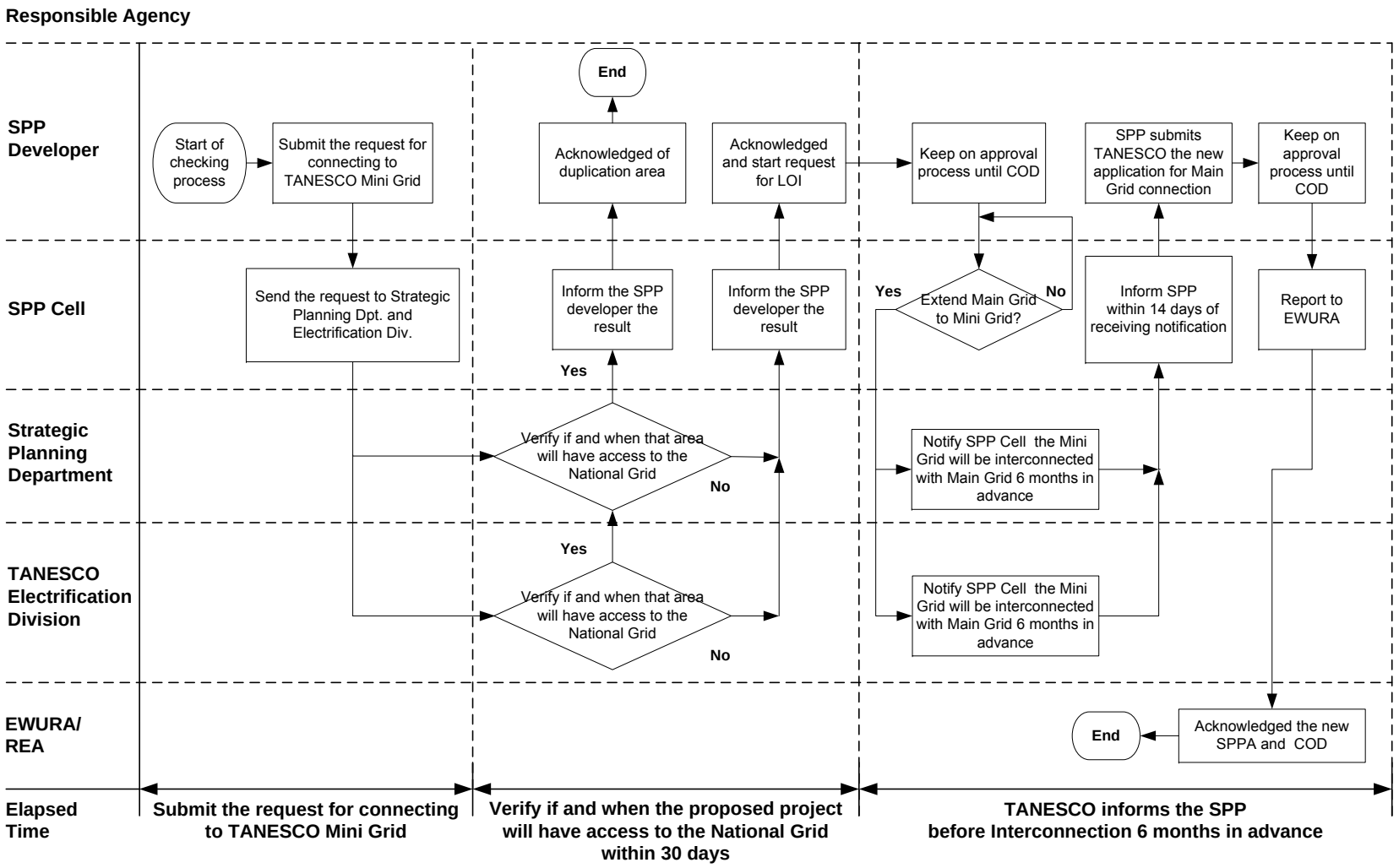



Fig.3: Checking for duplication of rural electrification projects procedure flowchart

## 2.3 STEP 3: Issuance of LOI

2.3.1 The SPP Cell officer will, within 14 days of receiving the aforementioned Site Reference Number from TANESCO, provide all relevant information regarding the proposed SPP project (including the Site Reference Number) to the regional office at the location of the proposed SPP project using Form 3A. The SPP Cell officer will, within 45 days of submitting Form 3A to the regional office, accompany the regional office engineer/district office engineer and the protection engineer to make the first formal visit to the proposed project site. The purpose of the visit is to confirm the site's feasibility and power export capacity, and to identify possible conflicts with other ongoing SPP or TANESCO projects in the project area. In the case of a very small SPP that can be connected to one of TANESCO's low-tension lines, only a Regional Office Engineer will be required to collect the required information from the project site.

After a thorough examination of all the issues addressed below (Section 3.1 and 3.2), and assuming Steps 1 and 2 have been successfully completed, the SPP Cell will use Form 3B to issue the LOI to the SPP Developer. The LOI should be issued no more than 30 days after the completion of all required examinations/inspections. EWURA should be notified as soon as possible regarding the LOI's issuance.

Note: *The LOI has an initial validity of 12 months that can be extended in increments of 6 months. The maximum term of the LOI, including extensions, should not exceed two (2) years.*

The information required during the first site visit (Form 3A) includes:

1) SPP Developer / Project Name: .....
   Site Reference Number: .....
   Location: .....

2) Name of connecting substation: .....
   Feeder No.: .....
   Distance from substation: ..... km

3) Presence of distribution line in vicinity of the project (Yes/No): .....
   Cable size: ..... sq.mm.
   Any section of the distribution line rated below the SPP project's planned power export? .....

4) Maximum feeder load: ..... MW
   Minimum feeder load: ..... MW

Maximum load at substation: ..... MW
Minimum load at substation: ..... MW

5) A single line diagram of the TANESCO distribution network to which the SPP is interconnecting, including information on the cable size, disconnecting switch, fuse and distribution transformer, etc.

6) Are there any other SPP application for LOIs within the same connected substation? .....

A total capacity of:
Synchronous Generator: …… MW
Induction Generator: ..... MW
Inverter-based Embedded Generation: ..... MW

7) Additional information will be required if the SPP application involves a connection to a TANESCO Mini Grid. This additional information includes:

TANESCO Mini Grid Total Generator: …….. MW

8) The SPP Developer and SPP Cell officer will jointly identify a Point of Common Coupling (PCC).

2.3.2 The initial verification process for the LOI's issuance is based on Form 2 of the Electricity (Development of Small Power Projects) Guidelines [1]. This form requires that the SPP Developer be informed of all technical details of TANESCO's existing systems within the proposed project area including transmission lines, distribution lines, switchgear and protection equipment. This information will be used to determine whether or not the project area's existing distribution system is capable of accommodating the SPP Developer's planned power deliveries. If the existing TANESCO system is unable to accommodate the planned power deliveries, the SPP Developer will be required to upgrade the system in order for the project to move forward. It is therefore necessary that the SPP Cell provide the SPP Developer with detailed technical information regarding the existing TANESCO power system in the project area in order for the SPP Developer to more accurately determine the project's technical and financial feasibility, which may include system upgrade costs.

The SPP Cell shall perform three primary inspections of the distribution system within the prospective project area before issuing LOIs to SPP Developers. These inspections include:

1) Maximum Export Capacity inspection

2) Maximum Number of Connected SPPs inspection
3) Thermal Overload Limit inspection

#### 2.3.2.1 Maximum Export Capacity Inspection

**(1) Main Grid Case**

According to the Draft of SPP Developer Guidelines for Grid Interconnection of Small Power Projects in Tanzania: Part A [2], the total export generating capacity that can be connected through a single Point of Supply (POS) to TANESCO's distribution system at or below 33 kV should not exceed 10 MW. The maximum export capacities for different voltage levels are outlined in Table 1.

Table 1: Capacity Limits of Embedded Generation

| Voltage Level | Max. Export Capacity at POS | Metering at |
|---|---|---|
| 400 V | 100-250 kW | 400 V |
| 11 kV | 5 MW | 11 kV |
| 33 kV | 10 MW | 33 kV |

Additionally, there are limits on the total combined export capacity of SPPs connected to the same feeder:

- For 33 kV system, SPPs shall not exceed a total combined capacity of 20 MW
- For 11 kV system, SPPs shall not exceed a total combined capacity of 10 MW
- For 400 V systems, SPPs shall not exceed a total combined capacity of 250 kW, or 80% of the Transformer rating, whichever is less.

Table A1 applies to SPPs that use synchronous generators (SG). Capacity limits for SPPs that use other types of induction generators (IG) and inverter-based embedded generators (IBEG) are listed below:

- **Induction Generator (IG)**
  - Squirrel Cage Induction Generator (SCIG)
  - Fixed Speed Wind Turbine - SCIG
  - Variable Speed Wind Turbine - Doubly-Fed Induction Generator (DFIG)

- **Inverter-based Embedded Generator (IBEG)**
  - Photovoltaic (PV)
  - Concentrating PV (CPV)
  - Wind Turbine
    - Permanent Magnet Synchronous Generator (PMSG)

- Full variable-speed Wind Energy Conversion System (WECS)

Induction generators (IG) require reactive power from the system. In practice, a capacitor will be installed to supply reactive power to the IG. The capacitor will generally be less than that of the IG requirement in order to prevent the induction generator's self-excitation, which could impact the distribution system. If a large number of induction generators are connected to the system, they could inhibit TANESCO's ability to provide reactive power to support its loads and its own induction generators.

Note: *TANESCO does not currently have capacitor banks installed in the distribution system.*

System-wide risks associated with voltage instability will increase if TANESCO fails to install sufficient and proper reactive power compensator equipment. SPP Developers employing induction generators are required to install and design a local capacitor for PF = 0.95 (import reactive power) from the Point of Supply (POS) and reduce import reactive power from the main grid. SPP Developers will be informed of the provisions and installation guidelines regarding the proper capacitor(s) and control equipment by the SPP Cell. The use of SCIG and DFIG in wind turbines may result in voltage flicker problems, especially in areas where wind speeds vary significantly. It should be noted that at the current point in time, the TANESCO grid remains relatively weak, making it more vulnerable to voltage flickers.

In addition, according to the Electric Power Research Institute (EPRI) Report, "Power Quality Impacts of Distributed Generation: Guidelines" [3], SPPs' use of inverter-based embedded generators (IBEG) may cause power quality problems such as harmonics and voltage flickers, especially large PV systems and wind farms.

Taking into account the above mentioned issues, it can be concluded that it is critical to specify the appropriate capacity for IGs and IBEGs connected to the TANESCO distribution system. The recommended total maximum export capacity for SPPs installed in the same feeder is listed below:

- **Induction Generator (IG)**
  - May not exceed more than 3 MW, including IG wind farm/turbines
- **Inverter-based Embedded Generation**
  - PV/CPV farm $\leq$ 3 MW
  - Wind farm/turbine $\leq$ 5 MW

**(2) TANESCO Mini Grid Case**

TANESCO's Mini Grids are "weaker", less stable, and more difficult to control than the national grid and often suffer from power quality problems. To prevent the aforementioned problems from occurring, total export capacity ceilings have been established for certain types of SPPs connected to TANESCO Mini Grids:

- **Synchronous Generator (SG)**
  - Export capacity shall not exceed 75% of the TANESCO Mini Grid's total installed generating capacity;
  - Wind farm/turbine shall not exceed 50% of the TANESCO Mini Grid's total generating capacity.

- **Induction Generator (IG)**
  - Export capacity shall not exceed 50% of the TANESCO Mini Grid's total generating capacity;
  - The project's generating capacity shall not exceed 1 MW;
  - Wind farms/turbines may not account for more than 30% of the TANESCO Mini Grid's total generating capacity.

- **Inverter-based DG**
  - Export capacity may not exceed 50% of the TANESCO Mini Grid's total generating capacity;
  - Wind farm/turbine may not exceed 40% of the TANESCO Mini Grid's total generating capacity.

In cases when several different generating technologies are connected at different points within the same Mini Grid, the total maximum export capacity of all the SPPs connected to the system shall not exceed 75% of the TANESCO Mini Grid's total generating capacity.

#### 2.3.2.2 Examination of Maximum Number of Connected SPPs

If there are several SPPs connected to the same circuit or feeder, they are likely to create utility control and operation problems, which may lead to safety concerns for both personnel and equipment. In addition, multiple circuit/feeder connections can complicate protection coordination, especially if a line-recloser is installed. It is therefore recommended that the total number of SPPs per feeder be limited to 4.

#### 2.3.2.3 Thermal Overload Limit Examination

The thermal overload limit examination is designed to prevent the overloading of power equipment such as conductors, distribution transformers, power transformers, switches, CB, CT, etc. The total maximum export capacity of SPPs connected to the distribution system will be examined/analyzed to ensure that the overall current does not exceed the equipment rating. The SPP's maximum export capacity will be calculated to determine whether or not it exceeds the specified equipment's thermal overload limit. A list of the equipment determined to be at risk of overloading and thus requiring an upgrade will be created and given to the SPP Developer.

The overall procedures for issuing a letter of intent (LOI) are shown in Fig.4.

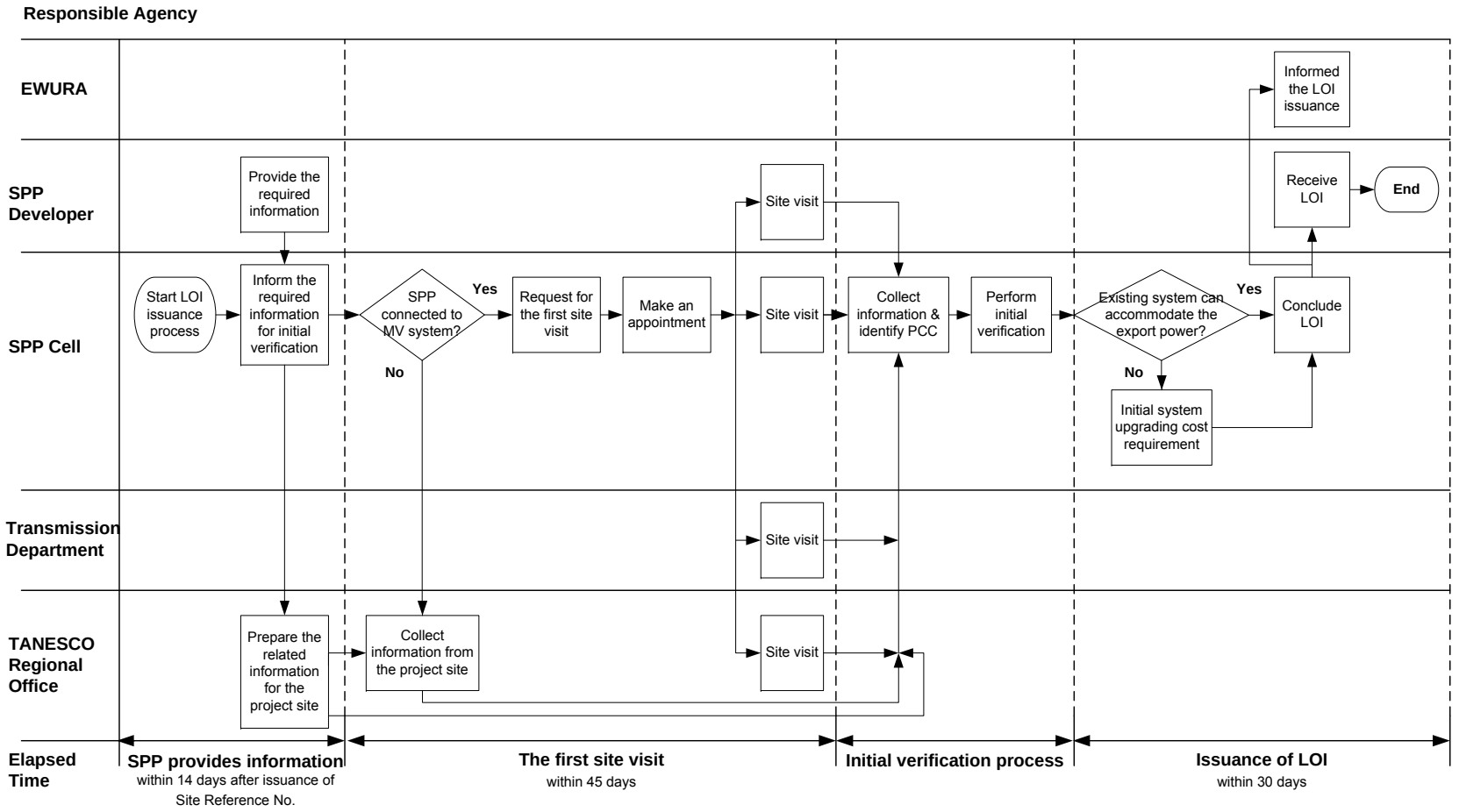



Fig.4: Issuance of Letter of Intent procedure flowchart

## 2.4 STEP 4: Issuance of SPPA

2.4.1 The Engineering Assessment (EA) shall be processed within 30 days of the LOI's issuance. The SPP Developer has 3 options to complete the EA:

**Option 1:** TANESCO conducts detailed interconnection studies, including Load Flow and Short Circuit Studies, to verify that power purchases from the SPP are technically feasible. The studies will take into consideration the expected quantity of power exports and the proposed location of interconnection. Efforts will also be made to identify any potentially negative impacts the proposed project may have on TANESCO's distribution system. The costs of preparing the study will be passed through to the SPP Developer (ref. Form 4A).

**Option 2:** TANESCO will provide the SPP Developer with a base case study of an equivalent TANESCO system, which the SPP Developer will then use to conduct more detailed interconnection studies, the results of which will be examined by TANESCO. Costs associated with the base case study's preparation will be passed through to the SPP Developer (ref. Form 4A).

**Option 3:** The SPP Developer will independently conduct detailed interconnection studies, the results of which will be examined by TANESCO. Once the accuracy of the studies has been verified, the SPP Cell will use Form 4B to inform the SPP Developer to proceed with the project.

Note: *Other departments within TANESCO (e.g. the Transmission Department or Strategic Planning Department) will initially be responsible for preparing the studies. The SPP Cell will eventually take over this responsibility when it has developed sufficient technical capacity to do so.*

The EA will be conducted in accordance with The Electricity (Development of Small Power Projects) Rules [4] and the Draft of the SPP Developer Guidelines for Grid Interconnection of Small Power Projects in Tanzania: Part B [5]. The results of the study will be organized in accordance with the **Guidelines for SPP Engineering Assessment** (Section 4 of PART I).

If, after conducting the EA, it is determined that TANESCO's distribution system will require upgrades to accommodate the total capacity from the proposed SPP project, the SPP Developer must agree to bear the cost of all required upgrades in order for the project to proceed. The TANESCO regional office will be responsible for estimating the system upgrade costs, as stated in item 2.4.2.

2.4.2 Within 30 days of the LOI's issuance, the TANESCO SPP Cell will submit a request to the TANESCO regional office in the project area to formulate an estimation of the

expected costs of upgrading the distribution network to accommodate power purchases from the proposed SPP project. The results of the estimation should be listed on Form 4C and returned to the SPP Cell upon completion.

2.4.3 The SPP Developer is required to submit the interconnection and electricity sale application to TANESCO no later than 12 months after the receipt of the LOI. In the event that the SPP Developer fails to submit the application within this time frame, the LOI will become null and void, at which point TANESCO may issue an LOI to a different SPP Developer for that site.

2.4.4 Collection of relevant documents for issuance of SPPA

In the case of option 1, the SPP Cell will use Form 4D to notify the SPP developer of the cost of any required upgrades to TANESCO's distribution system.

In the case of option 2 and 3, the SPP Cell will use Form 4E to notify the SPP developer of the EA's results as well as the cost of any required upgrades to TANESCO's distribution system.

Upon receipt of Form 4D or 4E, the SPP Developer should submit all relevant documents to TANESCO in order to conclude the SPPA. The SPP Cell will use Form 4F to request any supplementary documents required to conclude the SPPA. These documents are specified in the Appendices and Form 3 of the EWURA Guidelines for Electricity (Development of Small Power Projects) Guidelines.

2.4.5 After receiving all required documents, the SPP Cell will draw up the SPPA specifying a Commercial Operation Date (COD). The COD should not be more than 2 years from the date that the SPPA and any other supplementary documents are signed. Once signed, the SPPA shall be sent to, and examined by, the appropriate legal officer using Form 4G. Once the legal accuracy of the contract has been verified, the authorized personnel within the SPP Cell should notify the SPP Developer that the SPPA is ready for their signature. Once signed by the SPP Developer, the contract and all supplementary documents will be submitted to TANESCO's Managing Director for signature. The original copy of the contract should remain with the SPP Cell for safe keeping. One copy of the SPPA should also be sent to the SPP Developer. TANESCO should then inform EWURA of the SPPA's signing.

2.4.6 Upon receiving a copy of the signed SPPA, and in the case that the SPP Developer is not already a TANESCO customer, the SPP Developer is required to submit a TANESCO customer application before connecting to TANESCO's distribution system.

The overall procedures for issuing of an SPPA are shown in Fig.5.

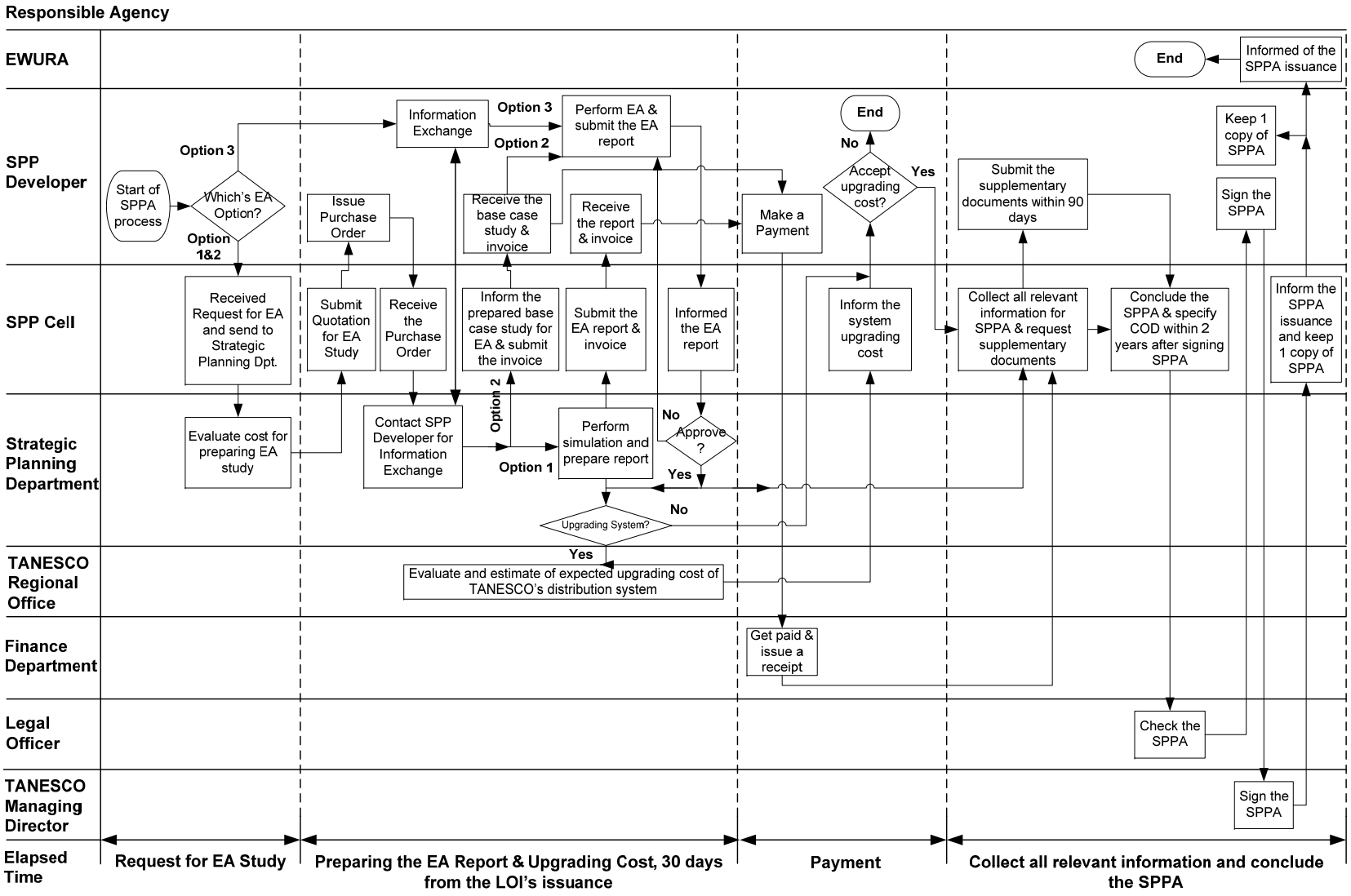



Fig.5: Issuance of SPPA procedure flowchart

## 2.5 STEP 5: Upgrading TANESCO's Distribution System

2.5.1 After receiving the SPPA, the SPP Developer is required to submit quarterly progress reports to TANESCO and EWURA referencing key milestones towards meeting the agreed upon COD. These reports should address, among other topics, the construction of the power plant as well as any required upgrades to TANESCO's distribution system.

2.5.2 Within 30 days of the SPPA's processing, the SPP Cell will use Form 5A to request TANESCO's Regional Office to survey the distribution system in the project area to assess various aspects of the SPP's proposed interconnection. The TANESCO Regional Office will, upon completing the survey, report back to the SPP Cell. Upon receiving the interconnection report from the TANESCO Regional Office, the SPP Cell will use Form 5B to issue a notification letter to the SPP regarding any required upgrades to the distribution system.

The construction process for improving/upgrading the distribution system for SPP interconnection is divided into two parts that respectively address locations along the distribution system in front of the SPP facility's POS and behind the POS.

