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Final Report – Volume 3a: New Customer Connection Policy and Connection Cost Methodology - Guidelines from the Electricity Regulatory Authority

Consulting Services for Electricity Cost of Service and Affordability of Tariff Studies

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Report for Electricity Regulatory Authority, Uganda

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Electricity Regulatory Authority, Uganda

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Table of Contents

Executive Summary

Introduction

The Electricity Regulatory Authority ("ERA" or "the Authority") is a Statutory Body established under section 4 of the Electricity Act, 1999, (Cap 145 Laws of Uganda) to regulate the generation, transmission, distribution, sale, export and import of electrical energy. It has a broad list of functions that make clear that it has been given wide responsibility for the supervision of the electricity supply industry. Several of these functions relate to the connection of new customers to electricity distribution networks.

ERA has decided to establish a new customer connection policy and connection cost methodology which is published in this document and is intended to give guidance to licensees, customers, potential customers who may seek a connection to the network and other stakeholders on the approach that should be taken in regard to new connections.

Legal aspects

The Electricity Act, 1999 provides a statutory framework regarding new customer connection to an electricity distribution network. In particular, section 58 of the Act states that a holder of a distribution licence must, among other things, provide access to all existing and potential users of the distribution system on payment of fees and charges for network services, which includes those for connection, with sections 77 and 79 showing further duties and exceptions.

Other important documents that provide the legal and regulatory structure for new connections are distribution licenses, the Primary Grid Code, the Quality of Service Code and the Distribution Line Construction Guidelines.

Key principles

It is important that everyone involved in new customer connections has a common view of the approach that should be followed to ensure that connections are efficiently and effectively provided in a way that meets customer expectations. This is termed the new customer connection policy.

Similarly, there needs to be a common approach to the assessment of connection costs which permits such costs to be broadly and consistently estimated. This is termed the connection cost methodology.

The policy and methodology have been developed to achieve the following objectives with appropriate trade-offs between simplicity and cost reflectivity:

- meet relevant legal and regulatory requirements;
- facilitate cost reflectivity by identifying the costs associated with a particular connection;

- provide transparency and consistency of approach for different customers in similar circumstances;
- provide simplicity to aid understanding and consistency;
- facilitate the avoidance of discrimination and perceived unfairness by the avoidance of cross-subsidies between customer groups;
- ensure efficient provision of connections to encourage the economic and efficient use of both electricity and energy, in general;
- encourage new connections and increase electricity access rates as far as possible; and
- ensure ease of application for connections and minimised transaction costs.

The amount of work – and the associated cost – for a distribution utility to provide a new connection to its network to a customer that requests one varies enormously depending on many factors including, for example, the following:

- the quantity of power distributed either from or to the network;
- whether it is a connection to supply demand or to connect generation or both;
- the type of connection required (single-phase or three phases);
- other features of the demand or generation, such as its technical characteristics and level at different times of the day, week or seasons;
- the distance of the point of connection from the existing network;
- security standards and design policies;
- the design of the existing network;
- the level of spare capacity on the existing network; and
- whether the utility needs to reinforce the network to ensure that supplies to existing and new customers are secure.

These considerations determine the amount of equipment that must be put into place, the work necessary to achieve this, and the associated cost.

This new customer connections policy and connection cost methodology is intended to specify;

- the connections policy that should be implemented by all utilities;
- the connection cost methodology that should implemented;
- the flexibility that may be required for utilities in certain circumstances; and
- the requirement for records to be kept.

New customer connection policy

It is important that everyone involved in new customer connections has a common view of the approach that should be followed to ensure that connections are efficiently and effectively provided in a way that meets customer expectations. This approach should be sufficiently flexible to deal with the large variations in customer requirements and the many situations that can arise. This is termed the new customer connection policy in these guidelines.

The policy covers the following aspects:

- information that must be provided by customers and procedures to be followed;
- applicable technical requirements and standards;
- customer responsibilities to ensure quality of supply;
- minimum technical solution;
- utility obligations and the basis for design of connections;
- network studies;
- energy rebate policy;
- competition in connections;
- cases where assets installed and paid for by a previous person who has been connected to the network are subsequently utilised to connect further connection applicants (these are sometimes called “second comers”);
- links to the connection cost methodology; and
- disputes.

A range of sample documents have also been developed.

Connection cost methodology

A methodology for assessing the costs of connections has been developed and this has been applied to a range of typical reference connection arrangements. These have been described in a series of drawings which include standardised lists of materials together with the associated quantities. Based on this information the resulting estimated costs for each of the connection arrangements has been estimated using a specially developed Microsoft Excel model.

The total cost is the sum of the costs for the following categories:

- **Direct costs**, i.e. costs of dedicated assets, i.e. costs of equipment that is for the sole use of the customer being connected, referred to as **service materials**. Ready boards are not included in these costs given that they do not form part of the distribution network;

- **Indirect costs**, i.e. costs of shared assets, including costs for equipment to connect to the nearest point on the network that is directly triggered by the new connection, but that may be shared subsequently, referred to as **line materials**;
- **Wider network reinforcement costs,** again costs of shared assets but these are electrically and usually physically further from the connection. Often there are no such costs. They are not included in standardised costs, and if required they are calculated based on unit costs.

In each case the cost assessment is based on the principle of the minimum technical solution. This means that the selected solutions and associated quantities of equipment, labour and transport items are based on the minimum required to provide the particular connection.

The estimated costs for the reference connection arrangements are applicable to 2018 For the next three years the estimated costs will be amended annually in line with the consumer prices index. After this both the designs and the underlying costs will be reviewed and reset.

If, at any time, the Authority comes to the view that there have been material changes either to the reference connection arrangements or the level of indexed costs substantially differs from the costs that are being incurred or both then it will initiate a review of the designs and the costs.

In order to provide transparency for judgements to be made about the compliance with this policy utilities must maintain comprehensive records, as follows:

- a consolidated summary of all connections provided by each utility in the form of a database with a line for each connection indicating its details must be maintained;
- this database should be made publicly available by utilities on their websites;
- the working files developed and utilised when considering designs and charges for connections should be retained; and.
- details of procurement costs of equipment items, as well as staff hourly remuneration rates and per-kilometre fuel and vehicle maintenance costs must be kept.

Connection charges

The connection cost methodology described above is used to assess the level of connection costs. An important matter is how the costs that are incurred in making such connections should be recovered, from whom, and when.

Generally, there are two sources of such cost recovery – firstly, as an element of the on-going tariff that the occupiers of the site will pay, or, secondly, as an up-front payment required from the person requesting the connection. The latter is generally

called a connection charge and represents some or all of the costs of connection - with the balance effectively being recovered through the tariff.

The approach to setting connection charges determines what a utility may charge when asked to connect an applicant to the distribution network. This charge is a contribution to the cost that the utility incurs in making a connection – and does not represent the purchase of the assets used to make the connection by the applicant. These assets are operated by the relevant licensee, but the ultimate owner is not necessarily the operator.

There are two broad methods of setting connections charges - *standard connection charges* or *case-by-case or non-standard connection charges.*

Standard connection charges will be used where the range of costs that occur within a specific connection category where a standard charge is to apply is not too wide.

Non-standard charges will be applied where such cost differences are too great.

ERA will generally require a *hybrid approach* where standard charges are applied to low voltage (single-phase and small three-phase) connections situated relatively closely to the existing network, and case-by-case (or non-standard) charges for the connection of larger customers, or customers more distant from the existing network.

In particular, the application of these approaches will also take account of Government policies to increase the level of electricity access to those who do not have it.

ERA will use the connection cost methodology (together with a supporting model) to set, and from time to time to amend, the applicability of standard connection charges and their levels, and the calculation of non-standard charges.

1 Introduction

The Electricity Regulatory Authority (ERA) is a Statutory Body established under section 4 of the Electricity Act, 1999, (Cap 145 Laws of Uganda) to regulate the generation, transmission, distribution, sale, export and import of electrical energy.

ERA's functions are:[1]

(a) to issue licenses for

(i) the generation, transmission, distribution or sale of electricity; and

(ii) the ownership or operation of transmission systems;

(b) to receive and process applications for licenses;

(c) to prescribe conditions and terms of licenses issued under this Act;

(d) to modify licenses issued under this Act;

(e) to make and enforce directions to ensure compliance with licenses issued under this Act;

(f) to establish a tariff structure and to investigate tariff charges, whether or not a specific complaint has been made for a tariff adjustment;

(g) to approve rates of charges and terms and conditions of electricity services provided by transmission and distribution companies;

(h) to review the organisation of generation, transmission and distribution companies or other legal entities engaged in the generation, transmission and distribution of electricity to the extent that that organisation affects or is likely to affect the operation of the electricity sector and the efficient supply of electricity;

(i) to develop and enforce performance standards for the generation, transmission and distribution of electricity;

(j) to encourage the development of uniform electricity industry standards and codes of conduct;

(k) to establish a uniform system of accounts for licensees;

(l) to advise the Minister regarding the need for electricity sector projects;

(m) to prepare industry reports and to gather information from generation, transmission and distribution companies;

(n) to prescribe and collect licence fees;

[1] Section 10, Electricity Act, 1999

(o) to provide for the procedure for investment programmes by transmission and distribution companies;

(p) to approve standards for the quality of electricity supply services provided;

(q) to approve codes of conduct in respect of the operation of transmission and distribution systems;

(r) to acquire information and carry out investigations relating to any of its functions; and

(s) to perform any other function that is incidental or consequential to its functions under this section, or as may be conferred on it by any other law

This list of functions makes clear that the Authority has been given wide responsibility for the supervision of the electricity supply industry. Several of the functions described above – including (c), (g), (i), and (p) - relate to the connection of new customers to electricity distribution networks.