2.5.2.1 The SPP Developer is responsible for all required improvements to the distribution system at locations behind the POS. The TANESCO Regional Office will, as in the case of a regular customer, examine only the proposed construction drawings and designs to determine what improvement, if any, will be required.

2.5.2.2 Components of the distribution system located before the POS should be considered TANESCO assets. There are two different options for the SPP Developer to upgrade TANESCO's distribution system: 1) TANESCO is responsible for all upgrades, the costs of which are passed through to the SPP Developer; or 2) the SPP Developer can independently hire a contractor to upgrade the distribution system in strict accordance with all relevant TANESCO construction standards. The sub procedures for the second option are described below:

(1) The TANESCO Regional Office will examine the designs of any new construction or upgrade to the TANESCO distribution system;
(2) The TANESCO Regional Office will deploy a TANESCO engineer to the project site to supervise the construction or upgrading of the distribution system to ensure compliance with TANESCO standards;
(3) The TANESCO Regional Office will, working through the aforementioned on-site engineer, join the commissioning committee that will be sent to the

project site to inspect the new construction and/or system upgrades before formally accepting them as TANESCO assets.

2.5.3 After the SPP Developer selects and issues payment for one of the options outlined in Section 2.5.2.2, the SPP Cell will use Form 5C (option 1 of 2.5.2.2) or Form 5D (option 2 of 2.5.2.2) to inform the TANESCO Regional Office that they or the SPP Developer has permission to begin the proposed construction and/or system upgrades.

2.5.4 The TANESCO Regional Office will inform the SPP Cell once the construction and/or upgrade is complete.

The overall procedures for upgrading TANESCO's distribution system are shown in Fig.6.

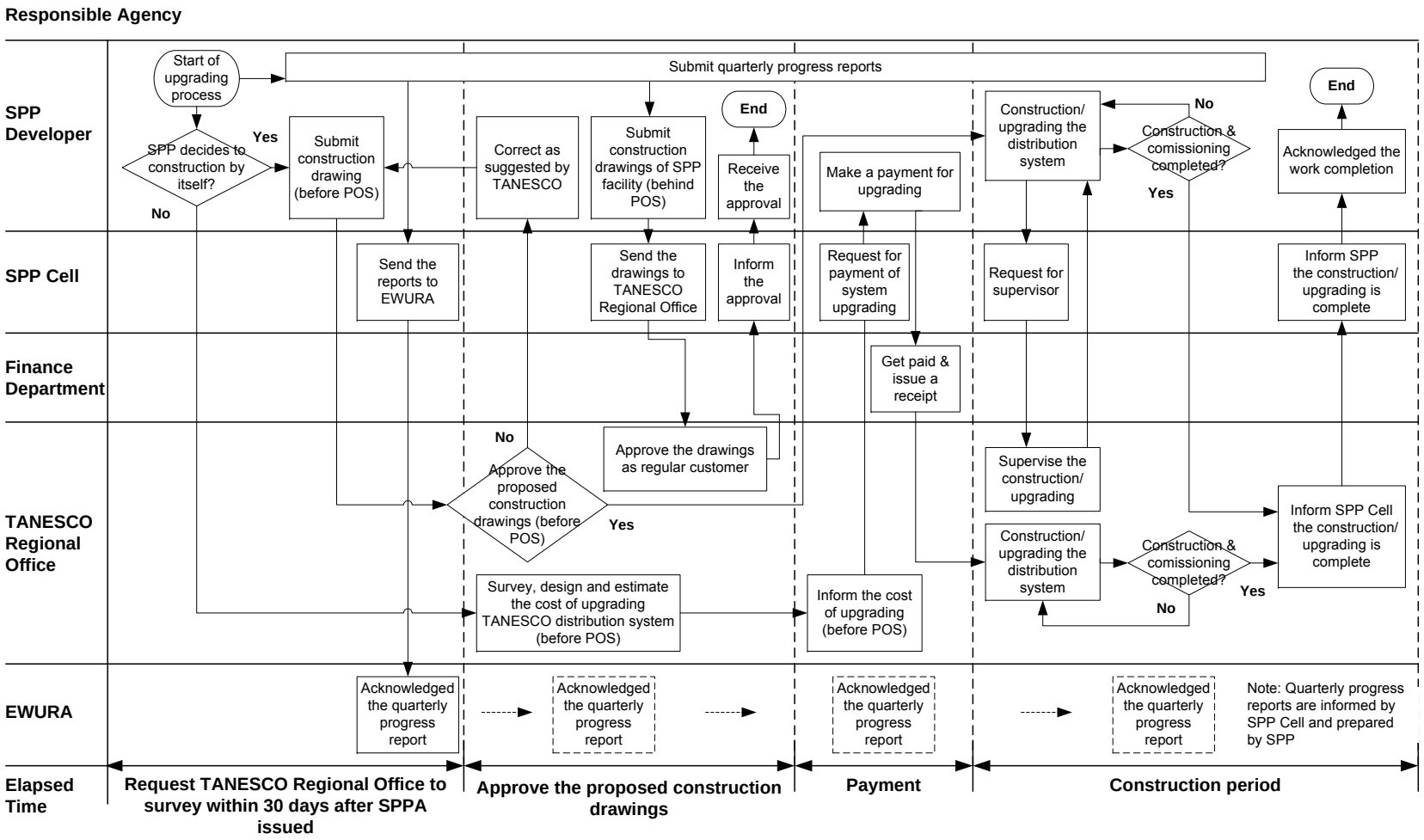



Fig.6: Upgrading TANESCO's distribution system procedure flowchart

### 2.6 STEP 6: Interconnection Protection and Testing

After the SPPA between TANESCO and the SPP Developer is formalized but before starting construction on the SPP's generating facilities, all construction/installation diagrams and information regarding the proposed protection coordination shall be submitted to the SPP Cell for verification and approval. The details for the various steps in this process are outlined below:

2.6.1 The SPP Developer submits all relevant construction/installation diagrams as well as the protection coordination study to the SPP Cell. These documents are then forwarded to TANESCO's Transmission Department for approval using Form 6A.

2.6.2 The Principal Protection Engineer, who operates under the authority of TANESCO's Transmission Manager, is responsible for investigating, testing and ultimately approving the protection coordination between the TANESCO and SPP protection systems. The verification and approval of the construction/installation diagrams and protection coordination should be based on the **Guidelines for Design Examination and Interconnection Protection Acceptance** (See section 5 of Part I).

2.6.3 The Principal Protection Engineer will inform the SPP Cell of the costs associated with the investigation and approval processes (e.g. relay setting and system protection tests, etc.) outlined above (Section 2.6.2). The SPP Cell will then notify the SPP Developer of all costs associated with these tests using Form 6B.

2.6.4 Once SPP Developer's payment for these tests has been processed, the SPP Developer will propose a date to the SPP Cell for the interconnection and relay setting tests, which will take place once the construction of the power plant is complete.

2.6.5 Within 30 days of receiving the SPP Developer's proposed testing dates, a protection engineer from the Transmission Department will be assigned to witness the tests. The protection engineer is responsible for recording the test results. The test should be conducted in accordance with the SPP Developer Guidelines for Grid Interconnection of Small Power Projects in Tanzania: Part A [2]. The test should also reference other relays, relevant protective devices and other required equipment not specifically mentioned in the Guidelines including:

(1) Earthing System
(2) Current Transformer (CT) and CT circuit polarity, ratio, insulation, excitation, continuity and burden tests
(3) Voltage Transformer (VT) and VT circuit polarity, ratio, insulation and continuity tests
(4) Relay pick-up and time delay tests

(5) Functional breaker trip tests from protective relays
(6) Relay in-service test to check for proper phase rotation and magnitude of applied currents and voltages
(7) Breaker closing interlock tests, and paralleling and disconnecting operation
(8) Non-export function (if applicable)

A reverse power or minimum power function, if used to meet the interconnection requirements, shall be tested using secondary injection techniques. Alternatively, this function can be tested by means of a local load trip test or by adjusting the generator output and local loads to verify the applicable non-export criterion (i.e., reverse power or minimum power).

(9) Primary current injection tests, where practical, to demonstrate the ratio of CTs and the continuity of CT wiring
(10) Secondary injection of test voltages and currents into test relays and the operation of the relays observed (i.e. commissioning tests, protective function tests and trip tests)
(11) Demonstration that the operation of a protection relay opens or inhibits the closure of the appropriate breaker or contactor (in service test)
(12) Other tests as required (for example earth resistance, insulation resistance, contact resistance)

The overall procedures for interconnection protection and testing are shown in Fig.7.

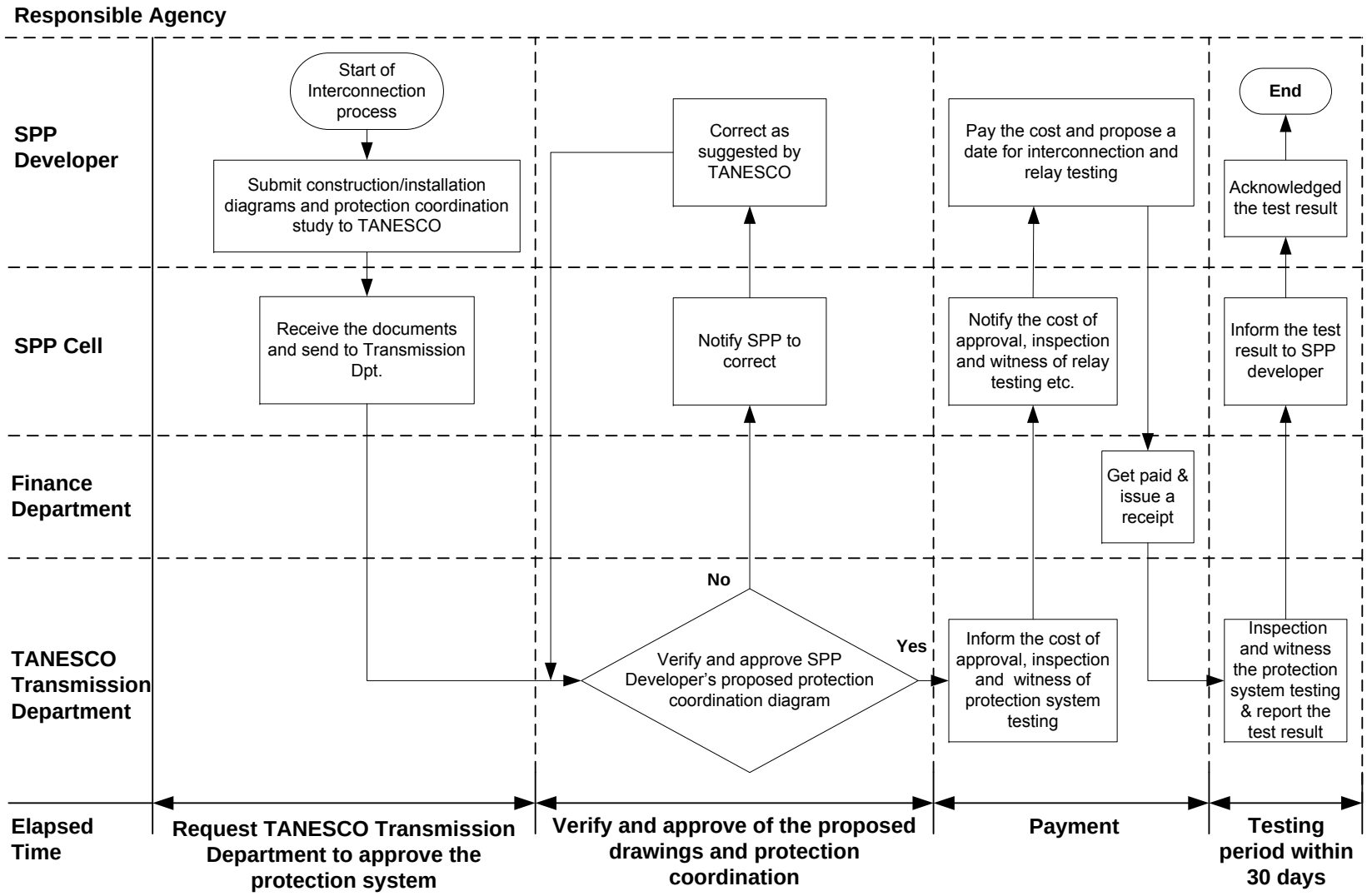



Fig.7: Interconnection protection and testing procedure flowchart

## 2.7 STEP 7: Metering Installation and Commissioning

2.7.1 Two weeks prior to the commencement of electricity sales, the SPP Cell will use Form 7A to coordinate with the SPP Developer to install the meter that will be used to calculate electricity sales. The SPP Developer has two options for meter installation:

2.7.1.1 The SPP Developer can purchase the electricity meter from TANESCO. The Principal Meter Engineer, who is under the authority of TANESCO's Large Power Division, is responsible for meter installation and commissioning. If the SPP Developer selects this option, the SPP Cell will request the Large Power Division to conduct a meter installation survey to assess installation costs using Form 7B. Once the survey is complete, the SPP Cell will inform the SPP Developer of the anticipated costs using Form 7C.

2.7.1.2 The SPP Developer may also purchase the required electricity meter from a source other than TANESCO, so long as the meter complies with all relevant TANESCO specifications. If the SPP Developer selects this option, the SPP Cell will use form 7D to request the Large Power Division to conduct a survey to assess the costs of meter installation, calibration and commissioning. Once the survey is complete, the SPP Cell will inform the SPP Developer of the anticipated costs using Form 7E.

2.7.2 Once the SPP Developer has chosen one of these two options and the meter has been successfully installed, the Principal Meter Engineer will inform the SPP Cell accordingly.

The overall procedures for meter installation and commissioning are shown in Fig.8.

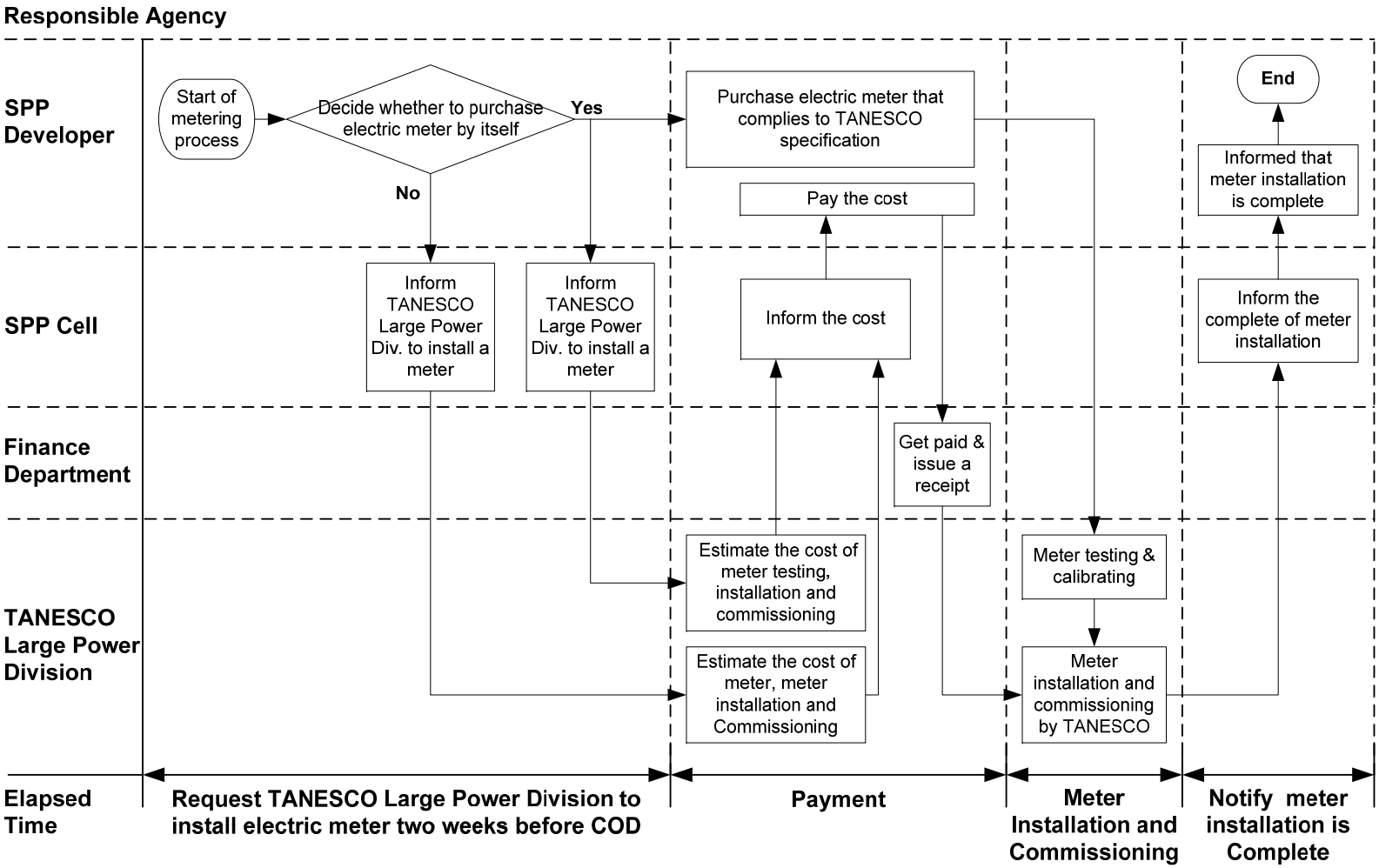



Fig.8: Metering installation and commissioning procedure flowchart

## 2.8 STEP 8: Initial Interconnection and Commercial Operation Date

The date of the project's official commissioning shall not exceed two years from the date that the SPPA was formalized and signed by both parties, except in cases where the SPPA specifically outlines a period exceeding two years. The initial interconnection - or first synchronization - can take place once the following tasks have been completed:

- The SPP's electrical system is installed and connected to TANESCO's distribution system;
- All relevant protective devices/equipment and the electricity meter have been installed and tested;
- For SPPs with an installed capacity greater than 1 MW, the necessary EWURA license for grid-interconnection has been obtained;
- For SPPs with an installed capacity less than 1 MW, the necessary registration has been obtained.

The process for completing the initial grid interconnection and achieving commercial operation requires the participation of the SPP Cell, the TANESCO Transmission Department, the TANESCO Regional office and the SPP Developer. The following steps are necessary to complete this process:

2.8.1 The SPP Cell will use Form 8A to inform the SPP Developer that they may begin preparing for commercial operation and formally apply for the required license.

2.8.2 The SPP Cell will conduct a site visit to: 1) ensure that all the necessary system upgrades are complete; 2) verify the Embedded Generator Test Record; 3) verify that the meter installation is complete; and 4) check that the appropriate license or registration from EWURA has been obtained.

2.8.3 The SPP Cell will coordinate with the SPP Developer's on-site team to prepare for the required grid interconnection tests. These tests include:

1) Synchronization Test

   - The synchronization test checks that the SPP facility's operation is synchronized with the Main Grid at the interconnection circuit breaker or low voltage circuit breaker. Tests of load supplying should start from 0% and gradually increase to 100% of the SPP facility's export capacity.

2) Trip Test

   - The Trip test verifies the trip operation at the interconnection circuit breaker or low voltage circuit breaker and ensures the plant is shutdown.

3) Proof of inability to energize dead lines or out-of-phase lines

- This test verifies that the SPP will not reconnect in the event that: (a) utility lines are de-energized; or (b) that utility lines are out-of-phase with SPP generator.

4) Anti-islanding Function Test (if applicable)

- The non-islanding function, if available, shall be checked by: (i) operating a load break switch and verifying that the interconnection facility ceases operation and does not energize the output terminals; and (ii) testing the reconnection (after the islanding condition has ceased). The test should seek to ensure that the automatic reconnection has the required time delay.

- In cases when the SPP facility's design allows for islanding conditions within the plant, the anti-islanding test will be performed by tripping the interconnection circuit breaker and monitoring how the system adjusts and changes into islanding operation mode.

2.8.4 The SPP Cell and SPP Developer will meet to clarify issues related to plant operation to ensure compliance with all relevant TANESCO – SPP Operation Guidelines. More specifically, the meeting will address the appropriate processes and procedures for meter reading/recording and the calculation of electricity sales in accordance with the TANESCO – SPP billing and settlement process, the details of which are addressed in Part II of this manual.

2.8.5 If everything is in order - all tests are successful and meetings complete - the Commercial Operation Date (COD) is declared a success. EWURA will also be informed of the COD.

2.8.6 After completing the initial interconnection, the SPP Cell issues an Interconnection Certificate as evidence of the SPP Developer's compliance with the standards specified in the SPPA using Form 8B. The certificate and the related standards are based on the Electricity (Development of Small Power Projects) Guidelines [1] and the Draft of SPP Developer Guidelines for Grid Interconnection of Small Power Projects in Tanzania: Part A [2]. An interconnection certificate is valid for 3 years.

If an SPP Developer fails to achieve commissioning date within time frame established in the SPPA, the SPPA will be rendered null and void unless both parties agree to an extension and the extension is approved by EWURA.

The overall procedures for the initial interconnection and commercial operation date are shown in Fig.9.

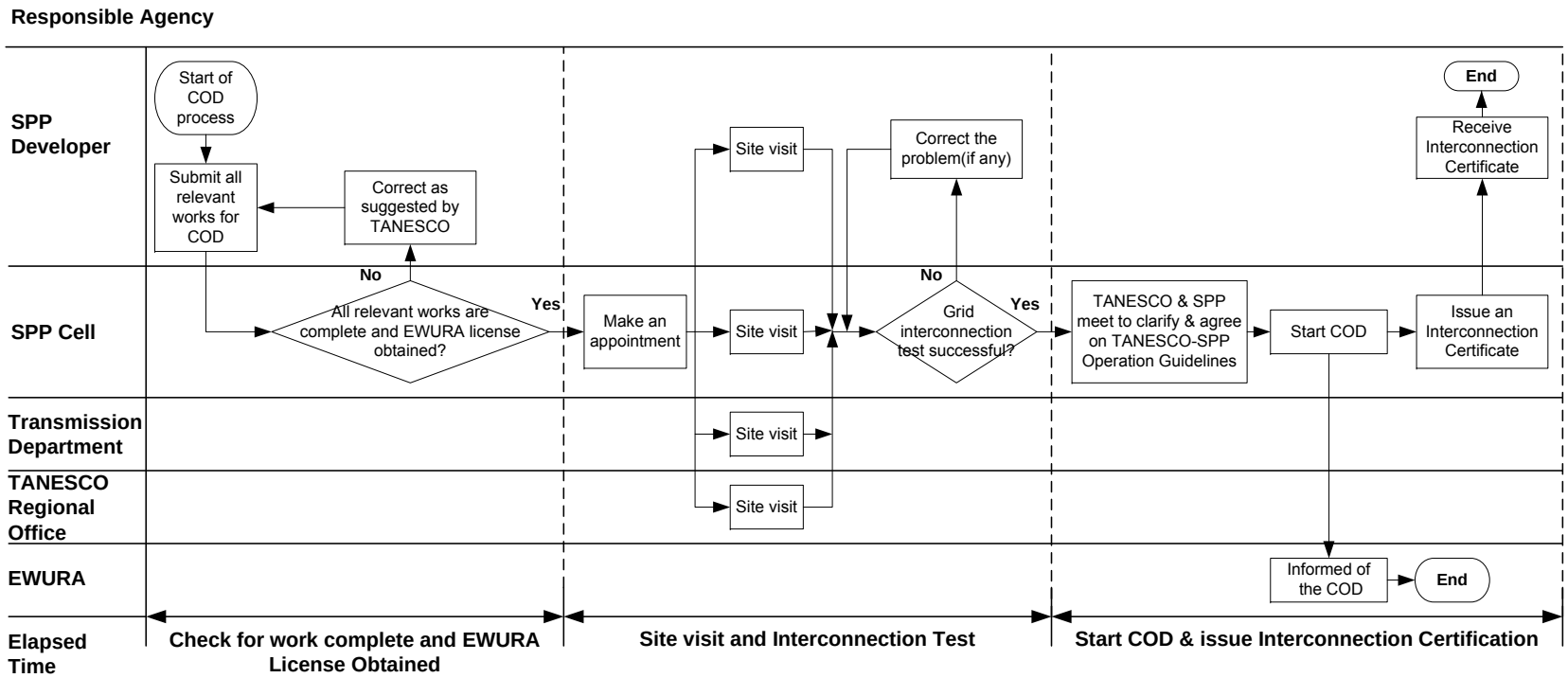



Fig.9: Initial interconnection and commercial operation date (COD) procedure flowchart

## 3. SPP Project Connected to SPP-Owned Mini Grid

For SPPs connected to SPP-owned Mini Grids, TANESCO is only responsible for checking to see if there are any existing or planned rural electrification or distribution extension projects in the proposed project area in order to prevent unnecessary duplication or system overlap. There are 3 steps required to complete this process (see Fig. 10):

**STEP 1: Request for Duplication Checking**

The SPP Developer prepares and submits the project proposal to TANESCO, which then forwards these documents to the SPP Cell.

**STEP 2: Checking with Rural Electrification Project**

The SPP Cell will use Form 9A to submit all relevant project documents to TANESCO's Electrification Division and Strategic Planning Department to check if there are any existing or planned rural electrification or grid extension projects in the proposed project area.

**STEP 3: Issuance of Duplication Checking Letter**

The results of this duplication checking and any potential overlap with the proposed SPP project should then be reported to the SPP Cell. The SPP Cell will then inform EWURA, REA and the SPP Developer of the results of these duplication checks using Form 9B. The SPP Developer will have 30 days to inform the SPP Cell of their "go or no go" decision regarding the proposed project. Once this decision has been made, TANESCO should inform REA and EWURA of the SPP developer's final decision on the project.

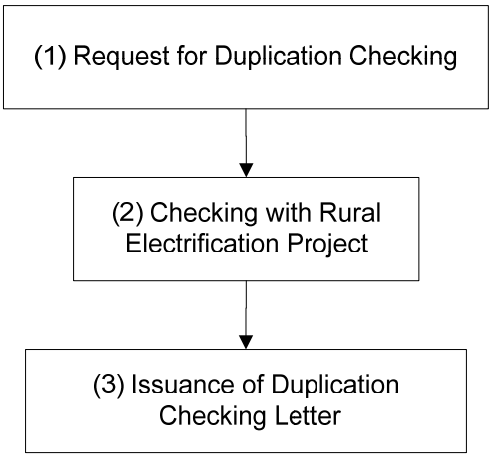



Fig.10: SPP Mini Grid Duplication Checking Flow Chart

The overall procedures for the SPP project to connect to an SPP-owned mini grid are shown in Fig.11.

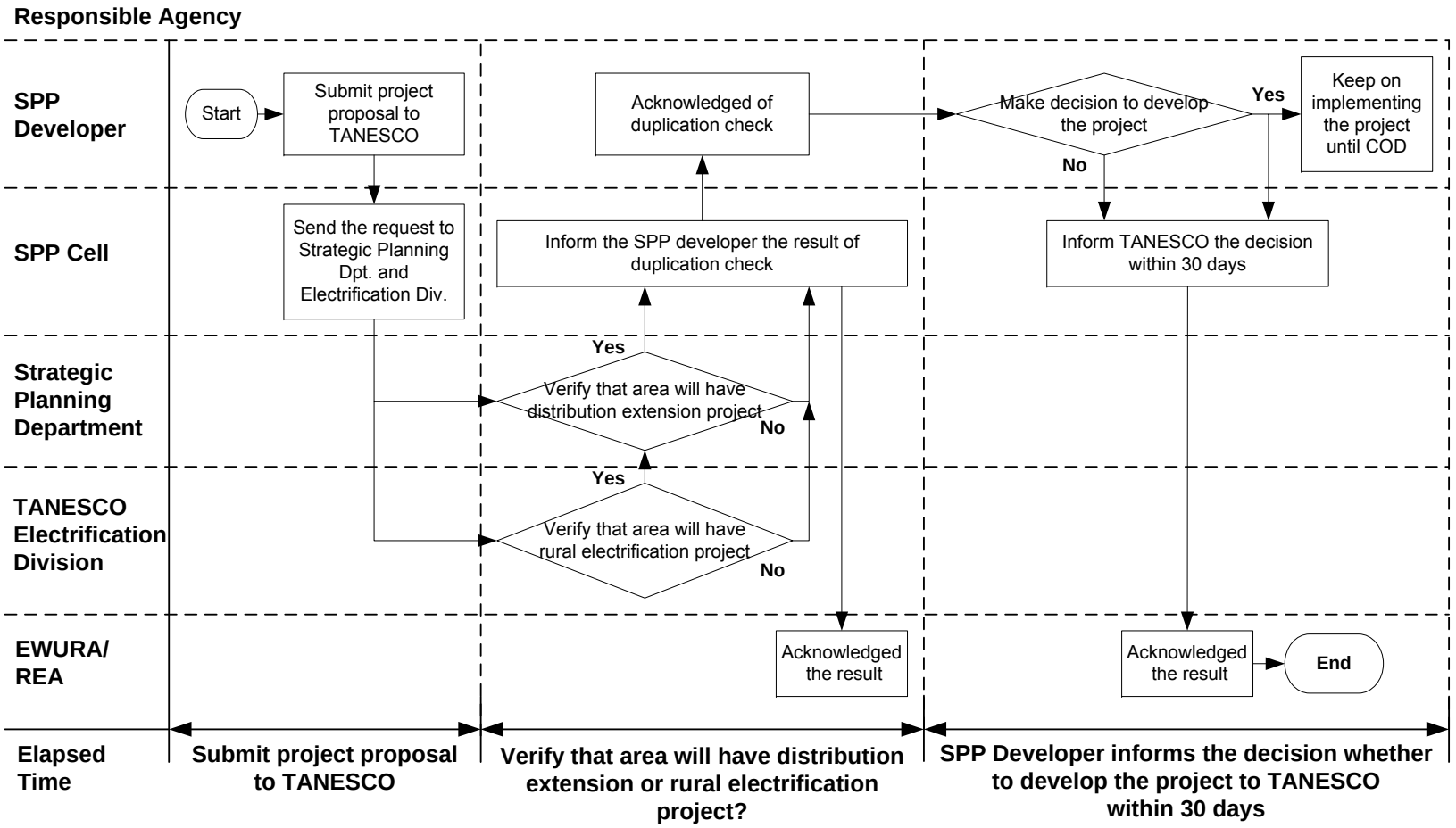
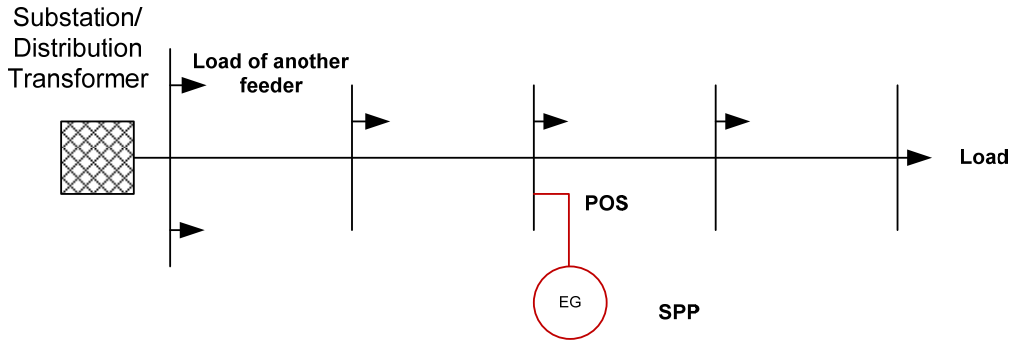



Fig.11: SPP project connected to SPP-owned mini grid procedure flowchart

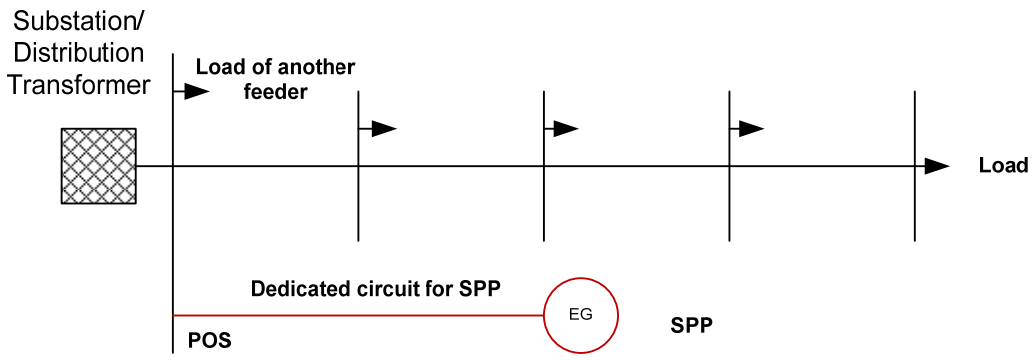
## 4. The Guidelines for SPP Engineering Assessment

The Engineering Assessment (EA) is designed to verify any possible impacts on the distribution system that may result from the proposed SPP project's interconnection to TANESCO's main grid. When the risk of impacts is determined to be high, the EA will provide the SPP Developer with information on the cost and nature of any required upgrades or adjustments to TANESCO's distribution system.

It is the SPP Developer's responsibility to propose where the SPP project will interconnect with TANESCO's distribution system. There are two types of SPP interconnections (ref. Figure 12), each of which will have different impacts on TANESCO's distribution system. SPPs that opt to connect to a TANESCO substation/distribution transformer are likely to have fewer impacts than SPPs directly connected to TANESCO's distribution system.




(a) SPP connected to TANESCO's distribution system




(b) SPP connected to TANESCO's substation/distribution transformer

Fig.12: Diagram of SPP interconnection to TANESCO's distribution system

## 4.1 The Content of the Engineering Assessment

The Engineering Assessment includes a Load Flow Study and a Short Circuit Study.

### 4.1.1 Load Flow Study

1) The current injection from the SPP shall be less than the thermal overload limit of all the equipment connected to TANESCO's distribution system in order to eliminate thermal overload risks.

2) Voltage variations at the POS/PCC should be limited to ± 5% of the nominal voltage under normal operating conditions. During abnormal conditions, voltage variations may exceed these values.

   Note: *It is anticipated that voltage regulations will be gradually improved as SPPs begin coming on line. Overvoltages of more than 1.05 pu. for medium voltage (MV) systems and 1.10 pu. for low voltage (LV) systems should not occur at any TANESCO customer buses.*

3) Due to TANESCO's limited capacity to provide reactive power, load consumption of reactive power from the system at TANESCO's substation shall not adversely impact the main grid. As a result, the total reactive power supplying from the Main Grid at the substation should be limited to no more than 125% of the previous maximum reactive power load consumption from the time when there was no SPP connection. In cases where the SPP project will be connected to TANESCO's Mini Grid, it is necessary to verify that TANESCO's generators supplying the Mini Grid can provide sufficient reactive power. Drawing large quantities of reactive power from TANESCO's distribution system will negatively impact TANESCO's main grid.

   i. SPP projects employing Synchronous Generators (SG) should be required to provide reactive power to support the distribution system by setting the SG to operate in power factor control mode at a PF between 090-0.95 when supplying reactive power. This will help reduce the system load by supplying reactive power.

   ii. SPP projects employing an Induction Generator (IG) are, unlike SG, incapable of providing reactive power. All projects that use IGs should therefore be required to install a capacitor bank at the SPP generating plant to reduce the consumption of reactive power from TANESCO's distribution system. This can be accomplished by specifying a power factor at the POS of between 0.90-0.95 when consuming reactive power. Once SPPs are connected to the distribution system, the reactive power supplied by TANESCO's substation should not increase more than 25% above the reactive power supply requirements that existed before the SPP's interconnection to

the grid. In order to prevent excessive reactive power consumption, the SPP may be required to reduce its maximum power export and/or install a capacitor bank.

iii. SPPs employing Inverter-based Embedded Generators (IBEG) are unlikely to impact the reactive power supply at TANESCO substations, as the units generally operate at unity power factor.

4) System losses are likely to increase if a large SPP is connected to the distribution system at a location far from the substation or at the end of the distribution line where the captive load is low (ref. Figure 12(a)). Under such circumstances, TANESCO will be responsible for the risks associated with increased system losses. If system losses increase by more than 10% of the maximum export capacity of the SPP, it may be necessary to: 1) increase the conductor size; 2) reduce the SPP's maximum power export; or 3) if possible, relocate the connection point in order to minimize the distance between the SPP and the substation or load point.

### 4.1.2 Short Circuit Study

1) The SPP's generating facility equipment, in aggregation with other generation on distribution circuits, shall not cause any distribution protective devices and equipment (including, but not limited to, substation breakers, fuse cutouts, load-break switches, and line re-closers) to exceed 87.5% of the short circuit interrupting capability. Additionally, the interconnection of any circuit that already exceeds 87.5% of the short circuit interrupting capability will not be permitted.

2) During single-line-to-ground fault, voltages at healthy phases shall be in the acceptable range within the appropriate time. Otherwise, the overvoltage in unfaulted phases for a certain of time can cause damage to equipment that is connected to the distribution system. Types of equipment that are potentially vulnerable to damage include:

   i) The gapless surge arrester, which is installed to protect the distribution transformer and other equipment from overvoltage resulting from lightning strikes;

   ii) The voltage transformer, which is installed at the substation.

   Note: *The voltage transformer's voltage factor rating should be considered and applied properly.*

## 4.2 Fast Track Screening Process

The Fast Track Screening Process is used to reduce the time for Engineering Assessments of small generators when the contracted sale of electricity does not exceed 1 MW. The Fast Track Screening Process is applicable to all types of SPPs that will connect to the 33 and 11 kV MV systems. For LV systems, if the SPP's maximum total power export does not exceed

50% of the maximum load, an Engineering Assessment is not required. The **Fast Track Screening Process** does not, however, exempt SPPs from completing the necessary processes/tests designed to verify the thermal overload of all equipment. Rules designated in the LOI limiting SPP Developers to no more than four SPPs also remain applicable.

### 4.3 Performing the Engineering Assessment

There are three different options available to SPP Developers that are required to complete an Engineering Assessment (EA):

1) TANESCO will conduct a detailed interconnection study, the costs of which will be passed through to the SPP Developer;

2) TANESCO will provide the SPP Developer with a base case study of the TANESCO distribution system. The SPP will use the base case study to conduct a detailed interconnection study, the results of which will be subject to TANESCO's review and approval;

3) The SPP will independently conduct a detailed interconnection study, the results of which will be subject to TANESCO's review and approval.

#### 4.3.1 TANESCO Conducts Detailed Interconnection Studies

The process for Option 1 (ref. Section 4.3) includes a variety of steps that are described in detail in the section below.

##### 4.3.1.1 Exchange of Information

The Engineering Assessment employs software simulations that require specific information regarding TANESCO's distribution system. As outlined in Annex 1 of the Draft of SPP Developer Guidelines for Grid Interconnection of Small Power Projects in Tanzania: Part A [2], the EA process requires information sharing between TANESCO and the SPP Developer.

Note: *The consultant has attempted to simplify the form (ref. Form 10A) used to facilitate information exchanges between the SPP Developer and TANESCO. The SPP Cell will be responsible for coordinating these exchanges.*

##### 4.3.1.2 System Modeling

The SPP Cell will work with the Planning Engineer to conduct all necessary system modeling of the electrical systems (i.e. the SPP facility's electrical systems and the TANESCO distribution system) using the information received from TANESCO. All system modeling will employ the DIgSILENT PowerFactory program, and start from the substation

where the SPP will be connected to TANESCO's grid. There are two options available for modeling TANESCO's electrical system:

1) Modeling the entire TANESCO electrical system by importing relevant TANESCO electrical system files from PSS/E program to DIgSILENT PowerFactory. Upon completing this task, the substation bus to which the SPP will be connected should be verified. Next, create a new "Single Line Graphic", copy the bus and paste it to the new Single Line Graphic, which can be created by selecting the "Plate graphic only" option. Next, draw the distribution system and all connected loads, including the prospective SPP, by creating Power System Elements using the DIgSILENT PowerFactory program and the information received from the SPP Developer and TANESCO.

   Note: *For system modeling processes, some of the buses or loads not related to the calculation can be grouped in order to simplify technical considerations and expedite the study. Additionally, the load consideration for the study are only required to cover two conditions - maximum and minimum loads.*

2) Create a distribution system that takes into consideration the prospective SPP connection by determining the equivalent circuit of the entire TANESCO electrical system at the substation's bus where the SPP will be connected. Use the PSS/E program to determine the equivalent circuit. The results will then be modeled as an external grid. Next, create the distribution system and other related components using the same procedures described in Option 1.

The advantage of Option 2 is that the model of the electrical system that is generated will be smaller in size, easier to use and better suited for larger, more stable Main Grid systems. For smaller grid systems, which are weaker and contain fewer buses, the risk of inaccurate modeling and errors is significant. Option 1 should therefore be employed when modeling smaller systems, as the model can be more easily applied to study the impacts on the stability of TANESCO's distribution system.

Note: *When the SPP project will employ a wind turbine, photovoltaic or other types of Inverter-base Embedded Generators, the SPP Developer shall submit models in a format that is compatible with the DIgSILENT PowerFactory program.*

#### 4.3.1.3 Simulation and Result Analysis

The Simulation and Results Analysis is comprised of a Load Flow Study and a Short Circuit Study.

#### 4.3.1.3.1 Load Flow Study

A Planning Engineer from the Strategic Planning Department will be assigned to perform the Load Flow Study using the DIgSILENT PowerFactory program. For the study, the load flow simulation will employ operating conditions that mirror the maximum power export of the SPP at max/min loads in accordance with the conditions outlined in Table 2.

**1) Thermal Overload Checking**

The Thermal Overload Check is used to assess the risk of overloading TANESCO's equipment once the SPP is connected to the TANESCO distribution system. The overload limit, ampacity, or rating of conductor or relevant equipment shall be entered in order to identify an overload conditions. During minimum load condition with the total maximum power export of all SPPs connected at the substation, power pass through a power transformer at a substation or a distribution transformer should be less than 80% of its capability. If the simulation results reveal that there is a risk of overloading, the SPP will be notified of the requirement to upgrade the system accordingly.

**2) Voltage Regulation and Operation Mode Setting**

a) Verify that the voltage at the POS during normal operation will remain within a range of ±5% for MV and ±10% for LV. Verify that there is no risk of overvoltage or undervoltage at all other locations in TANESCO's distribution system. During emergency operation, the voltage at the POS may operate within a range of ±10% for both MV and LV. In the case that buses in the SPP project area have experienced undervoltage problems prior to SPP connection, the risk of undervoltage is likely to decrease after the SPP connection, as it will increase the overall voltage in the system.

b) Examine which operating mode is most appropriate for SPP operation as well as the most suitable maximum power export.

i) **SG Case:** Typically, SPPs employing SGs will operate in power factor control mode (PFC). It remains necessary; however, to examine which mode of operation is the most appropriate in order to meet the electrical system voltage regulations at the POC under conditions that do not require drawing significant reactive power from the distribution system. The SPPA shall therefore specify operating modes for both voltage and PF. When there is an overvoltage problem, which is acceptable in some buses, it may be necessary to reduce the SG's maximum power export until the problem is solved. Once a new maximum power export quantity is determined, the SPP Cell will inform the

SPP Developer accordingly. Additional checks shall be carried out to determine: 1) whether or not the SPP will be required to operate in voltage control mode (VC); 2) whether or not the system voltage regulations will need to be improved following the SPP's interconnection to the TANESCO grid; and 3) any potential problems requiring the SPP to draw reactive power from TANESCO's system, which, once the level of risk is determined, can be used to improve system control and operation.

ii) **IG Case:** SPPs employing IGs shall specify the operating mode to draw reactive power from the system at PF = 0.95. This can be achieved by modeling the capacitor connected to the POS bus or generator terminal bus in accordance with the specific generator's technical data. Check the distribution system's voltage regulation, and whether or not it will be improved or worsened as a result of the SPP's interconnection to the TANESCO grid. Determine the risk of the SPP drawing too much reactive power from the system. If a problem exists, attempt to reduce the IG's maximum power export until the problem is solved. Once a new maximum power export quantity is determined, the SPP Cell will inform the SPP Developer accordingly.

iii) **IBEG Case:** SPPs employing IBEGs shall specify the operation mode required for the generator to operate at a unity power factor. Once specified, determine overvoltage conditions that are outside an acceptable range, and at what buses the overvoltage conditions occur. If there is determined to be an overvoltage problem, attempt to reduce the IBEG's maximum power export until the problem is solved. Once a new maximum power export quantity is determined, the SPP Cell will inform the SPP Developer accordingly.

**3) Reactive Power Supply from TANESCO's grid**

a) Examine the quantity of reactive power exported from the TANESCO substation closest to the SPP at locations both before and after the SPP connection. The quantity of reactive power required once the SPP is connected should not increase more than 25% from when the there were no SPPs connected to the Main Grid. When SPPs will connect to a TANESCO Mini Grid, it is necessary to verify whether or not the TANESCO generator will supply sufficient reactive power. If the available supply of reactive power is determined to be insufficient, it may be necessary to reduce the SPPs maximum power export or require the SPP to install an appropriately sized capacitor bank.

### 4) Incremental losses after SPP connection

a) Verify that the system losses in the circuit will not exceed 10% of the SPP's maximum power export once the SPP is connected to the distribution system. If the anticipated system losses appear likely to exceed this 10% ceiling, the SPP Cell will inform the SPP Developer that it is necessary to: 1) increase the conductor size; 2) reduce the SPP's maximum power export; or 3) if possible, relocate the connection point to be closer to the substation or load point.

b) If the SPP is connected to a dedicated line, as shown in Figure 12(b), the POS should be located at a TANESCO substation in order to reduce system losses.

Table 2: Load flow simulation results for the SPP under various operating conditions

| Conditions | Vs (p.u.) | Vm (p.u.) | Ve (p.u.) | Vpcc (p.u.) | Vpos (p.u.) | Veg (p.u.) | Qs (MVAr) | Losses (kW) | Overload (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|
| **Base Case without SPP** | | | | | | | | | |
| Max. Load | | | | | | | | | |
| Min. Load | | | | | | | | | |
| **Base Case with SPP during Max. Load** | | | | | | | | | |
| **For Synchronous Generator (SG)** | | | | | | | | | |
| PFC – 0.90 lagging | | | | | | | | | |
| PFC – 0.95 lagging | | | | | | | | | |
| PFC – unity | | | | | | | | | |
| PFC – 0.95 leading | | | | | | | | | |
| VC – 1.02 | | | | | | | | | |
| **For Induction Generator (IG)** | | | | | | | | | |
| PF – 0.95 leading | | | | | | | | | |
| **For Inverter-based EG (IBEG)** | | | | | | | | | |
| PF - unity | | | | | | | | | |
| **Base Case with SPP during Min. Load** | | | | | | | | | |
| **For Synchronous Generator (SG)** | | | | | | | | | |
| PFC – 0.90 lagging | | | | | | | | | |
| PFC – 0.95 lagging | | | | | | | | | |
| PFC – unity | | | | | | | | | |
| PFC – 0.95 leading | | | | | | | | | |
| VC – 1.02 | | | | | | | | | |
| **For Induction Generator (IG)** | | | | | | | | | |
| PF – 0.95 leading | | | | | | | | | |
| **For Inverter-based EG (IBEG)** | | | | | | | | | |
| PF - unity | | | | | | | | | |

**Note:** Vs = Voltage at Substation (p.u.),
Vm = Voltage at the middle of line (p.u.),

| | | |
|---|---|---|
| Ve | = | Voltage at the end of line (p.u.), |
| Vpcc | = | Voltage at PCC (p.u.), |
| Vpos | = | Voltage at POS (p.u.), |
| Veg | = | Voltage at terminal bus of embedded generator (p.u.), |
| Qs | = | Reactive power supplied by grid (MVAr), |
| Losses | = | Total losses on connected SPP feeder (kW), |
| Overload | = | Thermal overload limit violation or not (Yes/No). |

#### 4.3.1.3.2 Short Circuit Study

The SPP Cell will request the Protection Engineer to perform a Short Circuit Study using the DIgSILENT PowerFactory program. The study will determine short circuit risks for the Main Grid's maximum and minimum fault conditions. If the minimum grid fault conditions are not discernable, it is only necessary to examine the maximum grid fault conditions. The Short Circuit Study will verify the following conditions:

1) Examine the fault current contribution from the SPP by using the DIgSILENT PowerFactory program to calculate fault types, which may include three-phase faults, phase-to-phase faults and single-phase-to-ground faults. The fault study should be conducted for every bus in order to determine if any equipment is likely to experience a fault current exceeding 87.5% of the interrupting capacity of any protective devices. If the fault current is appears likely to exceed this ceiling, the SPP's maximum power export should be reduced or the equipment rating of the relevant hardware increased.

2) Examine the conditions under which single-phase-to-ground faults may occur both before and after the SPP connection to the TANESCO grid to ensure that voltages at healthy phases are in the acceptable range. Any difference in the values before and after the SPP's connection less than 5% are acceptable. If the value exceeds 5%, verify the appropriateness of the existing grounding method and change the system grounding as necessary to bring the value under the 5% level.

The SPP Cell is responsible for reporting the results of the EA to the SPP Developer using Form 10B. These results will include information on: any required equipment rating upgrades; conductor size upgrades; required reductions of the SPP's maximum power; and/or any other related upgrades (if available) that should be undertaken by the SPP Developer.

For EAs performed by TANESCO, TANESCO will charge the SPP Developer for the number of man-hours employed in the EA's preparation as well as for the use of the abovementioned software applications. With regard software use charges, SPP's requesting sales of electricity exceeding 5 MW will be charged approximately 2-3 % of the software's

value and SPPs requesting sales of electricity over 1 MW but not exceeding 5 MW will be charged approximately 1-2% of the software's value.

### 4.3.2 TANESCO will prepare a base case study of the parts of the distribution system that belong to TANESCO and the SPP will perform the remainder of the study

1) The SPP Cell will request the Planning Engineer to model the parts of the distribution system belonging to TANESCO. Once the study is complete, the planning engineer will report the results to the SPP Cell within 2 weeks of receiving the request.

2) Upon receipt of the study's results, the SPP Cell will submit these results to the SPP Developer using Form 10C. The SPP Developer will then employ these results in a model that takes into consideration the proposed SPP's generating facility devices and equipment to complete the study, the results of which will be submitted to the SPP Cell.

3) The SPP Cell will forward the results of the load flow study to the Planning Engineer and the short circuit study to the Protection Engineer. The engineers will respectively examine the results of these studies using the method described in Section 4.3.1. The planning engineer and protection engineer will send their independent assessments on the accuracy and legitimacy of these studies to the SPP Cell within one (1) week.

4) The SPP Cell will, upon receiving the engineers' respective assessments, review the results of the EA study (Ref. Section 4.3.1), including any required upgrades, and forward the conclusions of the EA to the SPP Developer using Form 10D.

5) The cost for services employed in completing the Engineering Assessment will be calculated by determining the costs incurred by TANESCO (i.e. man hours used to complete the required system modeling and examine the study's results as well as charges for software use, which should be charged at a rate of half of option 1).

### 4.3.3 SPP conducts detailed interconnection studies and TANESCO examines the results

1) The SPP Cell is responsible for collecting information from all related parties and exchanging all required information with the SPP Developer using Form 10E.