As part of the process of undertaking these functions the Authority has decided to establish a new customer connection policy and connection cost methodology which is published in this document and is intended to give guidance to licensees, customers, potential customers who may seek a connection to the network and other stakeholders on the approach that should be taken in regard to new connections.

The connection policy describes the process by which a person can obtain a new connection to the distribution network. A similar process will be applied where an existing customer wishes to alter the connection – for example, by requiring an increased maximum demand.

The connection cost methodology explains how the costs of connection can be estimated and provides such estimates for a set of typical connection arrangements. Note that these costs are subject to indexation and review.

ERA will periodically review the new customer connection policy and connection cost methodology and their application, particularly to the calculation of connection charges.

2 Background

Electricity distribution and supply licensees are required to put in place a connection policy for all categories of new and existing customers including those connecting at low voltage, medium voltage and high voltage and premises where there is distributed generation (i.e. medium, small and micro electricity generation equipment at sites connected to a distribution system). This document is intended to support this by providing guidance on the approach that the Authority expects utilities to take regarding such connections on the following key aspects:

- the legal aspects relating to new connections (section 3);
- key principles underlying the new customer connection policy and connection cost methodology (section 4);
- a new customer connections policy covering all categories of distribution and supply consumers adopted by the Authority and applicable to all licensees (section 5);
- a connection cost methodology also adopted by the Authority and applicable to all licensees (section 6); and
- connection charges (section 7)

3 New customer connections - Legal aspects

3.1 Electricity Act, 1999

As section 1 above indicates, one of ERA's functions is to issue licenses for the distribution of electricity. No person should distribute electricity without such a licence (unless subject to an exemption). Section 58 of the Electricity Act states that a holder of a distribution licence must, among other things, provide access to all existing and potential users of the distribution system on payment of fees and charges for network services, which includes those for connection.

Licensees must provide the Authority with the necessary information to enable these fees and charges to be set.

Section 77 of the Act states, among other things, that:

- where being required to do so by the owner or occupier of a premises a licensee must supply electricity to that premises, if necessary providing any necessary electricity lines, plant or equipment;
- the person requiring the electricity supply must apply in writing specifying the premises that is required to be supplied, the date that the applicant wishes such supply to begin, the maximum power required at any time and the minimum period for which the supply is required; and
- where an application for supply requires new electricity or plant to be put into place the licensee should respond, as soon as practicable with a notice that indicates the extent to which the applicant's requests can be met and indicating the tariffs or other charging arrangements (including financial security) that will be applicable.

Section 79 outlines some exceptions to the duty to supply electricity. These include:

- where there is already a supply of electricity provided by another licensee;
- to make a connection which may breach regulations under the Electricity Act;
- there are circumstances beyond the licensee's control; or
- it is not reasonable in the circumstances to provide a supply.

Both section 78 and 79 state that where a licensee does not supply electricity in line with the requirements outlined then the person may appeal to ERA.

Section 58 also outlines the approach where consumers can themselves access the distribution system and construct an electricity supply line to their premises. This may be permissible where a holder of a distribution licence cannot allow access - for reasons other than lack of capacity or technical conditions - but is subject to terms and conditions set by the Authority which could include those covering cost recovery, access for other consumers to the line, and the line's ongoing ownership.

3.2 Distribution Licences

Generally, licences for the distribution of electricity require licensees to provide access to consumers and licensed electricity suppliers in their authorised territories (or located at a defined distance from the licensee's assets unless specifically approved by ERA) to connect to and use distribution network facilities on a fair and reasonable basis and without undue preference.

These licences also indicate timescales by which a licensee must respond to applications for connection such as details of what must be provided including fees and charges.

3.3 Primary Grid Code

The Electricity (Primary Grid Code) Regulations, 2003, were produced under the powers conferred on the Authority under section 121 of the Electricity Act. Whilst the code mainly relates to the co-ordinated operation of the grid system and generation scheduling there are certain provisions which cover other aspects including new connections.

The code requires a licensee to use its best endeavours to make a supply available at a new address on the agreed date or, where there is no such date, as soon as possible, provided that:

- there is an adequate supply at the boundary of the new address;
- way-leave conditions have been satisfied; and
- the consumer meets a number of requirements. These include that the consumer has:
    - provided an electrical installation and any equipment within it that
        - comply with the code and any other applicable standards and
        - is installed properly and is in a safe condition;
    - ensured that a Completion of Wiring Certificate from an electrician has been provided to the licensee;
    - satisfied the licensee that there is suitable access to the meter and the electrical installation;
    - provided suitable load information;
    - entered an agreement to pay the licensee's connection fee, standing charge and electricity usage charges as approved by ERA;
    - provided contact details for billing purposes;
    - entered into a payment arrangement or given a security deposit, as required; and

- not got an outstanding debt from a previous supply (unless there is a dispute or payment arrangement).

Some other relevant Primary Grid Code requirements are described in section 5.

3.4 Quality of Service Code

The Electricity (Quality of Service Code) Regulations, 2003, were produced under the powers conferred on the Authority under section 120 of the Electricity Act. Part IX – New Construction, section 31 (1) of these regulations states that licensees should serve each qualified applicant for service within its service area as rapidly as practical.

3.5 Distribution Line Construction Guidelines

The Distribution Line Construction Guidelines 2017 were developed by the Authority in line with its functions, as stipulated in Section 11 of the Electricity Act 1999, which are “to develop and enforce performance standards for the generation, transmission and distribution of electricity; and to encourage the development of uniform electricity industry standards and codes of conducts”.

These guidelines prescribe the minimum construction requirements to be met during overhead distribution line construction. They are applicable to distribution utilities and certified contractors carrying out line construction work at the distribution level.

4 Key principles

This section identifies the key principles underlying the new customer connection policy and connection cost methodology,

It is important that everyone involved in new customer connections has a common view of the approach that should be followed to ensure that connections are efficiently and effectively provided in a way that meets customer expectations. This approach should be sufficiently flexible to deal with the large variations in customer requirements and the many situations that can arise. This is termed the new customer connection policy in these guidelines.

Similarly, there needs to be a common approach to the assessment of connection costs which permits such costs to be broadly and consistently estimated but again recognises the practical differences that can occur in providing such connections. This is termed the connection cost methodology.

Some of the key principles that underpin the new customer connection policy and connection cost methodology are shown below.

The policy and methodology have been developed to achieve the following objectives with appropriate trade-offs between simplicity and cost reflectivity, as explained below:

- meet relevant legal and regulatory requirements;
- facilitate cost reflectivity by identifying the costs associated with a particular connection;
- provide transparency and consistency of approach for different customers in similar circumstances;
- provide simplicity to aid understanding and consistency;
- facilitate the avoidance of discrimination and perceived unfairness by the avoidance of cross-subsidies between customer groups;
- ensure efficient provision of connections to encourage the economic and efficient use of both electricity and energy, in general;
- encourage new connections and increase electricity access rates as far as possible; and
- ensure ease of application for connections and minimised transaction costs.

The amount of work – and the associated cost – for a distribution utility to provide a new connection to its network to a customer that requests one varies enormously depending on many factors including, for example, the following:

- the quantity of power distributed either from or to the network;
- whether it is a connection to supply demand or to connect generation or both;

- the type of connection required (single-phase or three phases);
- other features of the demand or generation, such as its technical characteristics and level at different times of the day, week or seasons;
- the distance of the point of connection from the existing network;
- security standards and design policies;
- the design of the existing network;
- the level of spare capacity on the existing network; and
- whether the utility needs to reinforce the network to ensure that supplies to existing and new customers are secure.

These considerations determine the amount of equipment that must be put into place, the work necessary to achieve this, and the associated cost.

They also determine what is required locally to establish the new point of connection (i.e. to provide the particular connection and immediate line materials) and the possible requirement to reinforce the network in places which are geographically and electrically some distance from the connection point. The boundary of utility ownership and operation of equipment is the customer side of the meter such that utilities own and operate the equipment that is installed from (and including) the meter to the existing network (noting that owner and operator of a network are often not the same organisation). Connection charges allow utilities to recover part or all of the capital expenditure that is directly triggered by new connections.

This standardised new customer connections policy and connection cost methodology is intended to specify, for typical combinations of the above factors:

- the connections policy that should be implemented by all utilities including procedural aspects concerning the transfer of information, ownership of assets and identification of the responsibilities of each party;
- the connection cost methodology that should implemented by all utilities, to ensure that costs are recovered from all customers according to the same transparent rules;
- the flexibility that may be required for utilities in certain circumstances with appropriate justification; and
- the requirement for records to be kept.

5 New Customer Connection Policy

5.1 Introduction

It is important that everyone involved in new customer connections has a common view of the approach that should be followed to ensure that connections are efficiently and effectively provided in a way that meets customer expectations. This approach should be sufficiently flexible to deal with the large variations in customer requirements and the many situations that can arise. This is termed the new customer connection policy in these guidelines.

The policy covers the following aspects:

- information that must be provided by customers and procedures to be followed;
- applicable technical requirements and standards;
- customer responsibilities to ensure quality of supply;
- utility obligations and the basis for design of connections;
- minimum technical solution;
- network studies;
- energy rebate policy;
- competition in connections;
- cases where assets installed and paid for by a previous person who has been connected to the network are subsequently utilised to connect further connection applicants (these are sometimes called “second comers”;
- links to the connection cost methodology; and
- disputes.