2) The SPP Developer will create a model that takes into consideration the entire distribution system and performs all simulations/modeling in accordance with TANESCO's standards (ref. Section 4.3.1.).

3) Upon completing the study, the SPP Developer will submit the results of the study to the SPP Cell.

4) The SPP Cell will send the results of the load flow and short circuit studies to the Planning Engineer and Protection Engineer respectively. These engineers will examine the studies according to the methods described in Section 4.3.1. Upon examining the results of these studies, the engineers will forward their independent assessments of the accuracy and legitimacy of these studies to the SPP Cell within 1 week.

5) The SPP Cell will, upon receiving the engineers' respective assessments, review the results of the EA study, including any required upgrades, and forward the conclusions of the EA to the SPP Developer using Form 10D.

6) There is no charge for engineering services when the SPP chooses to conduct the EA independently.

TANESCO reserves the right to select the most appropriate of the above options. This means that initially, the SPP may conducts detailed interconnection studies that will be applied smoothen the process as it moves forward.

# 5. The Guidelines for Design Examination and Interconnection Protection Acceptance

After the SPP Developer receives the SPPA but before construction on the SPP Project begins, the details of all relevant construction/installation diagrams and relay coordination shall be submitted to the SPP Cell for verification and approval. The details of these verification and approval processes are addressed in detail below.

## 5.1 Examination and Comment for Design Upgrade and Modification

The Principal Protection Engineer is responsible for checking the suitability of the SPP's electrical system and facility equipment using the SPP Developer's construction/installation diagrams.

### 5.1.1 One Line Diagram

For SPPs connected to Medium Voltage (MV) systems, Utility Grade protection devices and equipment are required. The SPP Cell will check to be certain that the details of all protection devices and equipment employed in the SPP are in compliance with all relevant codes, including symbols and details, outlined in the construction and installation diagrams.

Additionally, the protection system at the Point of Supply (POS) shall be equipped with relay equipment that complies with the Minimum Protection Requirements of the Draft of SPP Developer Guidelines for Grid Interconnection of Small Power Projects in Tanzania: Part A [2], as shown in Table 3. The design and installation of the SPP facility shall comply with all electrical system installation standards, as defined by TANESCO.

**5.1.2** Protective equipment and other related equipment shall comply with all TANESCO specified standards or be a product that complies with international standards, as presented in Table 4.

Table 3: Summary of Minimum Protection Requirements [2]

| | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 | |
|---|---|---|---|---|---|---|
| Generator type | All | All | See Case 3 description | All | See Case 5 description | Self commutated static inverters |
| Minimum captive load(L) | L | L | L | | L | |
| Maximum cumulative installed capacity | < 0.5 x L | < 0.8 x L | > 0.8 x L | | > 0.8 x L | |
| Maximum site installed capacity | < 5 MW | < 5 MW | < 5 MW | > 5 MW | | |
| Under and over voltage protection (27/59) | ● | ● | ● | ● | ● | |
| Under and over frequency protection (81 U/O) | ● | ● | ● | ● | ● | |
| Loss of mains (81R) | * | ● | ● | | ● | |
| Neutral Voltage Displacement (NVD) protection (59N) | | | ● | *(1) | | |
| Loss of phase | ● | ● | ● | ● | ● | ● |
| Other | * | | * | * | * | * |

**Note:** Case 1: Generation less than 5 MW, Comparatively High Captive Load
Case 2: Generation less than 5 MW, High Captive Load
Case 3: Generation less than 5 MW, Lower Captive Load. All types except mains excited generators.
Case 4: Generation larger than 5 MW
Case 5: Induction generators and line commutated inverters, Low Captive Load. Mains excited induction generator with local power factor correction less than the reactive power demand.

- ● Mandatory minimum requirement

* For other requirements and alternatives see the descriptions under the respective case descriptions and requirements

(1) **NVD:** A technique to measure the displacement of the neutral voltage with respect to earth.

Table 4: Standards required for each protective devices and equipment

| Equipment | Standard |
|---|---|
| Meter | IEC 61036 and IEC 60687 |
| Instrument Transformer | IEC 60044-1 for CT and IEC 60044-2 for PT or ANSI C57.13 |
| Circuit Breaker | IEC 62271-100 and IEC 62271-200 or ANSI C37.11 or NEMA SG4 |
| Protection Relay | IEC 60255 according to supply list of TANESCO |
| Disconnecting Switch | IEC 62271-102 or ANSI C37.30 ANSI C37.32 and ANSI C37.34 |
| Dropout Fuse Cutout | IEEE C37 and ANSI C37 or NEMA SG2 |
| Surge Arrester | IEC 60099-4 or ANSI/IEEE C62.11 |

**5.1.3** Specifications for minimum equipment requirement are as follows:

**1) CT & VT**

a) Cast-resin insulated, Dry type

b) CT Class 5P20 or better

c) VT rated voltage factor (RVF) is 1.5 in an effectively grounded[1] system and 1.9 in a non- effectively grounded system, according to IEC 60044-2

d) Suitable burden (VA) of both CT and VT for all connected loads such as relays

e) Basic Insulation Level BIL: 95 kV for 11 kV and 150 kV for 33 kV

**2) Circuit Breaker**

a) Vacuum CB or $SF_6$ CB

b) Rated voltage 12 kV for 11 kV and 36 kV for 33 kV

c) BIL: 95 kV for 11 kV and 150 kV for 33 kV

d) Rated short-circuit breaking current: 25 kA for 1 second

**3) Surge Arrester**

a) Polymer-based surge arrester

[1] effectively grounded: grounded through a connection of sufficiently low impedances so that fault ground which may occur cannot build up voltages dangerous to personnel or other equipment

b) Rated voltage 9 kV for 11 kV and 30 kV for 33 kV

c) Rated discharge current: 10 kA

**4) Disconnecting Switch**

a) outdoor type

b) Rated voltage 12kV for 11 kV and 38 kV for 33 kV

c) Basic Insulation Level BIL: 95 kV for 11 kV and 150 kV for 33 kV

d) Rated normal current 600 A for 11 kV and 33 kV

e) Rated short-time withstand current (1 second) 25 kA for 11 kV and 33 kV

**5) Other Interconnection Equipment**

a) PV Inverter shall have Anti-Islanding Protection

- Comply with IEC 61727 and IEC 62116, or other equivalent standards accepted by TANESCO to prevent inadvertent islanding from occurring.

b) Inverter-based embedded generator

- Comply with IEEE 519/IEEE 1547, or others equivalent standards accepted by TANESCO to prevent power quality problems.

c) Export Transformer

With regard to the grounding of export transformers, and to ensure proper protection coordination, TANESCO should consider the use of winding connections in SPPs employing synchronous generators as follows:

i) For electricity sales greater than 3 MW, apply YNd winding connection.

ii) For electricity cells less than 3 MW, apply Dyn winding connection.

The use of winding connections has been proposed because most distribution system faults are of the single-phase-to-ground fault. When large SPPs apply YNd winding connections, the protection coordination with the relay at the substation becomes more efficient. The magnitude of ground fault current will be higher. This higher magnitude of ground fault current will, however, not impact TANESCO's distribution equipment because the fault level in TANESCO's distribution system is fairly low. A typical overcurrent relay (50/51) can be used for ground fault protection. The coordination of the overcurrent relay is much easier

than a Zero Sequence Overvoltage relay (59N). If 59N is not properly set, it may cause the SPP to trip when a ground fault occurs in another feeder.

Note: *When the SPP employs IGs or IBEGs, it is possible to use export transformers that employ Dyn winding connections as an alternative option.*

The protection engineer will, after examining all relevant documents/diagrams/illustrations, inform the SPP Cell within 1 week of whether the documents were approved, or if they will require modifications/corrections, and/or the installation of additional equipment. The SPP Cell will then inform the SPP Developer of this information using Form 11A. In the case that modifications/corrections and/or the installation of additional equipment is required, the SPP Developer will, upon making these modifications/corrections, resubmit the necessary documents/diagrams/illustrations to TANESCO for consideration.

### 5.2 Interconnection Protection Aspects

The protection schemes employed by the SPP Developer shall be coordinated with the protective systems employed in TANESCO's distribution system and designed for both current and anticipated future fault levels. All protection scheme proposals are subject to TANESCO's review and acceptance. The SPP protection schemes and settings will be evaluated using the following criteria:

1) All protective device settings and protection scheme designs shall be submitted to TANESCO for review and approval.

2) Protection settings may change over time in order to maintain adequate levels of system protection as the system's configuration changes.

3) All protection operations shall ensure that the generator(s) and all HV ground sources are isolated from TANESCO`s distribution system within the required time from the start of a disturbance.

4) All protection designs shall:

   a) Ensure proper coordination with TANESCO's protection systems;

   b) Ensure that the safety standards of the SPP's and TANESCO's respective distribution systems are maintained in order to protect the safety of both customers as well as the general public.

5) The design of protection equipment at the SPP generating facility shall be completed by a qualified professional engineer. This will ensure that the overall protection scheme and the physical interconnection to TANESCO's distribution system are both safe and reliable.

6) All of the SPP's protection functions shall remain operational in the case of distribution system disturbances or losses of supply for the required period of time needed to operate properly.

7) Additional protections above and beyond those listed in this document may be required and shall be communicated to the SPP Developer at the appropriate stage of project development.

8) For TANESCO's distribution system, any system fault will be followed by a trip and closed within 5 seconds. Under these conditions, the SPP facility shall be disconnected from the system before the Main Grid is re-energized to prevent damage to the SPP's generators. Such problems can be avoided by installing a synchronizing check relay (25) at the outgoing bus where the SPP is connected.

9) When a fault occurs within the SPP generating facility, the SPP shall be disconnected from TANESCO's distribution system before the operation of TANESCO's protective devices.

10) The SPP generating facility shall not energize TANESCO's distribution system when the distribution system is de-energized in order to avoid inadvertently causing an islanding condition, thus protecting the safety of both personnel and equipment. Exceptions exist for instances of intentional islanding that are used to increase system reliability, and will be considered on case-by-case basis.

Therefore, when the SPP Cell receives the protection schemes and setting values of protective devices from SPP Developer for consideration, SPP Developer shall also submit file of the system model using DIgSILENT PowerFactory program which have already done while preparing Engineering Assessment study. This file shall contain additional models of CT, relay and setting value according to the project proposal. The protection engineer will send his assessments of the setting value and protection coordination of this study to the SPP Cell within 2 weeks. This requires the examination of the SPP's protection system as well as the examination of how the system responds to faults within both the TANESCO and SPP Developer's distribution system. In order to determine if the protection devices are working properly, the 10 criteria above shall be taken into consideration in addition to the settings of the SPP's generator protection systems.

Note: *Generally, when a fault occurs within TANESCO's distribution system, the protection device at the connection point should become operational before the generator's protection equipment is activated. The values of both the SPP facility's protection systems at the interconnection point as well as the values of TANESCO's protection systems should be set according to the criteria shown in Section 5.2.1 and Section 5.2.2, respectively.*

### 5.2.1 Considerations regarding the settings of the SPP's protection system at the interconnection point:

1) Phase Overcurrent Relay (50/51)
   - Pickup 120% of the generator rating or the SPP transformer, whichever is less.
   - Standard Inverse Curve (IEC or ANSI)
   - The time delay of 50/51 should be faster than the operation of the HV fuse cutout, line-recloser, and the CB at the substation and shall be faster than the first shot reclose operation of the CB or line-recloser.
   - 50/51 shall operate faster than the operation of TANESCO's HV fuse cutout when connecting to a 400 V system.
2) Overvoltage Relay (59)
   - + 10 % shall trip within 3 seconds
   - + 20 % shall trip within 0.3 seconds
3) Undervoltage Relay (27)
   - - 15 % shall trip within 3 seconds
   - - 50 % shall trip within 0.3 seconds
4) Overfrequency Relay (81O)
   - + 1.5 Hz shall trip within 0.5 second
5) Underfrequency Relay (81U)
   - - 2 Hz shall trip within 0.5 second
6) Directional Overcurrent Relay (67/67N) (if applicable)
   - 110 % of generator rating and shall trip within 0.3 second
   - Ground setting 30 % of phase setting
7) Zero Sequence Overvoltage or Neutral Voltage Displacement (NVD) (59N)
   - 20% shall trip within 3 second
   - 30% for instantaneous trip

8) Reverse Power (32) (if applicable)

- 2-25% of the generator rating with a 2-10 operating time sec, or manufacturer's recommendations.
- The SPP facility may be required to halt operations for scheduled maintenance or other reasons. As the SPP generating facility may have an internal load supplied by TANESCO (including loads required to restart generators), the setting or the application of the reverse power relay shall also be taken into account under such circumstances.

9) Loss of Mains (81R)

- Rate of change of frequency
  - 2.5 Hz/sec within 0.5 second
- Vector Shift
  - $6^{\circ}$-$12^{\circ}$ in half a cycle within 0.5 second

10) Synchronizing Check Relay (25) (if applicable)

- Synchronization parameter limits for synchronous interconnection to the Main Grid, as shown in the table 5

Table 5: Synchronization parameter limits for synchronous interconnection to the Main Grid

| Aggregate rating of SPP generating units (kVA) | Frequency difference ($\Delta$f, Hz) | Voltage difference ($\Delta$V, %) | Phase angle difference ($\Delta\Phi$, °) |
|---|---|---|---|
| 0 – 500 | 0.3 | 10 | 20 |
| > 500 – 1500 | 0.2 | 5 | 15 |
| > 1500 – 10000 | 0.1 | 3 | 10 |

### 5.2.2 Considerations regarding TANESCO's protection system settings

The adjustment of the CB's operating time at TANESCO's substations can be divided into two intervals:

1) The first dead time of the CB at the substation feeder connected to the SPP facility shall not be less than 5 seconds.

2) The first dead time of the line-recloser (if any) connected to the SPP facility shall not be less than 5 seconds.

### 5.3 Interconnection Protection Acceptance

1) The SPP Developer shall provide TANESCO with complete documentation of the proposed SPP generating facility's interconnection protection scheme to ensure compliance with all requirements outlined within this document as well as all applicable TANESCO standards and regulations. Documents include but are not limited to:

   a) A detailed single line diagram;

   b) A thorough description of how the protection scheme(s) will function;

   c) A thorough description of failure modes;

   d) Detailed engineering drawings that include: design details on all protection and control systems/equipment; tele-protection (if applicable) and tele-metering (if applicable) schemes; and all the system components of the SPP facility, including manufacturer name and model number;

   e) The protection element settings in DIgSILENT Power Factory program format (pickup, timers, etc.);

   f) Details on the backup supply to any critical loads;

   g) Details on the Breaker Failure protection (if applicable); and

   h) Details on the disconnecting and interrupting device(s).

2) After examining all the documents listed above (Item 1), TANESCO will either approve the protection schemes and setting values, or request their revision. The Protection Engineer will inform the SPP Cell of TANESCO's decision within two (2) weeks of the decision's issuance. Upon receipt of this decision, the SPP Cell will proceed by informing the SPP Developer of TANESCO's decision using Form 11B.

3) If TANESCO recommends any changes/revisions to the SPP facility, the SPP Developer will be required to revise and re-submit the protection schemes and setting values to the SPP Cell.

4) The SPP Developer's most recent and up-to-date submissions/documents will be filed by the SPP Cell and shall coincide with the documentation retained by the SPP Developer.

Note: *All documentation shall be submitted together.*

### 5.4 Comments on Additional Protection Arrangements

Some of the protection arrangements outlined in the Draft of SPP Developer Guidelines for Grid Interconnection of Small Power Projects in Tanzania: Part A [2] are not practical according to experiences in Thailand. As such, the following suggestions have been proposed to enhance protection management, as well as overall system reliability and safety.

1) For small, Inverter-based EGs and IGs less than 1 MW, the HV fuse cutout can be used in place of a CB. If it is necessary to install a ground fault detection, a 59N signal can be assigned to Trip the CB on the LV side of the transformer.

2) SGs greater than 3 MW should use HV protection including 50/51 and 50G/51G with wye-grounded connections at the HV-side of the export transformer.

3) Export transformers greater than 5 MW should be equipped with 87T.

4) SPPs greater than 3 MW may require the installation of synchronizing check relays at the substation or block reclose relays for the feeder.

5) When the SPP connection is larger than 3 MW, it may be necessary to change the overcurrent relay to a directional overcurrent relay at the substation's outgoing CB in order to avoid sympathetic tripping when faults occur in other feeders.

6) It may be necessary to install a 27R (Instantaneous undervoltage Relay) to prevent the SPP from reconnecting to the system when the Main Grid is de-energized. When TANESCO's distribution system is de-energized due to maintenance, a 27R will prevent the SPP from re-connecting to the Main Grid. This function is similar to the synchronizing check relay's (25) back-up function, which improves safety.

## 6. SPP Application Approval and Interconnection Checklists

This appendix contains checklists for the various phases of the SPP Application Approval process, as outlined in Part 1 Section 2. These checklists are intended to provide a rough guideline for the TANESCO SPP Cell rather than a map to be followed meticulously.

**Step 1: Request for LOI**

| **Issue Acknowledgement of Application** | **Done** | **Date** |
|---|---|---|
| Acknowledgement receipt of SPP application | ☐ | ☐ |

| **Verify Request for LOI** | | |
|---|---|---|
| Verify that the request for LOI is complete? | ☐ | ☐ |
| Notify the SPP that its request for LOI is incomplete | ☐ | ☐ |
| All additional documents from the SPP have been received | ☐ | ☐ |

| | | |
|---|---|---|
| Inform SPP that the request for LOI is complete | ☐ | ☐ |
| Issue site reference number | ☐ | ☐ |

## Step 2: Checking for Duplication with Rural Electrification Projects (TANESCO Mini Grid)

| **Received the SPP's application for connecting to TANESCO mini grid** | **Done** | **Date** |
|---|---|---|
| Received the SPP's application and passed it through to the Strategic Planning Dpt. and Electrification Div. | ☐ | ☐ |

| **Verify if and when the proposed project will have access to the national grid** | | |
|---|---|---|
| Verify if and when the proposed project area will have access to the national grid | ☐ | ☐ |
| Inform the SPP developer of the duplication checking results | ☐ | ☐ |

| **TANESCO informs the SPP Developer 6 months in advance of the mini grid's connection to the main grid** | | |
|---|---|---|
| Inform the SPP Developer of the mini grid's interconnection with TANESCO's main grid 6 months in advance of the anticipated connection date. | ☐ | ☐ |
| SPP submits new application for main grid connection to TANESCO | ☐ | ☐ |
| COD (SPP main grid connection) | ☐ | ☐ |
| Report to EWURA | ☐ | ☐ |

## Step 3: Issuance of LOI

| **SPP Developer Provides Information** | **Done** | **Date** |
|---|---|---|
| Required information submitted to TANESCO Regional Office | ☐ | ☐ |
| Project site information prepared by TANESCO Regional Office | ☐ | ☐ |
| **The First Site Visit** | | |
| Request for first site visit sent to SPP Developer, Protection Engineer and TANESCO Regional Office | ☐ | ☐ |
| Appointment made for first site visit | ☐ | ☐ |
| First site visit completed | ☐ | ☐ |
| **Initial Verification Process** | | |
| Required information gathered and PCC identified jointly with SPP Developer | ☐ | ☐ |
| Initial verification completed | ☐ | ☐ |
| **Issuance of LOI** | | |
| Initial cost estimate for distribution system upgrades listed in the LOI if the existing system cannot accommodate the SPP's anticipated quantity of export power | ☐ | ☐ |
| LOI concluded | ☐ | ☐ |
| LOI issued and SPP Developer and EWURA informed accordingly | ☐ | ☐ |

## Step 4: Issuance of SPPA

| **Request for EA Study** | **Done** | **Date** |
|---|---|---|
| SPP Developer selects EA Option (1, 2 or 3) | ☐ | ☐ |
| Request for EA received and passed through to Strategic Planning Dpt. (Option 1 &2) | ☐ | ☐ |
| Estimate cost for preparing EA study (Option 1 & 2) | ☐ | ☐ |
| Check whether or not the distribution system requires any upgrades | ☐ | ☐ |

| **Preparing the EA Report & Estimating Upgrade Costs** |
|---|
| **Option 1** |

| | | |
|---|---|---|
| Submit quotation for EA Study to SPP Developer | ☐ | ☐ |
| Acquire purchase order from SPP Developer | ☐ | ☐ |
| Contact SPP Developer for Information Exchange | ☐ | ☐ |
| Perform simulation, submit the EA report and send invoice to SPP Developer | ☐ | ☐ |
| Evaluate and estimate the expected costs of upgrading TANESCO's distribution system | ☐ | ☐ |
| **Option 2** | | |
| Submit quotation for EA study to SPP Developer | ☐ | ☐ |
| Acquire purchase order from SPP Developer | ☐ | ☐ |
| Contact SPP Developer for Information Exchange | ☐ | ☐ |
| SPP receives base case study and invoice, performs EA and submits the EA study to TANESCO | ☐ | ☐ |
| TANESCO approves EA study | ☐ | ☐ |
| Evaluate and estimate the expected costs of upgrading TANESCO's distribution system | ☐ | ☐ |
| **Option 3** | | |
| SPP Developer initiates Information Exchange | ☐ | ☐ |
| SPP performs EA and submits EA study to TANESCO | ☐ | ☐ |
| TANESCO approves EA study | ☐ | ☐ |
| Evaluate and estimate the expected costs of upgrading TANESCO's distribution system | ☐ | ☐ |
| **Payment** | | |
| Payment for EA Study received and receipt issued (For Option 1 & 2) | ☐ | ☐ |
| Inform the SPP Developer of the estimated system upgrading costs | ☐ | ☐ |
| SPP accepts the terms and conditions of the system upgrading costs | ☐ | ☐ |
| **Conclude and Sign the SPPA** | | |
| Conclude SPPA & specify the COD date (must fall within 2 years of the SPPA's signing) | ☐ | ☐ |
| SPPA reviewed by Legal Officer | ☐ | ☐ |
| SPP Developer signs SPPA | ☐ | ☐ |
| TANESCO Managing Director signs SPPA | ☐ | ☐ |
| EWURA informed of the SPPA's issuance | ☐ | ☐ |

## Step 5: Upgrading TANESCO's Distribution System

| **Survey, design and estimate the expected costs of upgrading TANESCO's distribution system** | **Done** | **Date** |
|---|---|---|
| Will the SPP Developer complete the required upgrades without assistance from TANESCO?<br>If yes, the SPP Developer must submit construction drawings (before the POS) to TANESCO's Regional Office for approval. | ☐ | ☐ |
| Will the SPP Developer complete the required upgrades without assistance from TANESCO?<br>If no, notify the TANESCO Regional Office to survey, design & estimate the costs of the required system upgrades. | ☐ | ☐ |
| **Payment (SPP lets TANESCO construct/upgrade TANESCO's distribution system)** | | |
| Inform the SPP Developer of the system upgrade costs (before the POS) and request payment | ☐ | ☐ |
| Payment received and receipt issued | ☐ | ☐ |
| **Construction Period** | | |
| SPP Developer completes construction/upgrading of TANESCO distribution system | ☐ | ☐ |
| TANESCO Regional Office completes construction/upgrading of TANESCO distribution system | ☐ | ☐ |
| Quarterly progress report submitted to EWURA | ☐ | ☐ |

## Step 6: Interconnection Protection and Testing

| **Request TANESCO Transmission Department to approve the protection system** | **Done** | **Date** |
|---|---|---|
| SPP Developer's construction/installation diagrams and protection coordination study received | ☐ | ☐ |
| All relevant documents sent to Transmission Department (Protection Engineer) | ☐ | ☐ |

| | | |
|---|---|---|
| **Verify and approve of the proposed drawing and protection coordination** | | |
| Verify and approve the SPP Developer's proposed protection coordination/ protection diagram | ☐ | ☐ |
| Notify the SPP Developer of any need to make amendments/corrections, if any | ☐ | ☐ |
| **Payment** | | |
| Inform the SPP Developer of the cost of protection testing, etc. | ☐ | ☐ |
| Payment received and receipt issued | ☐ | ☐ |
| **Testing Period** | | |
| Protection system testing completed and results sent to SPP Developer | ☐ | ☐ |

## Step 7: Meter Installation and Commissioning

| **Request TANESCO Large Power Division to install electric meter** | **Done** | **Date** |
|---|---|---|
| SPP Developer decides whether or not it will purchase electric meter from TANESCO or from a third party vendor | ☐ | ☐ |
| TANESCO Large Power Div. informed of request to install electric meter | ☐ | ☐ |
| **Payment** | | |
| SPP Developer issues payment for the cost of the meter, meter testing, meter installation and commissioning (TANESCO provides meter) | ☐ | ☐ |
| SPP Developer issues payment for the cost of meter testing, meter installation and commissioning (SPP Developer purchases meter from a third party vendor) | ☐ | ☐ |
| **Meter Installation & Commissioning** | | |
| TANESCO completed installation and commissioning of meter | ☐ | ☐ |
| **Notify that meter installation is complete** | | |
| SPP Developer informed that the meter installation is complete | ☐ | ☐ |

## Step 8: Initial Interconnection and COD

| **Check to ensure all work in SPP Facility is complete and EWURA License is obtained** | **Done** | **Date** |
|---|---|---|
| All relevant work on SPP Project is complete | ☐ | ☐ |
| EWURA License obtained | ☐ | ☐ |
| **Site Visit and Interconnection Test** | | |
| Make appointment for final site visit | ☐ | ☐ |
| Grid interconnection test successful | ☐ | ☐ |
| **Start COD and Issue Interconnection Certificate** | | |
| TANESCO and SPP Developer meet to clarify and agree on TANESCO-SPP Operation Guidelines | ☐ | ☐ |
| Start COD | ☐ | ☐ |
| Interconnection Certificate issued to SPP Developer | ☐ | ☐ |
| EWURA informed of the COD | ☐ | ☐ |

# 7. Bibliography

[1] Energy and Water Utilities Regulatory Authority (EWURA), “Electricity (Development of Small Power Projects) Guidelines”, Aug. 2010.

[2] Energy and Water Utilities Regulatory Authority (EWURA), “Draft of SPP Developer Guidelines for Grid Interconnection of Small Power Projects in Tanzania: Part A”, Mar. 2009.

[3] Electric Power Research Institute, “Power Quality Impacts of Distributed Generation: Guidelines”, 2000.

[4] Energy and Water Utilities Regulatory Authority (EWURA), “The Electricity Act (Cap 131), The Electricity (Development of Small Power Projects) Rules”, 2010.

[5] Energy and Water Utilities Regulatory Authority (EWURA), “Draft of SPP Developer Guidelines for Grid Interconnection of Small Power Projects in Tanzania: Part B”, Mar. 2009.

# PART II

## TANESCO AND SPP OPERATIONS

# PART II: TANESCO AND SPP OPERATIONS

## 1. Introduction

The TANESCO and SPP Operations Manual offers system operation guidelines and procedures for both TANESCO as well as the SPP owner. The manual describes several coordination processes including but not limited to: the first synchronization; system operations under abnormal conditions; regular system maintenance; regular synchronization procedures; the renewal of Interconnection Certificates; SPP Monitoring and Reporting; and Billing and Settlement.

The manual also offers a guide for post-interconnection operation and coordination procedures to be employed by both TANESCO and the SPP owner. The manual is intended to foster and encourage close cooperation between TANESCO and the SPP owner with the aim of achieving the highest of safety standards in order to protect workers and the general public, as well as the TANESCO distribution system and the SPP developers' assets and investments.

TANESCO already possesses a Manual on Operations Practices [1] and Standardized Power Purchase Agreements for the Purchase of Grid-Connected Capacity and Associated Electric Energy [2] that together specify detailed operating guidelines and procedures. This pre-existing manual does not, however, address SPP interconnections. This TANESCO and SPP Operations Manual outlines additional procedures for proper operation and safety to be used with SPP interconnections.

## 2. General Requirements

2.1 TANESCO and the SPP Owner shall each specify a point of contact within their respective organizations that will be responsible for all correspondence and coordination between the two entities. This point of contact – or "coordinator" – will be responsible for supporting information exchange between the following individuals and departments:

(1) The TANESCO Dispatching Control Center (or the TANESCO Controller in instances when there is no Dispatching Control Center): The TANESCO Controller is appointed by TANESCO's Managing Director as recommended by a Senior-level manager within the System Control and Transmission Department. The TANESCO Controller is responsible for overseeing operation of the defined distribution system or a portion of the distribution system for five (5) years. The TANESCO Controller will hereafter be referred to as the "Controller".

(2) The TANESCO Operator is the individual responsible for the day-to-day operation of TANESCO's power system and will hereafter be referred to as the "TANESCO Operator". The TANESCO Operator is nominated and approved by TANESCO's Regional/Area manager. The TANESCO Operator is assigned by, or with the consent of, TANESCO's Dispatching Control Center or the TANESCO Controller.

(3) The SPP Operator is responsible for the day-to-day operation of the SPP system and will hereafter be referred to as the "SPP Operator". The SPP Operator is nominated and authorized on behalf the appropriate individual or individuals within the organizational structure of the SPP.

2.2 With regard to all coordination processes, the last communication shall be repeated and confirmed before proceeding further. The name of the individuals communicating as well as the time and date of each communications shall be logged for verification.

2.3 The SPP Coordinator shall promptly report any proposed changes in the SPP's system configuration that will affect the system interconnection and/or operation to the TANESCO Controller. Any proposed changes shall be approved by the TANESCO Controller before being implemented, except in emergency situations when immediate changes are required to protect human life and/or operating assets. In the case of emergency changes, the SPP Operator shall inform the TANESCO Controller of said changes as soon as possible.

2.4 The SPP Owner and TANESCO are mutually responsible for ensuring that communication systems, operation and control equipment, and protective devices are in proper operating condition through regular checks and scheduled maintenance.

2.5 The TANESCO Operator, (or the Person Issuing Work (PIW)/Person-In-Charge of Work (PICW)), is responsible for maintaining the distribution system in the area of the SPP Interconnection in strict accordance with the procedures set forth in the Manual on Operations Practices and the TANESCO and SPP Operation Manual. When using this TANESCO and SPP Operation Manual, the original TANESCO Manual on Operations Practices should be referred to regarding the following items;

(a) Item 3: Safety Coordination Procedures are referred to in Chapter 4: Control Procedure, and Chapter 5: Isolation and Earthing of Apparatus for Work;

(b) Item 6: Operation procedures for when TANESCO submits a requests to disconnect from the system in order to perform system maintenance are referred to in Chapter 4: Control Procedure, and Chapter 5: Isolation and Earthing of Apparatus for Work;

(c) Item7: Operation procedures during abnormal system operating conditions are referred to in Chapter 7: Operational Procedure for Fault Switching and Chapter 8: General Procedures;

2.6 The SPP Owner is responsible for operating and maintaining the SPP generating facility in accordance with all relevant safety and electrical codes, as well as laws dictated by national, provincial and local governmental agencies.

2.7 TANESCO reserves the right to disconnect SPPs from the grid at any time if it is discovered that the interconnection may negatively impact personnel safety and/or operating assets as well as the security, reliability and stability of TANESCO's distribution system.

2.8 TANESCO, including its employees, agents and representatives, maintain the right to enter the SPP's premises to:

(a) Inspect the SPP's generating facility and protective devices;

(b) Read or test instrumentation equipment installed by TANESCO provided that reasonable advance notice is given to the SPP Owner prior to entering its facility;

(c) Maintain or repair TANESCO equipment;

(d) Disconnect the generating facility without notice if, in TANESCO's opinion, a hazardous condition exists that requires immediate action to protect the safety of personnel, TANESCO facilities, other customers', and/or third parties' property and facilities from damage or interference caused by the SPP's generating facility, or malfunctioning protective devices;

(e) Open the Disconnect Switch without notice if TANESCO personnel require an operating clearance or Hold Tag.

**3. Safety Coordination Procedures**

To ensure proper cooperation regarding the control, operation and maintenance of TANESCO's Medium and Low Voltage Systems, and to protect the safety of personnel in the area of the SPP interconnection, SPP and TANESCO staff shall closely adhere to the Safety Coordination Procedures outlined below:

3.1 Prior to conducting maintenance or operations within TANESCO's distribution system, including both live and dead circuit conditions, the presence of the SPP interconnection shall be verified in order to protect personnel from exposure to

hazardous conditions. The SPP's interconnection status can be checked and/or confirmed by contacting the TANESCO Regional office or TANESCO Operator.

### 3.2 Operation under Cold Line Condition

3.2.1 If the SPP is interconnected to TANESCO's high voltage system, the Controller is required to submit a request to the TANESCO Operator at the relevant substation to open the circuit breaker at the high voltage side of the working circuit. In addition, the Controller will request the SPP Operator to disconnect from the grid to prevent back feeds that pose a risk to both SPP and TANESCO workers from occurring.

3.2.2 If a cold line operation takes place within TANESCO's medium voltage system, the procedures are as follows:

(1) If there is no SPP interconnected to TANESCO's distribution system, the Controller shall submit a request to the TANESCO Operator at the relevant substation to disconnect the outgoing feeder's circuit breaker.

(2) If the SPP is interconnected to TANESCO medium or low voltage system, the Controller shall submit a request to the TANESCO Operator at the relevant substation to disconnect the outgoing feeder. A request shall also be submitted to the SPP Operator to disconnect its generating facility from the grid.

3.2.3 If a cold line operation takes place within TANESCO's low voltage system, the procedures are as follows:

(1) If the SPP facility is not interconnected to TANESCO's low voltage system, TANESCO's Line Crew Foreman shall disconnect the circuit from the distribution system;

(2) If the SPP facility is interconnected to TANESCO's low voltage system, the TANESCO Line Crew Foreman shall disconnect the circuit from the system. Additionally, the Controller shall submit a request to the SPP Operator to disconnect its generating facility from the grid.

The overall safety coordination procedures for operation under Cold Line Condition are shown in Fig.1.

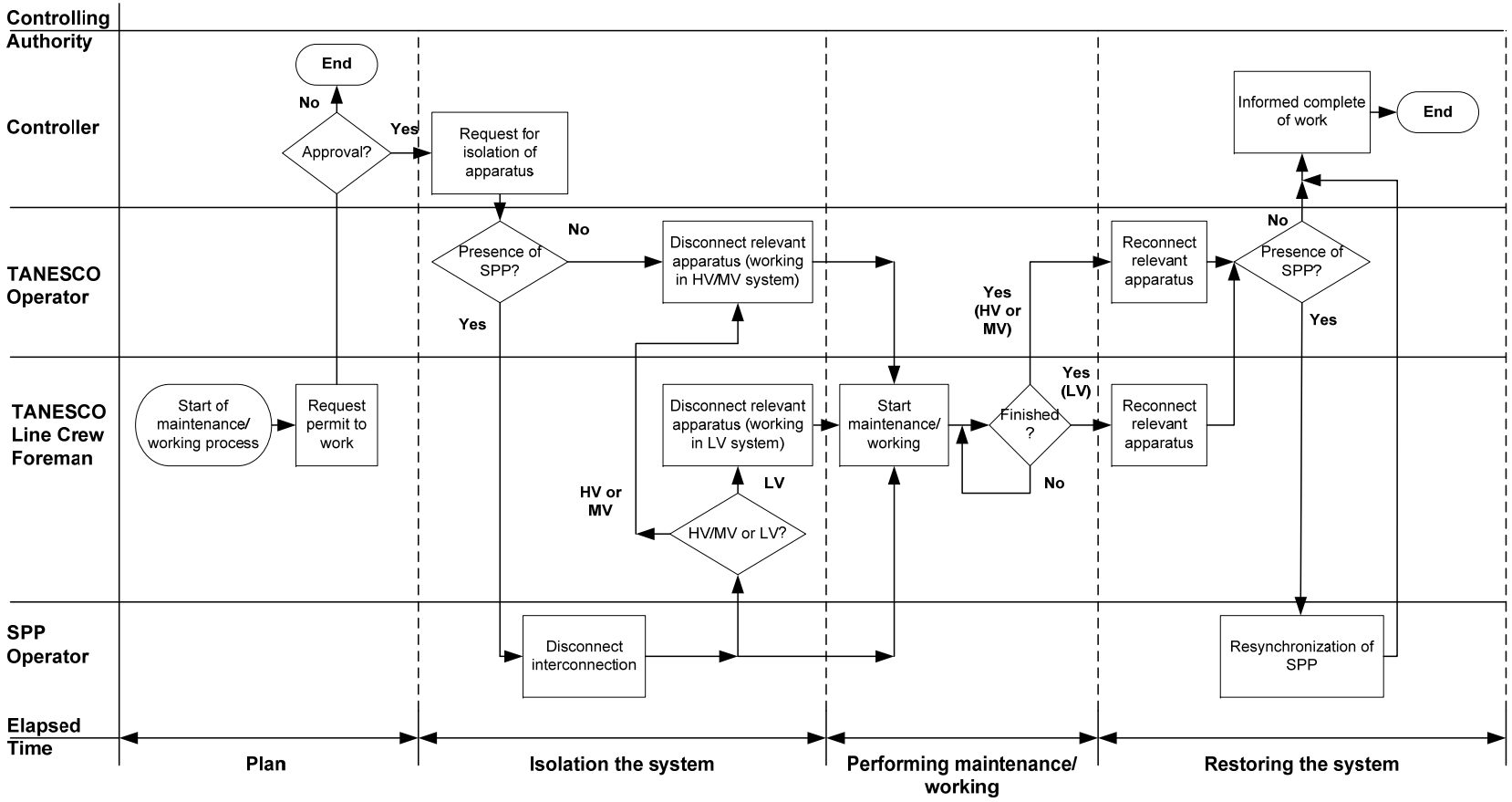



Fig.1: Flowchart of safety coordination procedure for operation under Cold Line Condition

### 3.3 Operation under Hotline or Live Line Condition

3.3.1 If the SPP is interconnected to TANESCO's high voltage system, the Controller shall inform the TANESCO Operator of the times and dates of the proposed maintenance/working schedule, as well as the location(s) of the relevant substation(s). If an accident or system outage occurs during operation, the Operator at the substation will be ordered to immediately disconnect the working circuit at the high voltage side. In addition, the Controller shall submit an urgent request to the SPP Operator to immediately disconnect the SPP facility from the grid.

3.3.2 If a live line operation takes place within TANESCO's medium voltage system, the procedures are as follows.

(1) If there is no SPP interconnected to TANESCO's distribution system, the Controller shall inform the TANESCO Operator at the relevant Substation of the times and dates of the proposed maintenance/working schedule. If an accident or system outage occurs during operation, the Operator at the substation will be ordered to immediately disconnect the Circuit Breaker of the outgoing feeder;

(2) If the SPP is interconnected to TANESCO's medium or low voltage system, the Controller shall inform the TANESCO Operator at the relevant substation of the times and dates of the proposed maintenance/working schedule. If an accident or system outage occurs during operation, the Operator at the substation will be ordered to immediately disconnect the Circuit Breaker of the outgoing feeder. In addition, the Controller shall submit an urgent request to the SPP Operator to immediately disconnect the SPP from the grid.

3.3.3 If a live line operation takes place within TANESCO's low voltage system, the procedures are as follows:

(1) If the SPP facility is not interconnected to TANESCO's low voltage system and an accident occurs during operation, the TANESCO Operator shall immediately disconnect the circuit from the system.

(2) If the SPP facility is interconnected to TANESCO's low voltage system and accident occurs during operation, the TANESCO Operator shall immediately disconnect the circuit from the system. Additionally, the Controller shall direct the SPP operator to immediately disconnect the SPP facility from the grid.

3.4 Once the operation is complete, the TANESCO Line Crew Foreman will inform all relevant parties accordingly and the circuit will be re-energized.

The overall safety coordination procedures for operation under Live Line Condition are shown in Fig.2.

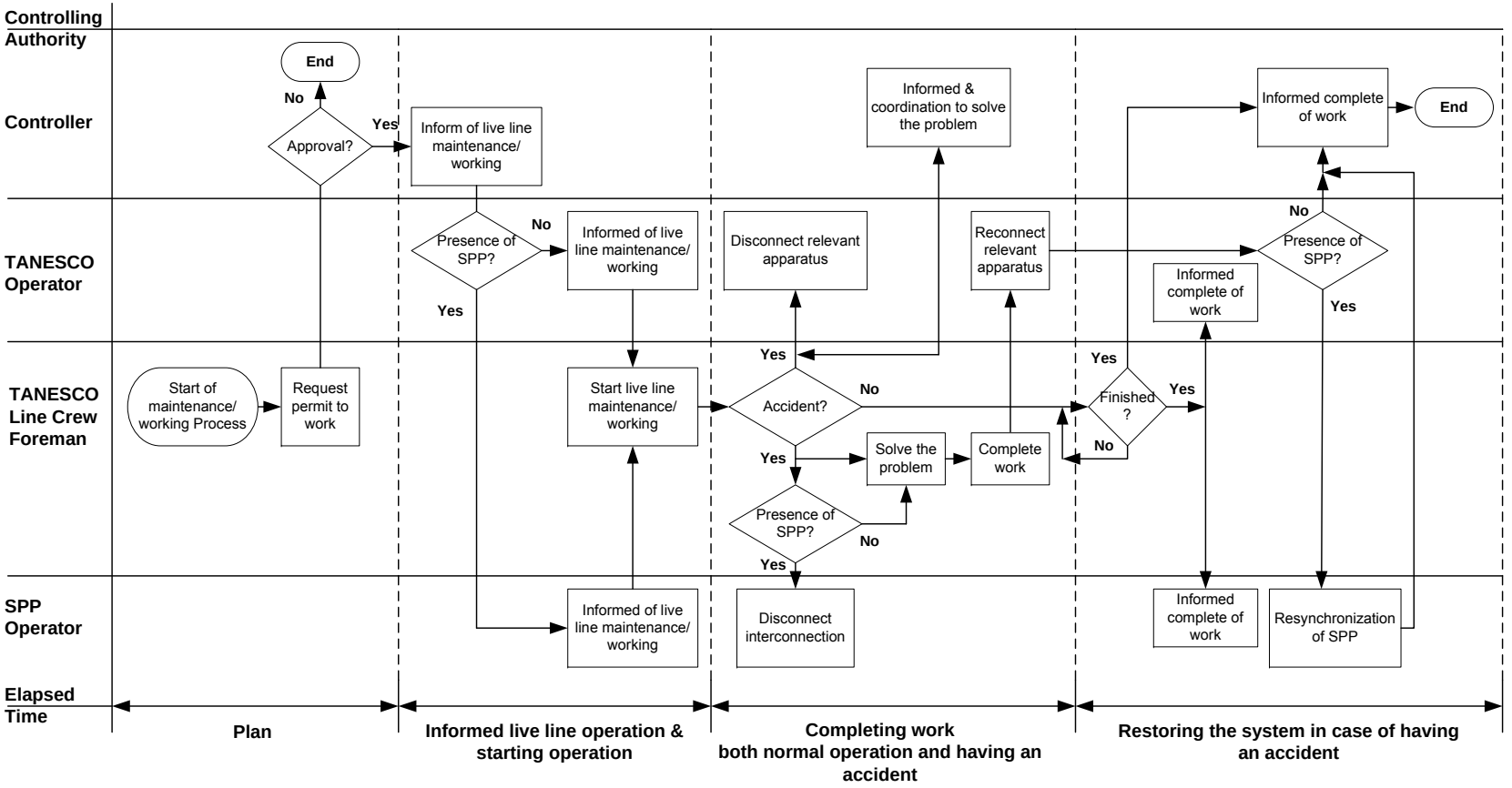



Fig.2: Flowchart of safety coordination procedure for operation under Live Line Condition

## 4. First Synchronization

4.1 According to the Standardized Power Purchase Agreement for Purchase of Grid-connected Capacity and Associated Electric Energy [2], the SPP Operator shall provide written notification to the Controller at least thirty (30) days prior to the first synchronization, at which point the SPP's generators will begin operating in parallel with TANESCO's distribution system. The SPP Operator shall also inform the Controller when operation has commenced each time an SPP facility resynchronizes or restarts after a period in operation.

4.2 It is the responsibility of the TANESCO Operator and Controller to explain all operating principles and procedures to the SPP Operator. The responsibilities for each step of the SPP synchronization testing shall also be clarified, including the appropriate methodology for all official communications between the aforementioned parties.

4.3 The TANESCO Operator and Controller shall coordinate with the SPP Operator to prepare for the required grid interconnection tests, which include:

1) Synchronization Test

- The synchronization test checks that the SPP facility's operation is synchronized with the Main Grid at the interconnection circuit breaker or low voltage circuit breaker. Tests of load supplying should start from 0% and gradually increase to 100% of the SPP facility's export capacity.

2) Trip Test

- The Trip test verifies the trip operation at the interconnection circuit breaker or low voltage circuit breaker and ensures the plant is shutdown.

3) Proof of inability to energize dead lines or out-of-phase lines

- This test verifies that the SPP will not reconnect in the event that: (a) utility lines are de-energized; or (b) that utility lines are out-of-phase with SPP generator.

4) Anti-islanding Function Test (if applicable)

- The non-islanding function, if available, shall be checked by: (i) operating a load break switch and verifying that the interconnection facility ceases operation and does not energize the output terminals; and (ii) testing the reconnection (after the islanding condition has ceased). The test should seek to ensure that the automatic reconnection has the required time delay.

- In cases when the SPP facility's design allows for islanding conditions within the plant, the anti-islanding test will be performed by tripping the interconnection

circuit breaker and monitoring how the system adjusts and changes into islanding operation mode.

The overall first synchronization procedures are shown in Fig.3.

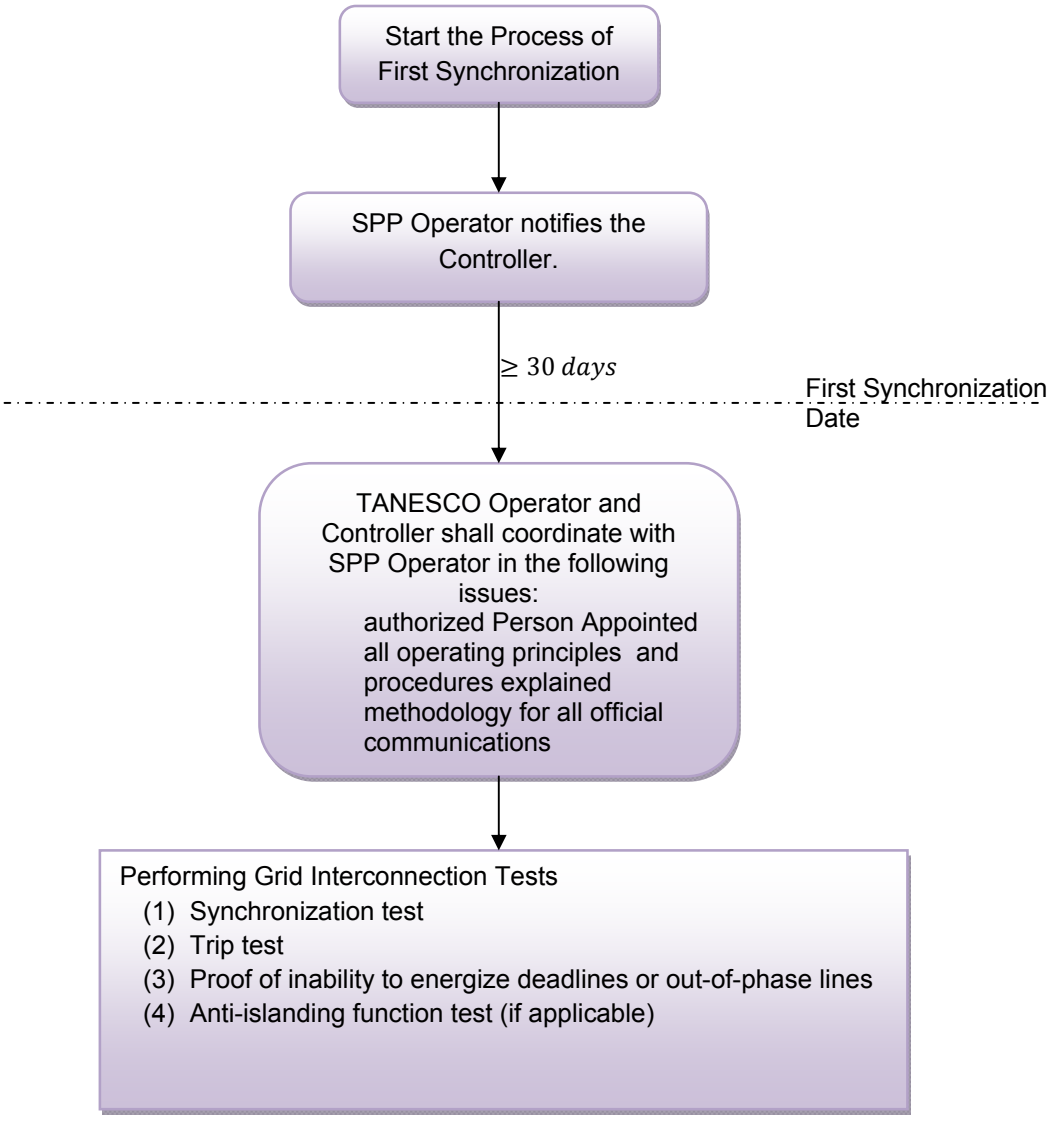



Fig.3: Flowchart of first synchronization procedure

## 5. Interruption of Delivery and Scheduled Outages of SPP Generating Facility under Normal Conditions

5.1 According to the Standardized Power Purchase Agreement for Purchase of Grid-connected Capacity and Associated Electric Energy [2], the SPP Operator shall notify the Controller one (1) month in advance of Scheduled Outages. The notification shall include a non-binding estimate of each outages expected length. The SPP Operator should notify the Controller of Unscheduled Outages as soon as possible and include a non-binding estimate of the outage's expected length. SPP Operators shall notify the Controller at least one (1) day in advance of any disconnection/ re-connection request.

5.2 The SPP shall notify the Controller in writing of any amendments to the dates and times of any scheduled outages at least one (1) day in advance of said scheduled outage.

5.3 According to Standardized Power Purchase Agreement for Purchase of Grid-connected Capacity and Associated Electric Energy [2], the SPP Operator may interrupt, reduce or cease delivers to TANESCO's distribution system only to the extent that the SPP Operator determines that such interruption, reduction or cessation is necessary in order to install or replace equipment, conduct maintenance, or assess maintenance requirements. Before any interruption, reduction or cessation of electricity deliveries, the SPP Operator shall first confirm that the aforementioned installations/maintenance/investigations are required for the facility to meet electricity deliver requirements to TANESCO's distribution system as outlined in the Power Purchase Agreement (PPA). The SPP Operator shall, prior to initiating any interruption, reduction or cessation of deliveries to TANESCO's distribution system, make every reasonable effort to provide the Controller with a minimum of twenty-four (24) hours advance notice. The notice should include an explanation of the cause of the interruption and an estimate of the interruption's expected start and duration.

5.4 The SPP Operator shall inform and receive approval from the Controller prior to performing any operations that require disconnecting or reconnecting to TANESCO's distribution system.

5.5 Upon connecting/disconnecting, the SPP Operator shall record the time and date of the operation and submit a corresponding report to the Controller.

The overall operating procedures for delivery interruptions and scheduled outages of SPP generating facilities operating under normal conditions are shown in Fig.4.