5.2 Information that must be provided by customers

5.2.1 Application

The start of the customer connection procedure is the application form that the person or company requesting a connection should complete. The connection applicants must provide sufficient information to the utilities for them to be able to prepare connection offers. Utilities are at liberty to prepare their own forms, but they would typically include at least the following information to be requested from customers:

- Full name of the applicant;
- Address of the applicant and location of the premises for which connection is being requested (GPS coordinates if the customer connection is done by a project/contractor);

- Telephone number and e-mail address (if applicable);
- Copy of national ID, passport or driving licence;
- Wiring certificate from certified electrician;
- Land title or letter of consent from landlord for tenants;
- Company seal & certificate of incorporation (for companies);
- Wayleave permission from land owners through which the line will pass (if applicable);
- Planned use of electricity: domestic (lighting, TV, cooking, etc), commercial, industrial;
- Number of rooms/bedrooms and material of wall and roof structure for the fixing of service cable, etc for domestic use;
- Type of commercial and industrial use;
- Where possible, the maximum power required or peak demand - in kilowatts (kW) or kilo-volt amperes (kVA);
- Date that the connection is required – unless it is required immediately; and
- The minimum time that the supply of electricity will be required (i.e. is it a temporary connection).

A sample application form is shown in Appendix 1. Increasingly, utilities should encourage customers to make such applications through their websites. The ability to continue to make them in paper form should be retained for a period of five years starting from 2019, during which there will be a transition from manual to electronic applications with applicants increasingly encouraged to use the online approach.

For customers requesting large or more complex supplies (such as a site where generation equipment may be used) more information is likely to be needed. The application form in Appendix 1 indicates the nature of such information.

As shown above, it will be important to know the date when the customer would like the connection to be made – unless it is required immediately. This should provide a reasonable time for the utility to go through the necessary planning and equipment installation process and take account of the published quality of service standards – and the customer's assessment of the peak demand (in kW) that they expect to require.

The standard connection to be offered for domestic and commercial customers is a single-phase connection. However, in cases where customers have special or high load requirements (three-phase motors, for example) three-phase connections will need to be provided.

As previously mentioned, additional information is required in cases where customers plan to have generation facilities to be connected to the network, like solar panels with inverters, small wind turbines, etc. This information is included in the sample application form in Appendix 1, which should be completed with all relevant details. In normal circumstances these micro-distributed generators (typically with maximum generation capacities of 5 kW, for single-phase connections, or 30 kW, for three-phase connections) do not cause a need to strengthen the capacity of the network, but a change in metering is required.

For industrial customers, it is important to know the type of load and estimates of both active and reactive power demands, and whether the load is likely to disturb the network, for example by producing harmonics, requiring high starting currents, operating reactive power controlling devices, or introducing large voltage drops, deviations or oscillations.

Connection applicants for distributed generation (larger than micro-distributed generation described above) need to provide detailed information on the planned facilities so that the effects of the additional generation on the network can be properly evaluated. If this additional information is not included on the initial application form (see Appendix 1) then it will be requested for inclusion in the schedules to the connection agreement for more complex connections (as shown in Appendix 3). More details on connection agreements are provided below.

5.2.2 Procedure after the application, including timescales

After the connection applicant has submitted the application form (Appendix 1) and received tentative information about the possibility for a connection, the second step is the inspection of the applicant's premises by the utility. Before the inspection the applicant needs to pay an inspection fee.

The result of the inspection is a plan and a cost estimate and offer of connection. In addition, the internal wiring and other facilities at the consumer must be checked and verified that they have been installed according to requirements and standards, including earthing.

The applicant should receive the offer with details of the connection fee within 10 working days of the utility receiving the payment for the inspection fee, as outlined in ERA's quality of service standards.

After the connection fee has been agreed upon, the next step is a connection agreement to be agreed between the utility and the connection applicant. The connection agreement sets out the terms under which the applicant will be connected and will remain connected to the distribution network.

A sample connection agreement is provided in Appendix 3 – utilities should use agreements substantially of this form unless they can demonstrate compelling reasons for not so doing. For small relatively simple connections then the connection agreement may be limited to the standard connection agreement terms and conditions

shown in Appendix 3 with a single schedule which essential incorporates the details shown on the application form.

For larger or more complex connections some additional terms as well as some or all of the detailed schedules as shown in Appendix 3 must also be included. The particular schedules required will depend on the circumstances of each individual site. This approach should be used for all premises connected at other than low voltage, sites where there is distributed generation (noting that in the case of micro-distributed generation the additional schedules required should be fairly limited), and other sites where there are complex connection arrangements and such an approach is reasonable.

In particularly complex arrangements it may be necessary for a non-standard connection agreement to be used. In all cases connection agreements must be fully discussed with the connection applicant during the connection process.

At the same time as the connection agreement is completed (or shortly afterwards) the agreed connection charge should be paid.

A copy of the relevant power supply agreement should also be given to the customer. This should be in line with the standard form of this agreement as approved by the Authority (unless there are compelling reasons for variations which must be approved by the Authority).