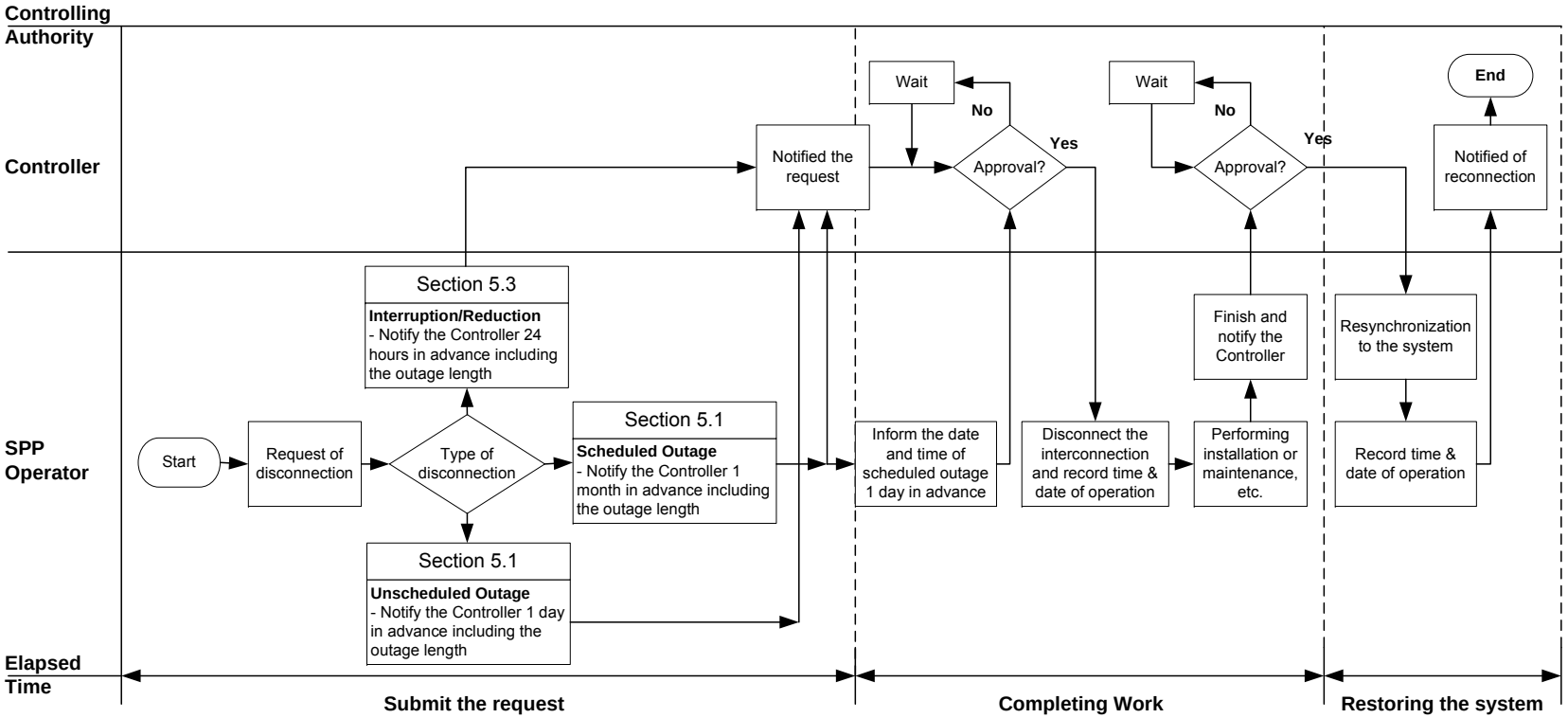



Fig.4: Flowchart of operating procedure for interruption of delivery and scheduled outages of SPP generating facility under normal condition

## 6. Operating Procedures when the SPP Facility is Requested to Disconnect from TANESCO's Distribution System for Maintenance

6.1 Upon receiving TANESCO's Request for Isolation from the PIW, the Controller shall provide a minimum of three (3) days advance written notification of the maintenance outage schedule to the SPP Operator. This three (3) day notification window does not apply to emergencies when an immediate threat is posed to personnel or TANESCO property, in which case the TANESCO Operator may immediately shutdown the system and notify the SPP Operator thereafter accordingly.

6.2 If, for any reason, TANESCO shall cancel or amend the maintenance outage/operation schedule, the Controller shall provide at least one (1) day advance written notification to the SPP Operator.

6.3 On the scheduled date of the maintenance outage, the Controller will request the SPP Operator to disconnect their generating facility from the grid, at which point the procedures will proceed in accordance with the Operation Practice Item 4.2: "Isolation of Apparatus for work" and Item 5: "Isolation and Earthing of Apparatus for work".

6.4 Upon completing the scheduled maintenance activity, (refer to: 4.7 "Reconnection of Apparatus"), the TANESCO Operator may re-energize the circuit, at which point the Controller will update the SPP Operator accordingly.

6.5 After TANESCO has re-energized the circuit, the SPP Operator will submit a request to the Controller for resynchronization. Upon receiving the Controller's permission/approval, the SPP Operator may thereafter perform the necessary operations to reconnect to the grid.

6.6 Upon reconnecting to the grid, the SPP Operator should record the time and date of the interconnection and submit a corresponding report to the Controller.

The overall operating procedures for when SPP facilities request to be disconnected from TANESCO's distribution system for maintenance are shown in Fig.5.

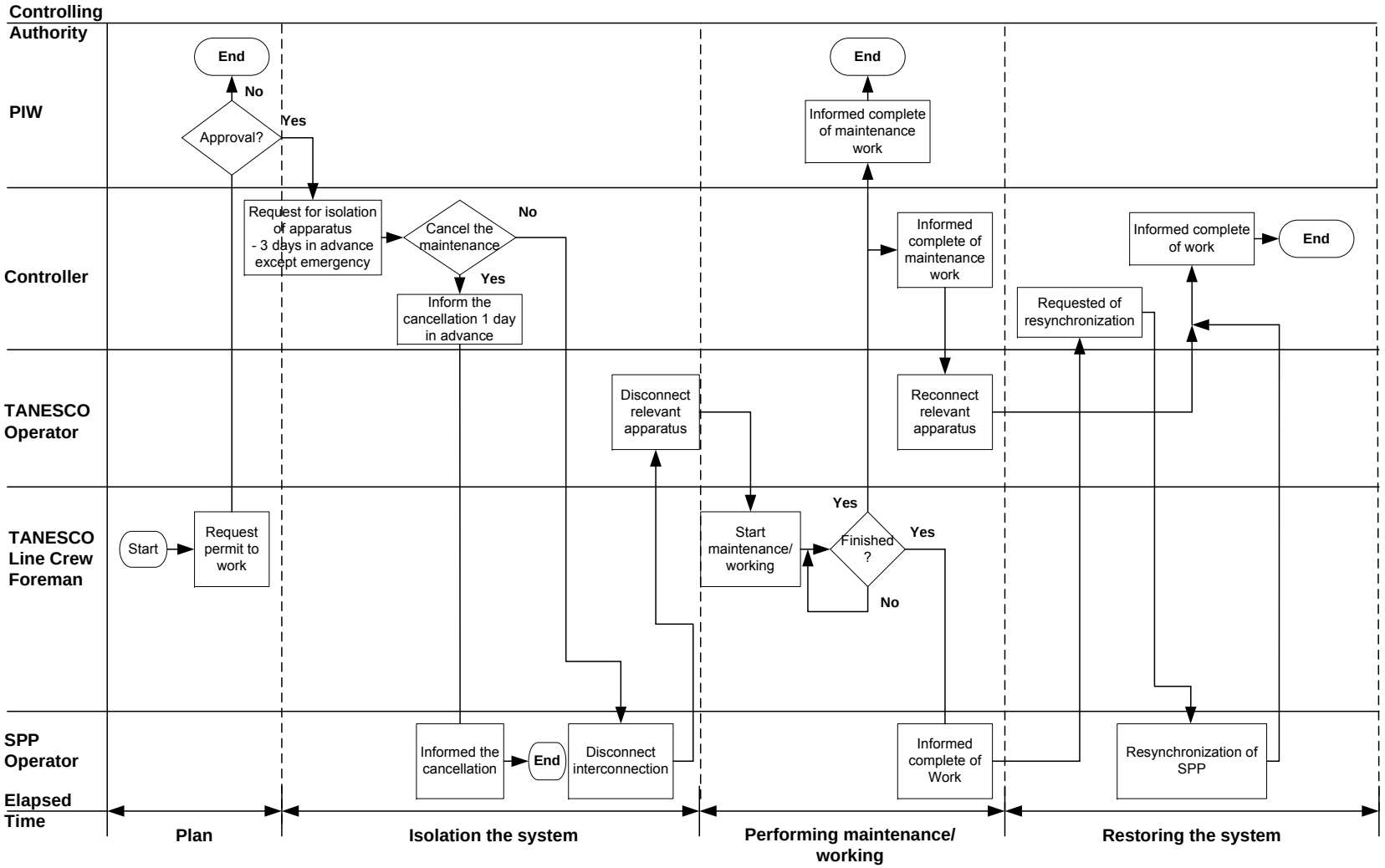



Fig.5: Flowchart of operating procedures when the SPP facility is requested to disconnect from TANESCO's distribution system for maintenance

## 7. Operating Procedures when a Significant Incident Occurs in TANESCO's Distribution System

7.1 When an abnormal condition such as a fault occurs in the system, TANESCO's protective devices will automatically disconnect the faulted circuit as shown in Fig.6. As a result, the SPP's protection system will also disconnect the SPP facility from the grid. The SPP disconnection, however shall be completed before the automatic reclosing operation of TANESCO's control system. If a permanent fault occurs, the Controller shall request the SPP Operator to inspect the operation of the protective device at the interconnection point to ensure that the SPP facility is disconnected. If the automatic protection devices do not activate, the circuit shall be manually disconnected from the grid. Furthermore, the SPP protection system shall be regularly inspected and the Controller informed in accordance with the procedures outlined in Operation Practice Item 7: "Operational Procedure for Fault Switching" and Item 8: "General Procedure".

7.2 If TANESCO can, based on the procedures in the Operation Practice Item 7: "Operational Procedure for Fault Switching" and Item 8: "General Procedure", repair the fault within 15 minutes, the circuit can be re-energized immediately. If, however, the repair time exceeds 15 minutes, the Controller shall inform the SPP Operator before re-energizing the circuit.

7.3 After TANESCO re-energizes the line, the Controller shall notify the SPP Operator of the time of operation accordingly.

7.4 Before the SPP reconnects to the grid, the SPP Operator shall first notify and receive approval from the Controller. SPP facilities with Automatic Reconnection control systems, e.g. Photovoltaic (PV) or Wind Farms that have pre-existing exemption agreements with TANESCO, are not required to notify and receive the Controller's permission before reconnecting to the grid. SPP facilities shall therefore be capable of performing two (2) important functions: 1) Block closing while de-energizing; and 2) Anti-Islanding.

Note: *Automatic Reconnection to TANESCO's distribution system is prohibited if the voltage and frequency of any phases are outside the operating ranges for a period of longer than 15 minutes.*

7.5 Once the SPP is reconnected to the grid, the SPP Operator should record the time and date of the interconnection and submit a corresponding report to the Controller.

7.6 Protection System Verification

Both the Controller and SPP Operator shall conduct regular inspections of their respective protection systems to ensure that the systems are working properly. If the system is not functioning properly, immediate measures shall be taken to remedy the problem and restore normal operation.

In instances when the Controller or SPP Operator identifies a problem originating from the other party, a joint meeting should be held to remedy the problem. The Controller, TANESCO Operator, Regional Officer, Protection Engineer, and SPP Operator should attend the meeting. A copy of the meeting's minutes shall be submitted to the TANESCO SPP Cell in order to prevent the problem(s) from occurring with other SPPs.

## 8. Operating Procedures when a Significant Incident Occurs within SPP's Distribution System

8.1 When abnormal conditions occur in the SPP's distribution system, the SPP's protection system will be activated and the generating facility will be disconnected from the grid as shown in Fig.6. The SPP Operator shall then investigate the incident and submit a report to the Controller accordingly.

8.2 After fixing the problem, the SPP Operator shall inform and receive approval from the Controller before reconnecting to the grid.

8.3 Once the SPP is reconnected to the grid, the SPP Operator shall record the time and date of interconnection and submit a report to the Controller accordingly.

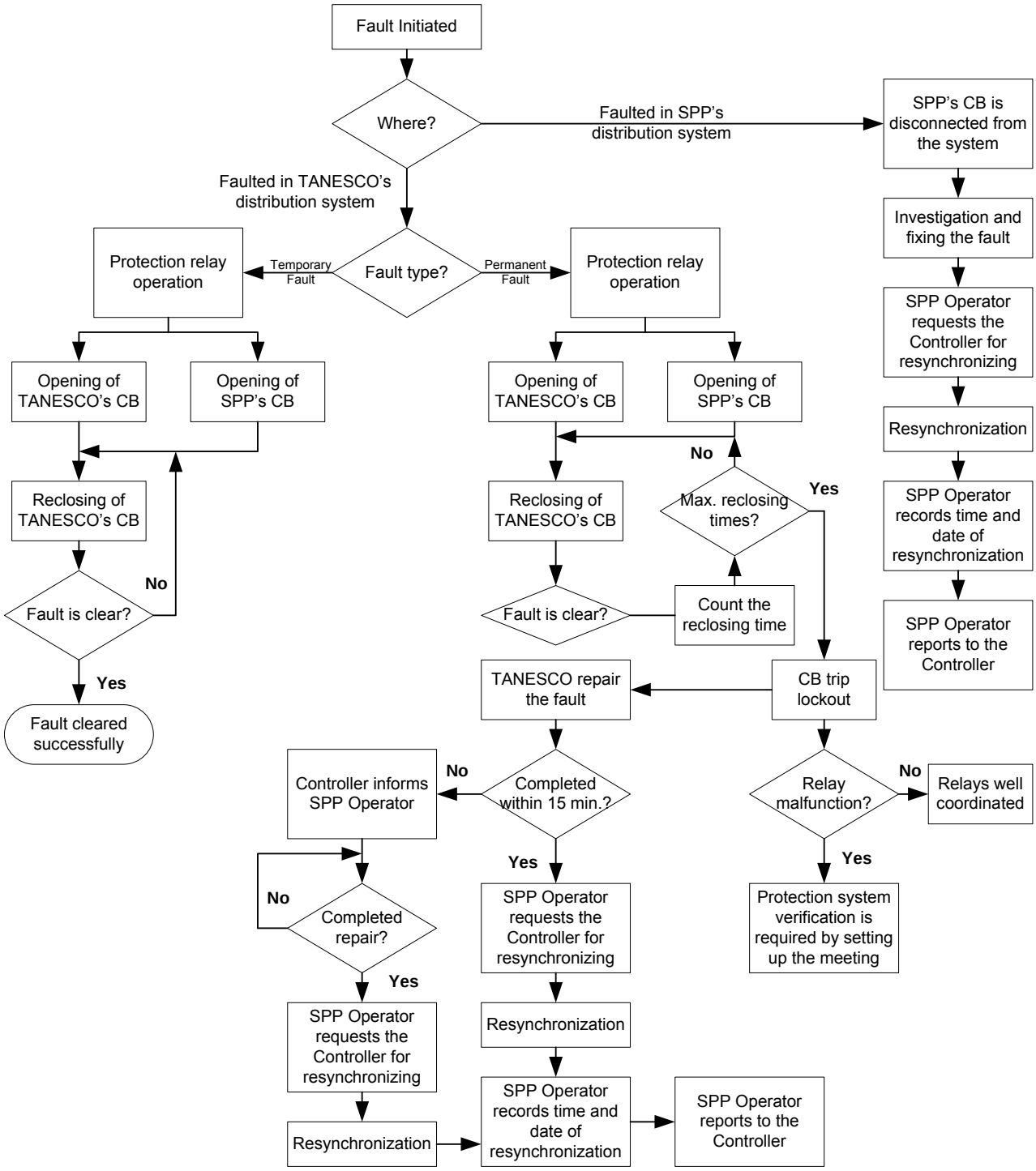



Fig.6: Flowchart of operating procedures when a significant incident occurs within the TANESCO's distribution system or SPP's distribution system.

## 9. Operation of Embedded Generator in Islanding Mode

Under normal operating conditions, the SPP's generating facility should not energize TANESCO's Distribution System when the system is de-energized. For this reason, the installation of anti-islanding detection and protection systems is required. If a part of the TANESCO distribution system that contains an SPP interconnection becomes isolated, the operator at the substation shall decide whether or not to temporarily suspend the SPP's operation.

In general, the option to temporarily autonomous SPP operation is allowed only in cases of intentional islanding, which require a pre-study that includes clear procedures for the intentional islanding to be conducted beforehand. SPP intentional islanding operations may also be conducted in cases where such operations have been successfully conducted in the past.

Note: *Only SPPs equipped with the specific types of generators and generator controls can operate under such conditions.*

Although intentional islanding may help improve system reliability and mitigate outage problems, improperly implemented anti-islanding procedures pose a risk to personnel and can damage TANESCO and SPP Facility assets. The implementation procedures outlined below takes these risks into consideration.

### 9.1 Transition from Grid-Connected to Islanding Mode

(1) Before energizing the circuit in an Intentional Islanding mode, a pre-study shall be undertaken that addresses best practices as well as the appropriate sequence of operations. This pre-study should be jointly conducted by the SPP Operator, the Controller and the TANESCO Operator;

(2) If the TANESCO Main Grid is de-energized for any reason and an Intentional Islanding operation is planned, as mentioned in item 9.1(1), the TANESCO Operator shall disconnect the circuit breaker of the relevant outgoing feeders and post a Warning Tag to prohibit the operation of any devices (e.g. relevant outgoing feeder circuit breaker) that display the active status of the Intentional Islanding operation;

(3) All workers shall be notified of the areas within the SPP facility and the TANESCO distribution system that will be impacted as a result of the Intentional Islanding mode.

### 9.2 Power Quality and Outage Management during Islanding Mode

(1) If any TANESCO customer complaints regarding power quality are received, TANESCO may choose to examine and/or immediately cancel the SPP's continued operation in Intentional Islanding mode. An appropriate solution to the problem (e.g. load shedding) should thereafter be determined to balance the load demand and the quantity of electricity generated by the SPP.

(2) If any customer complaints are received following a short circuit in the Intentionally Islanded grid, the TANESCO Operator shall examine whether or not the SPP facility's protection system was used to disconnect the SPP facility from the grid. The status of the SPP protection system should be determined before sending a crew to conduct additional investigations. The Controller as well as the SPP and TANESCO Operators shall communicate with one another to confirm that the SPP is disconnected from the grid after any short circuit in the Islanded Grid. TANESCO's Line Crew Foreman will inform the TANESCO Operator and the Controller once the fault has been repaired. Upon receiving notification from the Controller, the SPP Operator may re-energize the circuit in Intentional Islanding condition.

### 9.3 Resynchronization from Islanding to Grid-Connected Mode

Resynchronization is permitted once the Main Grid has been restored for at least fifteen (15) minutes. The TANESCO Operator shall instruct the SPP facility to disconnect its generating facility from the Main Grid before the island grid is reconnected to the main distribution system. Once the circuit is re-energized, the Warning Tag may be removed. The Controller should then issue a request to the SPP Operator to resynchronize its generation system with the main grid.

## 10. Synchronization

10.1 SPP generating facilities capable of independently generating voltage while disconnected from TANESCO's distribution system require proper synchronization facilities and equipment before reconnection to the grid is permitted.

10.2 Interconnection is prohibited if the SPP facility and/or TANESCO's distribution system are operating outside the limits specified in Item 10.3.

10.3 Synchronous, self-excited induction and inverter-based generators that produce fundamental voltage may operate in parallel with TANESCO's distribution system only when the frequency, voltage and phase angle differences are within the ranges specified in Table 1 at the moment of synchronization.

10.4 For synchronous generators, an approved automatic synchronization device is required if the plant is unattended (IEEE device number 25) to ensure that the SPP generating facility will not connect to an energized feeder without synchronizing first.

10.5 Separate synchronization facilities (e.g. IEEE device 25) are not a necessary requirement for a paralleling device of induction generators and inverter-based generators that do not produce fundamental voltage, and double-fed generators whose excitation is precisely controlled by power electronics to produce a voltage with a magnitude, phase angle and frequency that match those of TANESCO' distribution system.

Table 1: Resynchronization Requirements according to IEEE 1547 [3]

| Aggregate Rating of Generators (kVA) | Frequency Difference ($\Delta$f, Hz) | Voltage Difference ($\Delta$V, %) | Phase Angle Difference ($\Delta\theta$, $^\circ$) |
|---|---|---|---|
| 0-500 | 0.3 | 10 | 20 |
| > 500 – 1500 | 0.2 | 5 | 15 |
| > 1500 | 0.1 | 3 | 10 |

## 11. Frequency, Voltage and Power Factor Control

11.1 The SPP generating facility (synchronous and permanent magnet generators) should remain synchronized with TANESCO's distribution system while operating in parallel. If any abnormal conditions occur in TANESCO's distribution system, e.g. the system frequency moves out of the specified 48-51.5 Hz range for more than 0.5s, the SPP protection system shall automatically and immediately engage to disconnect the SPP generating facility from the grid.

11.2 The SPP is responsible for controlling the voltage magnitude and power factor at the power purchase connection point in accordance with the values specified in the SPPA.

## 12. SPP Monitoring and Reporting

### 12.1 General Requirements

12.1.1 The SPP Operator shall keep a written or electronic log that includes the date and time of any incidents (see Item 12.1.4. below) accompanied by a description of the incident.

12.1.2 The names of all data files should contain the date and time in accordance with IEEE Standard C37.232 - Recommended Practice for Naming Time Sequence Data Files.

12.1.3 The SPP Operator shall make the log, or a copy of the log, available for TANESCO's review within five (5) working days of receiving a request from TANESCO.

12.1.4 SPP facilities with an installed capacity exceeding 1 MW shall monitor and record the following data every 15 minutes:

a) Phase Voltages;

b) Frequency;

c) Phase Amperes;

d) Active Power (kW or MW);

e) Reactive Power (kVAr or MVAr);

f) Status of switching devices that are part of the protection and control scheme; and

g) Alarm conditions.

**12.2 Sequence of Event Reporting**

The Sequence of Event reporting for SPPs with an installed capacity exceeding 1 MW shall include the following information:

(a) The generator connection status (individual units);

(b) The Inter-trip or Transfer Trip signal status (if applicable);

(c) List of operated relays (including targets & description) and Annunciator display;

(d) All available Sequence of Events Records (SER) related to the above;

(e) SER for switching devices that are part of the protection and control scheme;

(f) Any changes in the values of Active Power (MW), Reactive Power (MVAR) Voltage and Frequency during the incident;

(g) The primary or suspect cause of the incident as well as any damage incurred (if any);

(h) The anticipated date when the SPP facility will be ready to reconnect to the grid; and

(i) The prevailing weather conditions at the time of the incident.

### 12.3 Monthly/Annual Summary of Operation Information

According to the "Draft of SPP Developer Guidelines for Grid Interconnection of Small Power Projects in Tanzania: Part A" [4], the SPP shall provide the following information to TANESCO on an annual basis for as long as the SPPA remains active. The information will be collected in a database that will assist TANESCO in planning system operations. The SPP Operator should, unless specified below, provide the following information to TANESCO at the end of each year of operation:

(a) Net energy export to TANESCO in kWh;

(b) Maximum and minimum net power export in kW;

(c) List of outages, to include dates, times, durations, probable cause (e.g. external or internal) and damages incurred (if any);

(d) Any planned outages (purpose, date, duration) for the twelve (12) calendar months ahead;

(e) Expected date of reconnection for any long-term outages, whether it was a partial or total outage; and

(f) Purchase of backup power in kWh.

In addition to the information above, the SPP is also required to provide an annual operations forecast, the details of which are addressed in the SPPA.

SPP facilities with an installed capacity exceeding 3 MW are required to provide relevant operational information on a monthly basis, within a month from the last day of each calendar month. SPPs with an installed capacity equal to or less than 3 MW are required to provide operational information on an annual basis, within one month from the end of the calendar year.

Note: *SPPs* should *submit the abovementioned operational information directly to the SPP Cell. The SPP Cell is responsible for collecting all operational reports from SPPs and tracking the number of applications pending/processed. This information should be formulated into an executive summary on a quarterly basis.*

## 13. Billing and Settlement

The Billing and Settlement procedures include numerous steps. These steps begin with the specification of a Commercial Operation Date (COD) when the SPP begins formally selling electricity to TANESCO. Once sales commence, the information from the SPP's meter shall

be submitted to all relevant parties on a monthly basis. The electricity purchased from each SPP should be calculated and settled each month according to the procedures outlined in Fig. 7.

Note: *The SPP Cell is responsible for informing SPPs, the TANESCO Regional Officer and the TANESCO Finance Department of any changes to the electricity power purchase rate for SPPs.*

The SPP Billing and Settlement Procedures are outlined below.

### 13.1 Commercial Operating Date (COD)

Once the First Synchronization is complete, the SPP will inform the SPP Cell that it is ready to commence electricity sales to TANESCO.

13.1.1 The SPP Cell will, upon receiving notification from the SPP, arrange a meeting with the TANESCO Regional Officer, the TANESCO Operation Center and the SPP Operator to specify the specific date when electricity sales will commence. During this meeting, the officers from the TANESCO Regional Office and the SPP that will be responsible for meter reading/recording should be nominated. This step shall be completed within 30 days from the date specified in Item 13.1.1.