When the utility has received payment of the connection charge and all obligations of the customer have been fulfilled, i.e. way-leaves and other clearances, the connection to the customer should be made within:

- 10 working days in the case of a single phase no pole service;
- 15 working days in the case of a single phase 1 pole or more, or in the case of a three-phase LIGHT connection, which is defined as three-phase connection within the utility's footprint where the installation does or does not require a transformer at the customer's premises and no significant network upgrade;
- 30 working days in the case of a three-phase HEAVY connection, which is defined as three-phase connection where the installation requires a transformer at the customer premises and requires significant network upgrade to connect the industry to the utility network (i.e. reconfiguration of the network, conductor upgrade, and/or substation upgrade).

The above timelines fulfil the requirements of the quality of service standards published by the Authority and should be met – unless there are exceptional circumstances where longer time periods are appropriate. Such extensions must be approved by the Authority.

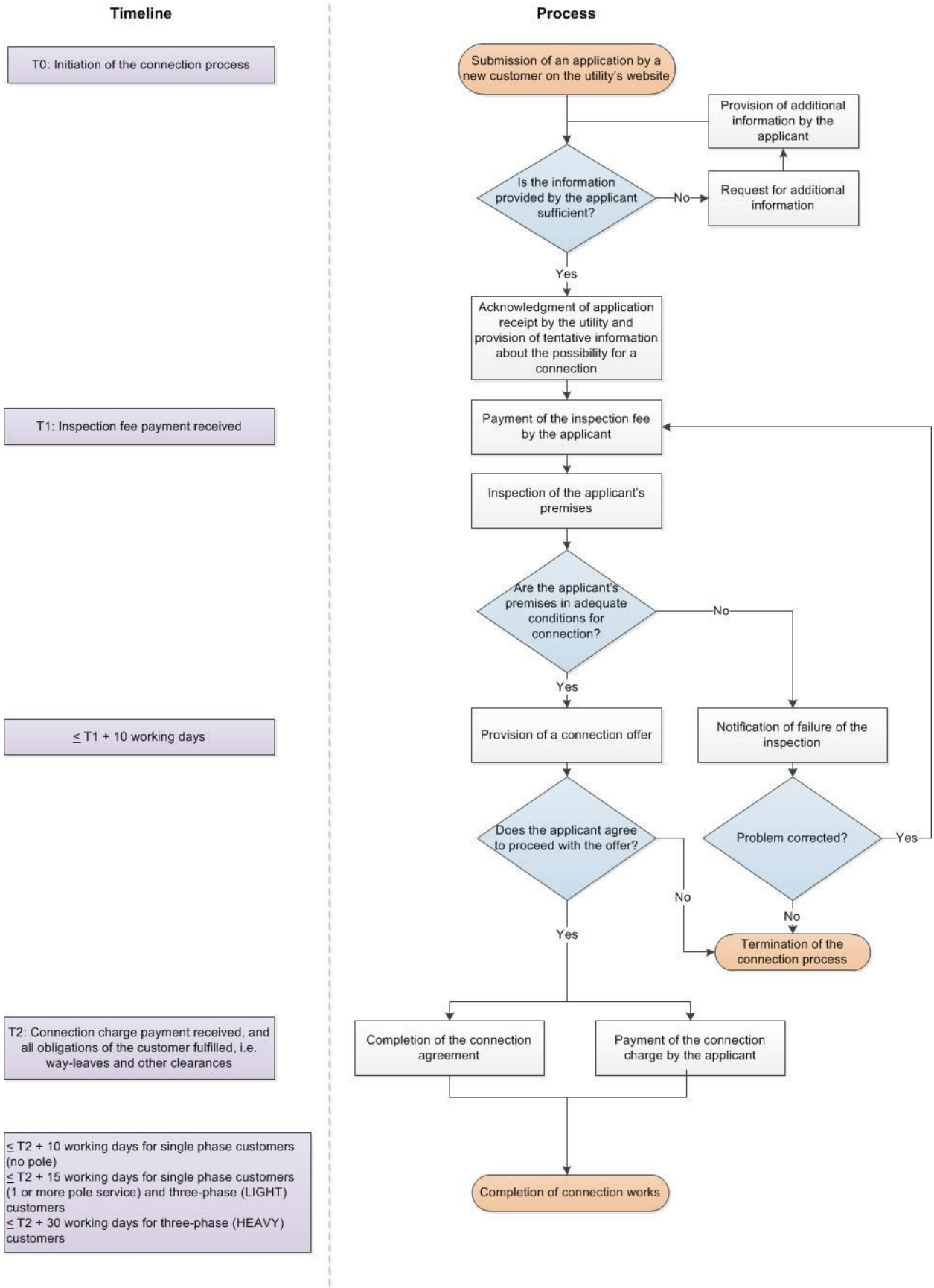
It is recognised that obtaining wayleaves has sometimes proved to be challenging. There are no uniform rules about compensation, and agreements have to be negotiated and agreed upon with each private landowner. This situation has caused

extensive delays to some projects. If the legal arrangements regarding this were to be reformed, other approaches to deal with such issues may be implemented.

In projects for rural network expansion, it has sometimes proven possible to adopt a collective approach to wayleaves whereby no one is connected unless everyone signs a suitable consent form (a sample form is provided in Appendix 2). Especially with simple low voltage connections, the responsibility for securing wayleaves should be with the customer. When permissions from authorities are required, the utility should be involved and provide support when needed, but ultimately the responsibility remains with the customer to secure the wayleave and be responsible for any resulting costs.

The connection process is summarised in Figure 1 below.

Figure 1: Connection process



5.2.3 Implementation of a new connection

The customer is responsible for providing the electrical installations within its premises, with the aid of certified wiremen/contractors. The utility is responsible for checking the installations/wiring and providing the connection to the network and the meter. In the case of large projects, such as rural electrification projects, the selected contractor may be responsible for all network installations including meters and possibly ready boards, but the final testing and energisation should be done by the utility responsible for the operation of the network.

Ready boards are a low-cost alternative solution to internal wiring, but neither of these solutions are provided routinely by utilities since the boundary of responsibility is at the meter. Therefore, equipment for connections, and associated designs and costs, should not include internal wiring or ready boards. Rural electrification projects often also cover the costs of ready boards, in order to attract as many customers as possible for connection at the earliest opportunity.

This new customer connection policy applies to all connections provided by ERA-licensed (and licence exempt) utilities.

5.2.4 Primary Grid Code requirements

The Primary Grid Code contains several relevant requirements for consumer connections in section 7.0 (connection of supply), especially in 7.3 (new connections) and these must be adhered to (see section 3.3).

5.3 Technical requirements and standards

5.3.1 Technical design options

The material below provides details of the typical range of technical options for provision of service connections. However, utilities must prepare, publish and keep reasonably up-to-date design rules and equipment specifications for connections. This documentation should be comprehensive and detailed, describing the basis and justification for the design of connections. Utilities may choose to co-operate in the development and maintenance of such guidelines. When they have been produced they should be inspected and approved by the Authority. Utilities should review these design rules and equipment specifications every three years, and submit them to the Authority for approval. However, utilities are responsible for ensuring that these documents remain appropriate and are suitably accessible to all who need them, therefore design rules can be changed at any time with the Authority's approval if new available technologies require it. The Authority should also periodically inspect them to verify their appropriateness but the primary responsibility for ensuring that these rules are in use in practice remains with the utilities.

Utilities must also maintain detailed records of the technical and financial aspects of all connections provided, as defined in section 6.5.

5.3.1.1 LV connections

The main options for connecting low voltage consumers, either single phase or three-phase, are:

- Overhead line with bare conductors;
- Overhead aerial bundled cable (ABC) – two core, three core with bare neutral/earth wire or four core service conductors;
- Overhead concentric (e.g. Solidal, Airdac) cable;
- Underground cable.

Overhead line with bare conductors has been widely used and it is still the cheapest alternative – in terms of capital cost. However, taking account of both safety and security, the use of bare conductors should generally not be adopted as a standard solution. Bare live wires are clearly a danger to public safety, and short-circuit faults are more common with bare conductors than cables. Illegal connections and stealing of electricity is made much easier as the bare wires can be “tapped” at any point.

ABC is usually a costlier solution (depending on the installation costs, since the cable itself is more expensive but installation is easier), but offers many advantages:

- easy installation;
- narrow right-of-way;
- less short-circuits;
- theft of electricity is more difficult;
- safer for the public;
- less maintenance and line inspections; and
- electrical performance (voltage drop, fault current) is better than with bare conductors of the same size.

Disadvantages can be:

- shorter span length; and
- more difficult repairs.

ABCs have either an insulated or bare neutral. ABC with an insulated neutral is currently commonly used. Drawings 3 and 4 in Appendix 4 provide illustrations of the construction of ABC lines for single phase connections using a traditional post- paid meter and wired pre-paid split meter respectively. Drawings 8, 9, and 10 show three phase ABC connection arrangements again with differing metering types.

Concentric cable is the most expensive capital cost of the overhead alternatives, but is the most effective in preventing the theft of electricity. Concentric cable is most

commonly used in single-phase connections, although three phase cables are also manufactured. Shorter span length can be a disadvantage.

It is recommended that either ABC or concentric cables should be used in new installations - concentric (Solidal) cable from the last pole to the connection point at the customer's premises and ABC cables in other parts of the network. Underground cables are special cases, used mainly in downtown urban areas.

Bare conductors should only be used for new connections in areas where the LV network has been already constructed earlier with bare conductors: in that case also the last span to the consumer should be a concentric (Solidal) cable.

As mentioned above, each of the utilities should publish their individual design rules and explain the adopted solutions.