13.1.2 On the first date of electricity sales – or the COD - the TANESCO Regional Officer shall record the initial value on the electricity meter installed at the SPP facility. This value will be used to calculate the initial quantity of electricity that the SPP sells to the TANESCO grid. These values should be recorded in Form-A1.

Note: *A copy of Form-A1 should be submitted to the TANESCO's Finance Department before the 5$^{th}$ day of the proceeding calendar month.*

### 13.2 Meter Reading and Information Submission

Meter reading officers from TANESCO's Regional Office and the SPP should record the value of electricity sales from the meter on the first date of each month. The value should be recorded on Form-A1. Four (4) copies should be made of this form by TANESCO's Regional Office, one of which will be retained by the designated officer from the TANESCO Regional Office. The TANESCO Regional Office will then submit the remaining three (3) copies of Form-A1 (one each) to the SPP Operator, SPP Cell and the TANESCO Finance Department.

### 13.3 Calculation of SPP Monthly Energy Charge

13.3.1 The SPP is responsible for calculating the monthly energy sales based on the SPPA using Form-A2.

13.3.2 The SPP shall submit Form-A2 accompanied with a copy of the Interconnection Certificate to the TANESCO Finance Department for verification. The SPP is also required to submit a copy of Form-A2 to the SPP Cell and TANESCO Regional Office.

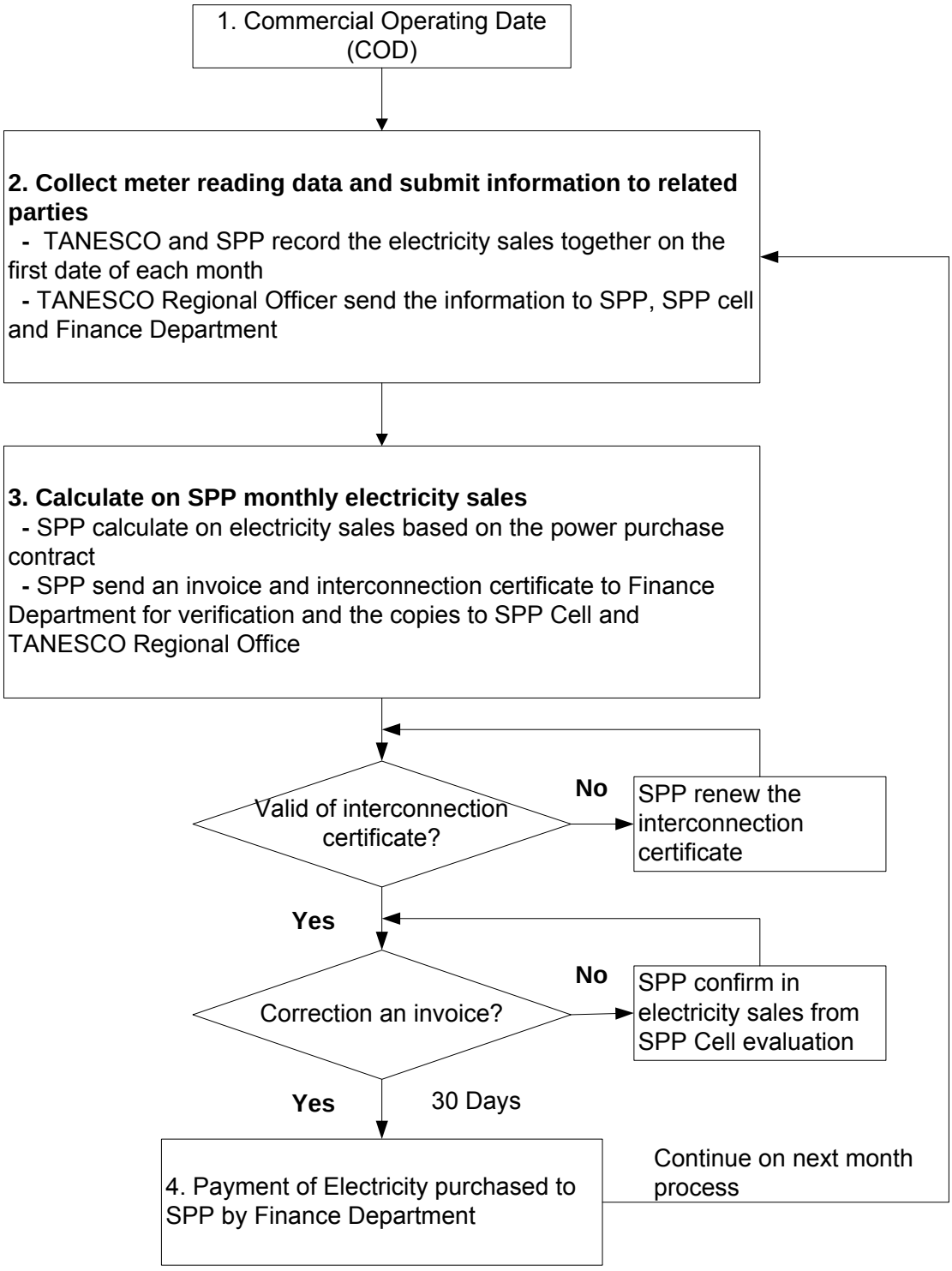



Fig. 7: Flow Chart of SPP Billing and Settlement Procedure

### 13.4 Payment of Electricity purchased from SPP

13.4.1 Upon receiving Form A-2, the TANESCO Finance Department will examine the SPP's invoice together with the Interconnection Certificate. Payment will be made to the SPP upon verification of the invoice's accuracy and the validity of the Interconnection Certificate. If the invoice is incorrect, the TANESCO Finance Department will notify the SPP and, in cooperation with the SPP, adjust the invoice accordingly. Payment will be issued via a cashier's check or cash within thirty (30) days of receiving the correct invoice.

13.4.2 If the Interconnection Certificate has expired, TANESCO will issue a notification to the SPP that it shall renew the certificate within three (3) months. The invoices presented by the SPP will be paid during the three (3) months window after the SPP is notified. Invoices will not be processed if the SPP fails to renew the Interconnection Certificate after this three (3) month grace period.

## 14. Renewal of Interconnection Certification

According to the Electricity Act (Cap 131), The Electricity (Development of Small Power Projects) Rules [5], an interconnection certificate is valid for three (3) years. In order for an SPP to renew its Interconnection Certificate, TANESCO shall witness functional trip tests, as outlined in the SPP Developer Guidelines for Grid Interconnection of Small Power Projects in Tanzania: Part A [4]. The SPP shall also provide TANESCO with at least thirty (30) days advance notice of the scheduled trip test and allow TANESCO personnel to witness the test. TANESCO also has the right to request that all protective devices and metering equipment be field tested and calibrated by qualified personnel every three years, and that written copies of the results be provided to TANESCO.

## 15. Bibliography

[1] TANESCO, "Manual on Operations Practices", Feb 1997.
[2] Ministry of Energy and Minerals, "Standardized Power Purchase Agreement for Purchase of Grid-Connected Capacity and Associated Electric Energy", June 2009.
[3] IEEE 1547, "Standard for Interconnecting Distributed Resources with Electric Power Systems", 2003.
[4] Energy and Water Utilities Regulatory Authority (EWURA), "Draft of SPP Developer Guidelines for Grid Interconnection of Small Power Projects in Tanzania: Part A", Mar. 2009.
[5] Energy and Water Utilities Regulatory Authority (EWURA), "The Electricity Act (Cap 131), The Electricity (Development of Small Power Projects) Rules", 2010.

# APPENDIX I

## Templates for Internal Communication within TANESCO and External Communication between TANESCO and SPP Developer

# APPENDIX 1A

## Form 1A: Acknowledgement of Receipt of SPP Application for Electricity Sales

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Application to sell electricity to TANESCO

Reference is made to your letter dated ……on the above subject.

We are pleased to inform you that we have received your application to sell electricity to TANESCO. We will review all the documents you submitted and get back to you within 14 days if additional documents are required.

Best regards,

For: TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 1B

## Form 1B: Site Reference Number

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Site Reference Number

Please refer to your initial application dated……regarding your intention to develop a SPP project and sell electricity to TANESCO.

We are pleased to confirm receipt of your completed application. At this stage, we would like to inform you of your site reference number for the project.

Please include this site reference number in all future communications regarding this project with TANESCO and related government agencies.

Your site reference number is …….

Best regards,

For TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 2A

## Form 2A: TANESCO Mini Grid, Checking for Duplication with TANESCO Rural Electrification and Distribution Extension Projects

**TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

| | |
|---|---|
| **From:** Senior Manager Strategic Planning and Projects | **To:** Senior Manager Distribution, Manager Projects |
| **Ref:** SMSPP/MSP/SPPA/ | **Date:** |

**RE:** SPP application to sell electricity to TANESCO Mini Grid

**Subject:** TANESCO Mini Grid project

An SPP Developer located at …… has submitted an application to sell electricity to the TANESCO Mini Grid at ……

With regard to this requested connection, would you kindly check if there are any rural electrification projects or distribution extension projects being planned to extend TANESCO's distribution system to that TANESCO Mini Grid?

If there are any projects planned for this area, please specify the anticipated month and year that the Mini Grid in question will be connected to TANESCO's Main Grid.

Your cooperation is sincerely appreciated.

Senior Manager Strategic Planning and Project

# APPENDIX 2B

## Form 2B: Notification of Results of Duplication Checking with TANESCO Projects for SPP Developer Requesting Connection to TANESCO's Mini Grid

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Duplication checking of the proposed SPP connection to TANESCO Mini Grid

Reference is made to your letter dated ……..regarding your interest in developing an SPP project to sell electricity to TANESCO's Mini Grid at ……

We have cross-checked the TANESCO Mini Grid at…… with all of TANESCO's pre-existing and planned distribution projects. It is anticipated that this Mini Grid will be connected to TANESCO's Main Grid by …..... (Note: This date is an approximate estimation and is subject to change).

As per TANESCO regulations, once the Mini Grid is connected to TANESCO's Main Grid, the SPPA for Mini Grid connection will be terminated and replaced by a new SPPA for Main Grid connections.

We hope that this information will be useful for you in deciding whether or not to proceed with the proposed project and encourage you to contact us with any questions you may have.

Best regards

For TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 2C

## Form 2C: Notification of Requirement for SPP Connected to Mini Grid to Formalize a New SPPA for Main Grid Connection

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Request for new SPPA for Main Grid Connection to replace SPPA for Mini Grid Connection

Reference is made to the SPPA number…… dated …….regarding your SPP facility that is currently connected to TANESCO's Mini grid at……..

We would like to inform you that the TANESCO Mini Grid to which you are connected will be formally connected to TANESCO's Main Grid in ……...(MONTH/YEAR).

As per TANESCO regulations, the arrival of the main grid will result in the automatic termination of your current SPPA for connection to TANESCO's Mini Grid.

With respect to the pending termination of your current SPPA, we kindly request that you submit an application for a new SPPA for a main grid interconnection at your earliest convenience.

Your prompt submission of this application will allow us to formalize the new SPPA before the current SPPA's termination.

Best regards,

For TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 3A

## Form 3A: SPP First Site Visit

**TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

| | |
|---|---|
| **From:** Senior Manager Strategic Planning and Projects | **To:** Senior Manager System Control and Transmission, Regional Manager of …… |
| **Ref:** SMSPP/MSP/SPPA/ | **Date:** |

**RE:** First site visit to SPP project location

**Subject:** SPP project name

The SPP located at …….has submitted an application to up-sell …… MW of electricity to TANESCO's distribution grid at a connection point in…….

With regard to this requested connection, we would like to invite a TANESCO Protection Engineer / Regional Office Engineer to survey the visit together with SPP Engineer, Mr.…… on ……..

The purpose of this visit is to evaluate the maximum power export capacity at the proposed location, and determine whether there are any conflicts between the proposed project and other on-going privately-owned or TANESCO projects.

Please find a map of the proposed SPP project's location attached hereto.

Your cooperation is sincerely appreciated.

Senior Manager Strategic Planning and Projects

# APPENDIX 3B

## Form 3B: Letter of Intent

Date:

SMSPP/MSP/SPPA

SPP Developer (*Name and Address*):

Embedded Generating Plant (*Name and Address*):

Site Reference Number:

## Letter of Intent

This refers to your Initial Application dated [*date of initial application*], expressing your desire to develop the Embedded Generating Plant described above. The proposed Embedded Generating Plant has been allocated **the Site Reference Number** shown above, which should be used in all future correspondence with TANESCO and documentation about the Plant.

Details of the Embedded Generating Plant are the following: [*Location, Province, District, land ownership details, map references and any other information useful to clearly identify the site*]

The primary source of energy of the Embedded Generating Plant**:** *[hydro, wind, biomass (specify the type such as saw dust, rice husk, wood), solar, CHP, etc*]

The Point of Supply (*POS)* location is [ ]

The Point of Common Coupling (*PCC*) location is [ ]

The TANESCO is pleased to inform you that have no objection to purchase electrical energy from the proposed Embedded Generating Plant (*hereafter referred to as "the Plant"*), subject to the Terms and Conditions stated below,

1. The Plant shall be built by [*name of individual or Company*], and shall remain under your ownership until such time the Plant enters Commercial Operation.

2. This Letter of Intent is not transferable, without the written consent of the TANESCO and such consent should be copied to EWURA.

3. If at any time you decide not to proceed with development of the proposed Plant, you shall promptly inform the TANESCO about your decision.

4. The Plant shall be designed, built, commissioned and operated to satisfy the Standards and Requirements determined by the TANESCO.

5. The design, construction, testing, commissioning and operation of the Interconnection of the Plant with our network shall be according to the requirements and procedure specified in the "Guide for Grid Interconnection of Embedded Generators, Tanzania" (hereafter referred to as “the Guide”). A copy of the Guide will be provided to you upon request.

6. The physical location of the Point of Supply, at which TANESCO shall meter and receive the Plant output, is shown in the attached single-line diagram.

7. The physical location of the Point of Common Coupling, beyond which other TANESCO customers may be connected, is also shown in the attached single-line diagram.

8. TANESCO hereby confirms that “its system (including transmission lines, distribution lines, switchgear and protection) is capable to accommodate the power delivered by the SPP Developer”.

   OR “its system (including transmission lines, distribution lines, switchgear and protection) is unable to accommodate the power delivered and therefore you are allowed to meet the costs for upgrading the system”.

9. The TANESCO shall assist you to obtain any rights of way or easements required to build the interconnection facilities, including the transmission line.

10. All equipment and transmission line(s) on the TANESCO side of the Point of Supply shall be maintained by TANESCO.

11. The applicable tariff shall be as stated in Appendix A of the SPPA or as may be determined by EWURA.

12. This Letter of Intent is valid for a period of twelve (12) months (unless extended as stipulated in the Rules published by EWURA), during which period you should submit to the TANESCO the Feasibility Study and an outline plan for the construction of the Plant. You should also provide the TANESCO the information required to proceed with studies required to specify the requirements for the interconnection.

13. A Standardized Small Power Purchase Agreement (SPPA) shall be signed between [*name of individual or Generating Company*] and the TANESCO, within the period of validity of this LOI, as extended by TANESCO.

14. TANESCO reserves the right to examine the detailed designs of the Plant and equipment, and the facilities required for the interconnection with TANESCO network.

15. Commissioning tests of the Plant will be conducted by you, at your expense, and TANESCO shall be notified when such tests are conducted.

16. Commissioning tests of the Interconnection facilities (without actually making an interconnection) shall be conducted by you, at your expense, and TANESCO shall be notified when such tests are conducted, and may attend such tests.

17. Tests on the Interconnection between the Plant and TANESCO network shall be conducted by [*Generating Company*] and witnessed by TANESCO as specified in the Guide. The costs of such tests shall be borne by you.

18. It would be your sole responsibility to obtain all the necessary approvals for the construction of the Plant and Interconnection facilities from the relevant Government [and other] agency.

19. It will be necessary for you to obtain a license from EWURA to generate and sell electricity to the TANESCO prior to commencement of construction of the Plant.

20. Any costs incurred by you in the fulfillment of requirements specified in this letter are at your sole risk and expense, with no claim whatsoever on TANESCO

21. The detailed feasibility report and the plan for construction, including the design details, should be submitted to TANESCO within six (6) months of the date of this LOI.

22. The progress of the project should be reported to TANESCO every three (3) months from the date of this LOI.

Yours truly,

FOR: TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 4A

## Form 4A: Engineering Assessment Fee

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Engineering Assessment

Reference is made to your letter dated ……in which you expressed your intent to sell electricity to TANESCO's grid at….. …….

In order to process your request, TANESCO will need to carry out an engineering assessment to evaluate whether the proposed SPP's interconnection location and power export capacity comply with relevant technical regulations.

The total costs of this engineering assessment is Tshs…….

TANESCO will promptly begin conducting the engineering assessment upon receipt of the aforementioned sum.

Best regards,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# Appendix 4B

## Form 4B: Notify SPP Developer to Perform Engineering Assessment

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Engineering Assessment

Reference is made to your letter dated ……expressing your intention to sell electricity to the TANESCO grid located at….. …….

TANESCO kindly requests that you perform a power flow and short circuit study in order to evaluate whether the power export capacity of the proposed SPP facility complies with TANESCO's technical regulations.

The information on TANESCO's power system that is required to complete these studies can be obtained either at the TANESCO Regional Office or the TANESCO Head Office.

The results of these studies should be submitted to TANESCO to ensure that your SPP application is processed in a timely manner.

Best regards,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 4C

## Form 4C: Notify Regional Office to Estimate System Upgrade Cost

**TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

| | |
|---|---|
| **From:** Senior Manager Strategic Planning and Projects | **To:** Regional Manager of….. |
| **Ref:** SMSPP/MSP/SPPA/ | **Date:** |

**RE:** Initial estimation of power system upgrade costs

**Subject:** SPP project name

This letter is in reference to the proposed SPP project located at……, and the corresponding application to sell a maximum capacity of ……MW of electricity to the TANESCO grid at substation……, feeder number….. .

Note: *The location of the proposed point of connection is shown on the map that is attached hereto.*

We kindly request you to assess whether or not the proposed SPP project will require any upgrades to the existing TANESCO power/distribution system. Please send us the initial estimate of all system upgrading costs and the details of the required upgrades at your earliest convenience so that we may notify the SPP Developer for further processing.

Your cooperation is highly appreciated.

Senior Manager Strategic Planning and Projects

# APPENDIX 4D

## Form 4D: Notify SPP of cost of required TANESCO's Distribution System Upgrades

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Cost of required TANESCO distribution system upgrades

To be able to purchase power from the proposed SPP facility at the maximum capacity, it will be necessary to upgrade TANESCO's distribution. The cost of the required system upgrades for your proposed SPP facility to connect to the TANESCO grid is Tshs ……. The proposed upgrades will ensure that the system is able to receive power exports from the proposed project in a manner that is safe and efficient.

This entire cost for required distribution system upgrade will be borne by the project developer.

Best regards,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 4E

## Form 4E: Notify SPP of Engineering Assessment Result and Cost of required TANESCO's Distribution System Upgrades

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Engineering Assessment results and anticipated costs of required distribution system upgrades

Reference is made to your letter dated …… and the corresponding engineering assessment (EA), i.e. power flow and short circuit study, which were performed by you. We have examined the engineering assessment and are pleased to inform you that the study is satisfactory, and that the proposed SPP project complies with all relevant TANESCO technical regulations.

The cost of the system upgrades required for your proposed SPP facility to connect to the TANESCO grid is Tshs ……. The proposed upgrades to TANESCO's distribution system will ensure that the system is able to receive power exports from the proposed project in a manner that is both safe and efficient.

The entire cost for the required distribution system upgrades will be borne by the project developer.

Best regards,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 4F

## Form 4F: Documents Required for SPPA

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Documents required for SPPA

This letter is in reference to TANESCO's issuance of the LOI dated…… to notify you that we are prepared to begin processing the Standardized Power Purchase Agreement (SPPA) for your signature. In order for us to prepare the SPPA, we will require the following documents, the details of which can be found in the Appendences, Form 3 of the **Electricity (Development of Small Power Projects) Guidelines**, August 2012. Please send us these documents at your earliest convenience:

1. **Information about the Generating Company:** company name; address; phone/fax; and company registration information.
2. **Project Information:** project type (primary energy source); project location; installed generating capacity, export capacity; and expected annual energy dispatch.
3. **Interconnection Information:**
   - 3.1 Single-line Diagram of the grid interconnection as well as proposed setting of all protection relays and switchgear
   - 3.2 For synchronous generators, please provide the following (including items 3.2.2.3-3.2.2.7 and 3.2.3.2-3.2.3.3 for generators above 500 kW in capacity)
     - 3.2.1 Site name, location, site reference number, generating company name, contact, point of supply (location), maximum export capacity, maximum import capacity, power factor operating range
     - 3.2.2 Generator (for each synchronous generator):
       - 3.2.2.1 Terminal Voltage (kV)……
       - 3.2.2.2 Machine rating (MVA)……
       - 3.2.2.3 Stator resistance (pu)……tolerance %
       - 3.2.2.4 Sub-transient reactance (pu)……tolerance %
       - 3.2.2.5 Transient reactance (pu)……..tolerance %
       - 3.2.2.6 Synchronous reactance (pu)……tolerance %

3.2.2.7 Sub-transient time constant (ms)…tolerance (ms)
3.2.2.8 Transient time constant (ms)……tolerance (ms)
3.2.3 Transformer (for each generator transformer):
3.2.3.1 Rating (MVA)……
3.2.3.2 Reactance (pu)……..tolerance %
3.2.3.3 Resistance (pu)…….tolerance %
3.2.3.4 Voltage ratio ……..vector group……..
3.2.4 Cable or line between the generator and Point of Common Coupling where this cabling distance exceeds 50 meters
3.2.4.1 Voltage (V)……..
3.3.4.2 Reactance (Ohm)……Resistance (Ohm)……..

Please note that the company stamp or logo should be affixed to all the documents listed above, which should also be signed by the SPP endorser.

We are looking forward to your continued cooperation in this process.

Best Regards,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 4G

## Form 4G: Draft SPPA Submitted to TANESCO Legal Officer

**TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

| | |
|---|---|
| **From:** Senior Manager Strategic Planning and Projects | **To:** Legal Officer |
| **Ref:** SMSPP/MSP/SPPA/ | **Date:** |

**RE:** Reviewing of the draft SPPA

**Subject:** SPP project name

This letter is in reference to the SPP located at ……., which has applied to sell ……. MW of electricity to TANESCO's distribution system at substation ……..…... feeder number ……

Please find attached hereto the Draft SPPA of the SPP project for your review and comment (if any).

Should you have any questions, please don't hesitant to contact us.

Your cooperation is highly appreciated.

Senior Manager Strategic Planning and Projects

# APPENDIX 5A

## Form 5A: Notify Regional Office to Perform the Detail Design for Upgrading of TANESCO's Distribution System

**TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

| | |
|---|---|
| **From:** Senior Manager Strategic Planning and Projects | **To:** Regional Manager of….. |
| **Ref:** SMSPP/MSP/SPPA/ | **Date:** |

**RE:** Detail design for upgrading of TANESCO power system

**Subject:** SPP project name

This letter is in reference to the SPP located at ……., which has applied to sell ……. MW of electricity to TANESCO's distribution system at substation ……..…... feeder number …… The point of connection is shown on the map attached hereto.

You notified us earlier of the initial investment costs required to upgrade TANESCO's distribution/power system to accommodate the proposed SPP's interconnection to TANESCO's grid. We are now in the process of formalizing the SPPA with the SPP Developer, and kindly request you to formulate detailed designs for the required upgrades to TANESCO's distribution system.

These designs will be used by the SPP Developer to complete their own construction drawings. Your prompt completion of these designs is greatly appreciated, as it will allow the SPP Developer to move forward with relevant project planning and construction processes.

Your cooperation is highly appreciated.

Senior Manager Strategic Planning and Projects

# APPENDIX 5B

## Form 5B: Notify SPP Developer to Implement the Upgrading TANESCO's Distribution System

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Construction work to upgrade the distribution/power systems for the SPP project (name)

In order for the proposed SPP facility to up-sell power to TANESCO's distribution system, it will be necessary to reinforce and upgrade TANESCO's distribution systems, as well as those of the SPP Developer as follows:

1. Distribution system(s) behind the Point of Supply (POS)

As the developer, you are required to submit construction drawings/diagrams of the proposed SPP facility and distribution system to TANESCO's regional office at …….. for approval before construction can begin. The upgrading of assets located behind the POS is the responsibility of the SPP Developer.

2. Distribution system(s) before the POS

All assets before the POS belong to TANESCO. The construction work for the required upgrades to TANESCO's distribution/power system can be undertaken by TANESCO or by a contractor of your choosing. If you would prefer that TANESCO complete the required upgrades, you are requested to pay TANESCO a total of Tshs ……. Payment must be received in full before construction on the required upgrades to the distribution system will commence.

If you prefer to have your own contractor carry out the required distribution system upgrades, we kindly request that you undertake the following steps:

1) Submit all relevant construction drawings/diagrams to the TANESCO Regional Office noted above for examination and approval. Please note that all equipment and technical specifications of the upgrade shall comply with all relevant TANESCO standards.

2) A TANESCO engineer will be on-site to co-supervise construction as well as the commissioning of the required upgrades.

Your prompt response regarding which of the two options you'll be undertaking is greatly appreciated.

Best regards,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 5C

## Form 5C: Notify Regional Office to Construct and Upgrade TANESCO's Distribution System

**TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

| | |
|---|---|
| **From:** Senior Manager Strategic Planning and Projects | **To:** Regional Manager of….. |
| **Ref:** SMSPP/MSP/SPPA/ | **Date:** |

**RE:** Construction and upgrading of TANESCO and SPP Developer's distribution systems

**Subject:** SPP project name

This letter is in reference to the SPP located at ……., which has applied to sell ……. MW of electricity to TANESCO's distribution system at substation ……..…... feeder number …… The point of supply (POS) is shown on the map attached hereto.

The SPP Developer has requested that TANESCO be responsible for the required power and distribution system upgrades to assets belonging to both TANESCO and SPP Developer. The developer has paid TANESCO for the construction costs - both parts and labor – which amount to Tshs ……..

We therefore kindly request that you commence construction to upgrade the distribution systems belonging to the SPP Developer (behind the POS) and the distribution system belonging to TANESCO (before the POS) at your earliest convenience so that we can finalize the SPPA.

The construction drawings and details concerning the required upgrades are attached hereto.

Your cooperation is greatly appreciated.

Best regards,

Senior Manager Strategic Planning and Projects

# APPENDIX 5D

## Form 5D: Notify Regional Office to Co-supervise Distribution System Construction Work

**TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

| | |
|---|---|
| **From:** Senior Manager Strategic Planning and Projects | **To:** Regional Manager of….. |
| **Ref:** SMSPP/MSP/SPPA/ | **Date:** |

**RE:** Construction and upgrading of TANESCO and SPP Developer's distribution systems

**Subject:** SPP project name

This letter is in reference to the SPP located at ……., which has applied to sell ……. MW of electricity to TANESCO's distribution system at substation ……..…... feeder number …… The point of supply (POS) is shown on the map attached hereto.

The SPP Developer recently notified TANESCO that it will take full responsibility for the construction of the required power and distribution system upgrades to assets belonging to both TANESCO (before the POS) and the SPP Developer (behind the POS).

We therefore kindly request that you assign a Regional Engineer to co-supervise the construction of the required upgrades to TANESCO's distribution system with the SPP contractor's supervisor. Please also assign a Regional Engineer to conduct a post-construction inspecting of the upgrades to TANESCO's distribution system to ensure compliance with all relevant TANESCO regulations.

The construction drawings and other technical details are attached hereto.

Your cooperation is greatly appreciated.

Best regards,

Senior Manager Strategic Planning and Projects

# APPENDIX 6A

## Form 6A: Notify System Control and Transmission Department to Examine Interconnection and Protection System

**TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

| | |
|---|---|
| **From:** Senior Manager Strategic Planning and Projects | **To:** Senior Manager System Control and Transmission |
| **Ref:** SMSPP/MSP/SPPA/ | **Date:** |

**RE:** SPP power plant and export of electricity to TANESCO grid

**Subject:** SPP project name

This letter is in reference to the SPP project located at …… with an installed capacity of……MW that, according to the conditions outlined within the SPPA, is planning to export power at a maximum of ….. MW to TANESCO's Main Grid.

Please find the documents regarding the SPP project attached hereto for your review and comments. The main documents comprise electrical drawings/diagrams of the proposed interconnection arrangements that need to be inspected by your protection engineers to ensure the proposed designs comply with the grid system protection requirements.

We therefore kindly request that you review these diagrams at your earliest convenience so that we can conclude the SPPA.

Your cooperation is greatly appreciated.

Best regards,

Senior Manager Strategic Planning and Projects

# APPENDIX 6B

## Form 6B: SPP Interconnection and Relay Setting Test Charge

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: SPP Interconnection and Relay Setting Test Charge

Please refer to the SPPA number……dated…….. You are hereby requested to pay TANESCO a total of Tshs ……

This sum includes the cost of interconnection and protection system testing, travel allowance for TANESCO staff, as well as all required transportation to and from the project site.

The job will be undertaken upon receipt of payment.

Best regards,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 7A

## Form 7A: Notify SPP Developer to Select Meter Installation Options

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Meter installation

This letter is in reference to the SPPA number…….., dated …….

In order to prepare for the commissioning of your SPP facility, you are required to install a three phases AMR meter to measure electricity sold to TANESCO. You have two options regarding meter installation:

1. You may purchase the meter directly from TANESCO. The cost of the meter includes installation and commissioning, which will be undertaken by TANESCO.

2. You may independently purchase an alternative meter that complies with TANESCO specifications. TANESCO will, however, remain responsible for meter installation, calibration and commissioning, the costs of which will be passed through to you.

Please inform us of which option you prefer at your earliest convenience so we can begin making arrangements accordingly.

Best regards,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 7B

## Form 7B: Notify Large Power Division to Estimate All Metering Systems Cost for SPP Developer

**TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

| | |
|---|---|
| **From:** Senior Manager Strategic Planning and Projects | **To:** Manager Large Power |
| **Ref:** SMSPP/MSP/SPPA/ | **Date:** |

**RE:** Metering system cost estimation

**Subject:** SPP project name

This letter is in reference to the SPP project located at …… with an installed capacity of……MW that has plans to export power at a maximum of ….. MW to TANESCO's main grid at substation……. feeder number…under the SPPA number ……., dated ……..

In accordance with the successful testing and commissioning of the abovementioned SPP's interconnection facilities, you are hereby requested to provide us with an estimation of project metering system costs, i.e. the price of the electricity meter as well as any charges for meter installation and commissioning. We will notify the SPP Developer of these costs accordingly.

Please provide us with this information as early as possible so that we can continue moving forward with the project. We will inform you of the SPP developer's decision regarding project metering as soon as possible.

Please find the map of the SPP project's location attached hereto.

Your cooperation is greatly appreciated.

Best regards,

Senior Manager Strategic Planning and Projects

# APPENDIX 7C

## Form 7C: Notify SPP Developer of Anticipated Meter Installation Costs (Meter Provided by TANESCO)

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Costs associated with meter installation

This letter is in reference to your letter dated…….., in which you informed us of your decision to allow TANESCO to provide and install the three phases AMR meter that will be used to measure electricity sold to TANESCO.

The total costs of the three phases AMR meter, meter installation and commissioning is Tshs……. The entirety of this cost will be borne by the project developer.

TANESCO will install, calibrate and commission the meter upon receipt of the aforementioned sum.

Best regards,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 7D

## Form 7D: Notify Large Power Division to Estimate Meter Calibration, Installation and Commissioning Cost to SPP Developer

**TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

| | |
|---|---|
| **From:** Senior Manager Strategic Planning and Projects | **To:** Manager Large Power |
| **Ref:** SMSPP/MSP/SPPA/ | **Date:** |

**RE:** Estimation of installation, calibration and commissioning cost of metering equipment

**Subject:** SPP project name

This letter is in reference to the SPP project located at …… with an installed capacity of……MW that has plans to export power at a maximum of ….. MW to TANESCO's grid at substation ……. feeder number … under the SPPA number……., dated ……..

Testing and commissioning of the abovementioned SPP's interconnection facilities has been completed. You are hereby requested to provide us with an estimate of meter installation, calibration and commissioning costs (excluding the cost of the electric meter). We will notify the SPP Developer of these costs accordingly.

Please inform us as early as possible once the metering equipment is installed and commissioned in order to commence power purchases from the SPP.

Please find the map of the SPP project's location attached hereto.

Your cooperation is greatly appreciated.

Best regards,

Senior Manager Strategic Planning and Projects

# APPENDIX 7E

## Form 7E: Notify SPP Developer of Anticipated Cost to Meter Installation (Meter Provided by SPP Developer)

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Cost associated with meter installation

This letter is in reference to your letter dated…….., in which you informed us that you will independently purchase a three phases AMR meter that complies with TANESCO specifications in order to measure electricity sold to TANESCO.

TANESCO will remain responsible for meter installation, calibration and commissioning, the total cost of which is Tshs…… This cost will be borne by the project developer.

TANESCO will install the meter upon receipt of the aforementioned sum.

Best regards,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 8A

## Form 8A: Notify SPP Developer to Submit EWURA License

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: EWURA License

Following the successful testing and commissioning of the interconnection facilities and metering system at the project site, you are requested to submit to us the EWURA license for Grid-interconnected SPPs with an installed capacity of greater than 1 MW (or the EWURA registration for SPP facility's with an installed capacity less than 1 MW) as soon as possible in order to commence power deliveries to TANESCO's grid.

Your continued cooperation is greatly appreciated.

Best regards,

For TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 8B

## Form 8B: Issuing of Interconnection Certificate and Related Documents

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Interconnection Certificate

This letter is in reference to your application for an Interconnection Certificate and electricity sales for the SPPA number ……. dated ……..,

We are pleased to inform you that your application has been processed and approved. Your Interconnection Certificate is attached hereto.

We appreciate your continued cooperation.

Best regards,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

## Interconnection Certificate Form

## Interconnection Certificate

**Issued on:** **Valid from: [date of Test Record]**
**Until: [date three years from Test Record]**
**Seller Name and Address:**
**Embedded Generating Plant Name and Address:**
**Site Reference Number:**

This is to certify that upon a request made by the Seller, the TANESCO ELECTRIC SUPPLY COMPANY LIMITED ("TANESCO") has conducted the necessary inspection and testing of the interconnection of [name of embedded generating plant], to the DNO network, on [INSERT DATE].

The TANESCO is satisfied that [embedded generating plant] complies with the mandatory requirements specified in the "Guide for Grid Interconnection of Embedded Generating Plants in Tanzania" [dated (INSERT DATE OF GUIDE)].

The **Embedded Generator Test Record** is attached. Exemptions, waivers or conditions allowed by the TANESCO are listed below.

1.

2.

(Signed by Managing Director of TANESCO or Authorized Nominee)

The originals of this Interconnection Certificate and the attachment are retained at [Seller's name and address or Embedded Generating Plant name and address]

Yours truly,

FOR: TANESCO ELECTRIC SUPPLY COMPANY LIMITED

MANAGER DIRECTOR

# APPENDIX 9A

## Form 9A: SPP Mini Grid, Checking for Duplication with Rural Electrification and Distribution Extension Project

**TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

| | |
|---|---|
| **From:** Senior Manager Strategic Planning and Projects | **To:** Senior Manager Distribution, Manager Projects |
| **Ref:** SMSPP/MSP/SPPA/ | **Date:** |

**RE:** SPP application to sell electricity to a Mini Grid

**Subject:** SPP Mini Grid project

The SPP Developer located at …… has submitted an application to sell electricity to a community at …….. , which is serviced by a Mini Grid.

With regard to the proposed connection, would you kindly check if there is any rural electrification or distribution extension projects currently being planned by TANESCO that would extend TANESCO's Main Grid to that community?

If yes, please specify the month and year of the anticipated connection date to TANESCO's Main Grid, as we are required to inform the SPP Developer and REA of any duplication of this SPP Mini Grid proposal and other TANESCO projects.

Your cooperation is greatly appreciated.

Best regards,

Senior Manager Strategic Planning and Project

# APPENDIX 9B

## Form 9B: Notify SPP Developer the Result of Duplication Checking with TANESCO Project

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Results of Duplication checking of the proposed SPP Mini Grid with TANESCO's distribution system

This letter is in reference to your letter dated …….. expressing your intention to develop an SPP isolated Mini Grid.

After cross-checking the area of your proposed SPP Mini Grid with all existing and prospective TANESCO grid expansion projects, we found that the proposed project area will be connected to TANESCO's Main Grid by …..(month and year).

We hope that this information will be useful to you in deciding whether or not to proceed with the project.

Best regards,

For TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 10A

## Form 10A: Notify SPP Developer to Submit the Generation Data and Information on Facility Equipment

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Generating Data and Facility Equipment for Engineering Assessment

Reference is made to your letter dated ……expressing your intention to sell electricity to the TANESCO grid at the location of…..……

Before your application can be processed and approved, TANESCO shall carry out an engineering assessment to evaluate whether or not the power export capacity of the proposed project is suitable for the TANESCO grid according to TANESCO technical regulations. In order to carry out this assessment, TANESCO requires you to provide the generating data and information on the facility equipment listed below.

**For synchronous generators with an installed capacity ABOVE 1000 kW**

Site Name ……...

Location ……..

Site Reference Number ……

Generating Company Name……

Contact ……

Point of Supply (location) ……

Maximum export capacity ……

Maximum import capacity ……

Power factor operating range ……..

**Generator (for each synchronous generator)**:

Terminal voltage (kV) …….

Machine rating (MVA) …….

Stator resistance (pu) ……. tolerance % ……

Sub-transient reactance (pu) ……. tolerance % …….

Transient reactance (pu) …… tolerance % …….

Synchronous reactance (pu) ……. tolerance % …….

Sub-transient time constant (ms) ……. tolerance (ms) …….

Transient time constant (ms) …… tolerance (ms) …….

**Transformer (for each generator transformer);**

Rating (MVA) ……..

Reactance (pu) …….. tolerance % …….

Resistance (pu) ……. tolerance % …….

Voltage Ratio ……. vector group ……

**Cable schedule between the Generator and Point of Common Coupling where this cabling distance exceeds 50 meters (for each section);**

Voltage (V) ……..

Distance (km) ……

Reactance (Ohm/km) …… Resistance (Ohm/km) ……. (positive sequence)

Reactance (Ohm/km) …… Resistance (Ohm/km) ……. (zero sequence)

You are therefore required to submit all data mentioned above including Single Line Diagram of SPP generating facility to TANESCO for further Engineering Assessment.

Yours truly,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 10B

## Form 10B: Notify SPP Developer of Results of Engineering Assessment

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Results of Engineering Assessment

Attachment: Report of Engineering Assessment performed by TANESCO

Reference is made to your letter dated ……expressing your intention to sell electricity to the TANESCO grid at the location of…..…… TANESCO recently completed the required engineering assessment, the results of which are summarized below.

- ☐ The proposed SPP Project will have no adverse impact on TANESCO's distribution system. Therefore, you are permitted to supply electricity to TANESCO's distribution system as per your request. Maximum export capacity (kW) ……
- ☐ The proposed SPP Project will have some adverse impacts on TANESCO's distribution system. To mitigate these adverse impacts, you will be required to:.

    - ☐ Reduce the quantity of power export to a Maximum export capacity (kW) of ……
    - ☐ Upgrade TANESCO's distribution system
    - ☐ Relocate your power plant to another location
    - ☐ Install a capacitor bank

Please find the details of the appropriate mitigation methods in the attached report.

Yours truly,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 10C

## Form 10C: Provide SPP Developer of Model of TANESCO's Distribution System

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Model of TANESCO's Distribution System

Attachment: 1. CD containing TANESCO's Distribution System in DIgSILENT format
2. Table 1: Load flow simulation results of the SPP at various operating conditions

Reference is made to your letter dated ……expressing your intention to sell electricity to TANESCO's grid at the location of…..……

Please find enclosed herein a base case study containing TANESCO's Distribution System prepared by TANESCO. The base case study can be used to inform the design and implementation of the required Engineering Assessment (EA), which you have agreed to complete independently.

As part of the EA, you shall model the SPP facility's generating system and perform Load Flow and Short Circuit Studies. The results of the Load Flow Study should be displayed using Table 1. To complete the Short Circuit study all faults (i.e. three-phase faults, phase-to-phase faults, phase-to-phase-to-ground faults and single-phase-to-ground faults) shall be simulated at all buses. The results of the Short Circuit Study are comprised of an initial symmetrical short circuit current and peak current as well as the maximum voltage of healthy phases for short-circuit to ground fault cases.

After completing the Engineering Assessment, you are required to submit the report to TANESCO. TANESCO will then review your results and inform you of any other requirements for mitigating any adverse impacts that the SPP Facility may have on TANESCO's distribution system.

Yours truly,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

Table 1: Load flow simulation results of the SPP Facility under various operating conditions

| Conditions | Vs (p.u.) | Vm (p.u.) | Ve (p.u.) | Vpcc (p.u.) | Vpos (p.u.) | Veg (p.u.) | Qs (MVAr) | Losses (kW) | Overload (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|
| **Base Case without SPP** | | | | | | | | | |
| Max. Load | | | | | | | | | |
| Min. Load | | | | | | | | | |
| **Base Case with SPP during Max. Load** | | | | | | | | | |
| **For Synchronous Generator (SG)** | | | | | | | | | |
| PFC – 0.90 lagging | | | | | | | | | |
| PFC – 0.95 lagging | | | | | | | | | |
| PFC – unity | | | | | | | | | |
| PFC – 0.95 leading | | | | | | | | | |
| VC – 1.02 | | | | | | | | | |
| **For Induction Generator (IG)** | | | | | | | | | |
| PF – 0.95 leading | | | | | | | | | |
| **For Inverter-based EG (IBEG)** | | | | | | | | | |
| PF - unity | | | | | | | | | |
| **Base Case with SPP during Min. Load** | | | | | | | | | |
| **For Synchronous Generator (SG)** | | | | | | | | | |
| PFC – 0.90 lagging | | | | | | | | | |
| PFC – 0.95 lagging | | | | | | | | | |
| PFC – unity | | | | | | | | | |
| PFC – 0.95 leading | | | | | | | | | |
| VC – 1.02 | | | | | | | | | |
| **For Induction Generator (IG)** | | | | | | | | | |
| PF – 0.95 leading | | | | | | | | | |
| **For Inverter-based EG (IBEG)** | | | | | | | | | |
| PF - unity | | | | | | | | | |

**Note:** Vs = Voltage at Substation (p.u.),
Vm = Voltage at the middle of line (p.u.),
Ve = Voltage at the end of line (p.u.),
Vpcc = Voltage at PCC (p.u.),
Vpos = Voltage at POS (p.u.),
Veg = Voltage at terminal bus of embedded generator (p.u.),
Qs = Reactive power supplied by grid (MVAr),
Losses = Total losses on connected SPP feeder (kW),
Overload = Thermal overload limit violation or not (Yes/No).

# APPENDIX 10D

## Form 10D: Notify SPP Developer of Review of Engineering Assessment

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Review of Engineering Assessment

Reference is made to your letter dated …… which contained the results of the Engineering Assessment performed by ……

TANESCO has reviewed the Engineering Assessment, the results of which are summarized below:

- ☐ The proposed SPP project will have no adverse impact on TANESCO's distribution system. Therefore, you are permitted to supply electricity to TANESCO's distribution system as per your request. Maximum export capacity (kW) ……
- ☐ The proposed SPP project will have some adverse impacts on TANESCO's distribution system. To mitigate these adverse impacts, you will be required to:
  - ☐ Reduce the power export quantity to a Maximum export capacity of (kW) ……
  - ☐ Upgrade TANESCO's distribution system
  - ☐ Relocate your power plant to another location
  - ☐ Install a capacitor bank.

Yours truly,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 10E

## Form 10E: TANESCO's Data for Engineering Assessment

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: TANESCO's Data for Engineering Assessment

Attachment: 1. CD containing a Single Line Diagram of TANESCO's Distribution System
2. Table 1: Load flow simulation results of the SPP facility at various operating conditions

Reference is made to your letter dated ……expressing your intention to sell electricity to the TANESCO grid at the location of…..……

TANESCO would like to provide you with some of the data required to conduct an engineering assessment that will help TANESCO evaluate whether the power export capacity of the proposed project is suitable for TANESCO's grid. The following information should be integrated into your Engineering assessment.

**TANESCO Main Grid's Equivalent Parameters:**

Reactance (Ohm) …… Resistance (Ohm) ……. (positive sequence)

Reactance (Ohm) …… Resistance (Ohm) ……. (zero sequence)

**Distribution Line Parameters (for each line type):**

Reactance (Ohm/km) …… Resistance (Ohm/km) ……. (positive sequence)

Reactance (Ohm/km) …… Resistance (Ohm/km) ……. (zero sequence)

A Single Line Diagram of TANESCO's Distribution System is also attached hereto.

In order to complete the Engineering Assessment, you shall perform both a Load Flow Study and a Short Circuit Study. The results of the Load Flow Study can be

listed in Table 1. For the Short Circuit study all faults (i.e. three-phase faults, phase-to-phase faults, phase-to-phase-to-ground faults and single-phase-to-ground faults) must be simulated at all buses. The results of the Short Circuit Study are comprised of the initial symmetrical short circuit current and peak current as well as the maximum voltage of healthy phases for short-circuit to ground fault cases.

After completing the Engineering Assessment, you are required to submit the report to TANESCO. TANESCO will then review the results and inform you of any additional requirements for mitigating any adverse impacts the SPP Facility may have on TANESCO's distribution systems.

Yours truly,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

Table 1: Load flow simulation results at various operation conditions of SPP

| Conditions | Vs (p.u.) | Vm (p.u.) | Ve (p.u.) | Vpcc (p.u.) | Vpos (p.u.) | Veg (p.u.) | Qs (MVAr) | Losses (kW) | Overload (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|
| **Base Case without SPP** | | | | | | | | | |
| Max. Load | | | | | | | | | |
| Min. Load | | | | | | | | | |
| **Base Case with SPP during Max. Load** | | | | | | | | | |
| **For Synchronous Generator (SG)** | | | | | | | | | |
| PFC – 0.90 lagging | | | | | | | | | |
| PFC – 0.95 lagging | | | | | | | | | |
| PFC – unity | | | | | | | | | |
| PFC – 0.95 leading | | | | | | | | | |
| VC – 1.02 | | | | | | | | | |
| **For Induction Generator (IG)** | | | | | | | | | |
| PF – 0.95 leading | | | | | | | | | |
| **For Inverter-based EG (IBEG)** | | | | | | | | | |
| PF - unity | | | | | | | | | |
| **Base Case with SPP during Min. Load** | | | | | | | | | |
| **For Synchronous Generator (SG)** | | | | | | | | | |
| PFC – 0.90 lagging | | | | | | | | | |
| PFC – 0.95 lagging | | | | | | | | | |
| PFC – unity | | | | | | | | | |
| PFC – 0.95 leading | | | | | | | | | |
| VC – 1.02 | | | | | | | | | |
| **For Induction Generator (IG)** | | | | | | | | | |
| PF – 0.95 leading | | | | | | | | | |
| **For Inverter-based EG (IBEG)** | | | | | | | | | |
| PF - unity | | | | | | | | | |

**Note:**
Vs = Voltage at Substation (p.u.),
Vm = Voltage at the middle of line (p.u.),
Ve = Voltage at the end of line (p.u.),
Vpcc = Voltage at PCC (p.u.),
Vpos = Voltage at POS (p.u.),
Veg = Voltage at terminal bus of embedded generator (p.u.),
Qs = Reactive power supplied by grid (MVAr),
Losses = Total losses on connected SPP feeder (kW),
Overload = Thermal overload limit violation or not (Yes/No).

# APPENDIX 11A

## Form 11A: Notify SPP Developer of Review of SPP Interconnection Devices, Equipment and Drawings

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Review of SPP Interconnection Devices, Equipment and Drawings

Reference is made to the SPPA number…….., dated …….

TANESCO has reviewed the SPP Interconnection Devices, Equipment and Drawings for the proposed SPP Facility. The results of our review are summarized below:

- ☐ All Interconnection Devices, Equipment and Drawings are suitable for the proposed SPP Facility.
- ☐ Some of the Interconnection Devices, Equipment and Drawings for the proposed SPP Facility are suitable, however they will require some corrections and or modifications:.

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

Yours truly,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX 11B

## Form 11B: Notify SPP Developer of Review of Protection Schemes and Setting Values

**TANESCO LOGO**

---

**Our Ref:** **Date**
**SMSPP/MSP/SPPA/**
**SPP Name:**
**SPP Address:**
**Attn:**

Dear Sir,

RE: Review of the protection schemes and setting values

Reference is made to the SPPA number…….., dated …….

TANESCO has reviewed the protection schemes and setting values of the proposed SPP Facility, the results of which are summarized below:

- ☐ All the proposed protection schemes and setting values for the SPP Facility are approved.
- ☐ Some of the protection schemes and setting values for the proposed SPP Facility are approved, however they will require some corrections and or modifications:.

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

Yours truly,

For TANZANIA ELECTRIC SUPLY COMPANY LIMITED

MANAGING DIRECTOR

# APPENDIX II

## Meter Record Form and SPP Monthly Energy Charge Calculating Sheet

# APPENDIX 1A
## FORM 1A: Meter Record Form

SPP Name…….Month.....Year.....
Record Date.....Voltage Level…….....
TANESCO Branch Office Name…….....

| Description | TANESCO Meter | | SPP Meter |
|---|---|---|---|
| | Meter No:…… | | Meter No:…… |
| | Energy | Demand | Energy |
| Last Month Record | | | |
| This Month Record | | | |
| Different | | | |
| Multiplying Factor* | | | |
| Net Energy/Demand | | | |

.....(SPP Meter Reader) .....(TANESCO Meter Reader)
(……..) (…….)
Position ..... Position .....

.....(SPP Witness) .....(TANESCO Witness)
(……..) (…….)
Position ..... Position .....

*Multiplying Factor = CT Ratio × PT Ratio

# APPENDIX 1B
# FORM 1B: SPP Monthly Energy Charge Calculating Sheet

## SPP Monthly Energy Charge Calculating Sheet

**SPP Name: ……**
**Month: …….. Year: ……**

| **Description** | **TANESCO Meter** Meter No: ……..... | | **SPP Meter** Meter No: …… |
|---|---|---|---|
| | **Energy (kWh)** | **Demand (kW)** | **Energy (kWh)** |
| Last Month Record | | | |
| This Month Record | | | |
| Difference | | | |
| Multiplying Factor* | | | |
| **Net Energy/Demand** | | | |
| **TANESCO electricity charge calculation** | | | |
| **Description** | Quantity (kWh or kW) | Rate (Tsh/unit) | Total Charge |
| Energy Charge | | | |
| Demand Charge | | | |
| Services Charge | | | |
| Other Service Charges (……..) | | | |
| Subtotal | | | |
| VAT …… % | | | |
| **Total** | | | |
| **SPP energy charge Calculation** | | | |
| **Description** | Quantity (kWh or kW) | Rate (Tsh/unit) | Total Charge |
| Energy Charge | | | |
| VAT …… % | | | |
| **Total** | | | |
| | | | |
| **NET SPP CHARGE** | | | |

*Multiplying Factor = CT Ratio × PT Ratio