5.3.1.2 Metering

Electromechanical kWh meters have now been replaced by electronic meters, which can offer a range of other functions and remote meter reading possibilities depending on the level of sophistication. Prepayment meters are also widely used to facilitate the payment in advance for the supply of electricity and sometimes to collect pre-existing debts.

Both the Primary Grid Code and Quality of Service Code define requirements for metering. Among other items the Primary Grid Code (section 24.0 Metering and Settlement) and the Quality of Service Code (Part VIII – Meters), require each licensee to provide, install, own and maintain suitable meters necessary for the measurement of electricity delivered to its consumers,

The location of the meter can be inside the house, or more commonly in a meter box outside of the house or on the utility pole with an information console in the customer's property (split-type – wired or wireless) for monitoring the consumption and loading new pre-payment energy units.

Unless there are exceptional reasons why not, the following approach should be used for most consumers - split-type pre-payment meter, where the meter itself is located on top of the utility pole, since this type of metering both secures the payment and is most effective in preventing meter tampering and electricity theft. This can be implemented using a standard wired or a wireless connection between the meter and the customer information unit. Where technically feasible, wireless technology should be used. However, the use of wireless communication is not recommended in areas where communication challenges remain and there is a risk that communication between the meter and the customer information unit may be lost.

Large consumers who need their own 33 kV or 11 kV transformer can be connected and metered on the LV side of the transformer (in which case the transformer is owned and maintained by the utility) or on the HV side using CTs and VTs, in which case the responsibility of the utility stops at the metering point. Connections costs for these large consumers should be assessed on a case-by-case basis. Ultimately, however, utilities

should provide the connection at the voltage level requested by the customer, unless there are significant reasons why this would be inappropriate. If the requirement for an additional transformer is triggered directly by a connection then it should be provided, and the costs assessed according to this policy, but the metering point should be at the point of connection at the voltage level requested.

5.3.1.3 Transmission to distribution connections

Connections from transmission to distribution take place at substations, for example 132/33 kV, with the ownership boundary between transmission and distribution utilities at the secondary side of the main transformers. All equipment at 33 kV and below in all substations (132/66/33/11 kV) is generally operated by the distribution company (although the ultimate owner is not necessarily the operator), except the incomer bays from the main power transformers and the bus coupler, which belong to the transmission utility - UETCL.

5.3.1.4 Generation to distribution connections

Connections from large-scale generation to transmission take place at interconnection points, normally at the primary voltage side of the generation substation, belonging to the generation company. However, if the substation is connecting more than one generating plant, or if the substation is a major point on the transmission system, it is more appropriate for the substation to be in the ownership of the transmission utility. Again, such the costs of such connections would be assessed on a case-by-case basis. In the majority of cases, and by default, generation substations should be owned by generation companies. However, in line with this policy, utilities must consider the sharing of assets and the minimum technical solution (as defined in section 5.5) in each case, and keep records of the design decisions.

5.3.2 Standards and codes to be complied with

The Primary Grid Code, the Quality of Service Code and the Distribution Line Construction Guidelines contain technical and design criteria, procedures to be followed by the network operators in the planning and development of the transmission/distribution system, and connection conditions specifying the technical, design and operational criteria to be complied with by any user connected or seeking connection with the network operator.

According to the Primary Grid Code, Ugandan National Standards and Codes are to be followed or in their absence international standards, like IEC, IEEE or British standards.

The main parts of the Primary Grid Code are:

- System operation, scheduling and dispatch; and
- Distribution and retail sales.

The design rules and equipment specifications used by utilities must adhere to these standards and codes’

5.4 Customer responsibilities to ensure quality of supply conditions at the point of connection are met

The Primary Grid Code specifies (section 6.3: Consumer installation and equipment) certain requirements on the customer to ensure that:

- the consumer's electrical installations and equipment are maintained in a safe condition;
- the protection equipment in the consumer's installation is in compliance with safety regulations or requirements; and
- reliability and quality of supply to other consumers are not adversely affected by the actions or equipment of the consumer.

Furthermore section 8 (Quality of supply) of the code sets out the regulations for the operation of both customers' and utilities' assets. There are requirements for customers to limit:

- demand for reactive power (section 8.5 – Power Factor);
- harmonic currents (section 8.6);
- deviation of phase currents (section 8.9 – load balance); and
- voltage fluctuations (section 8.10) at points of common coupling.

These kinds of requirements are applicable to industrial and other medium and high load consumers, but, in normal cases, are not directly applicable to single phase domestic or small-scale commercial consumers. The deviation of phase currents is difficult for domestic or commercial consumers to manage in practice. The electrical appliances of these customers are predominantly single phase and, although they are connected to separate phases, deviations can occur depending on their operation. Therefore, as part of their normal activities, utilities should manage their networks such that these specific requirements are not imposed directly on domestic or commercial customers.

The customer is responsible for installing and maintaining protection equipment which is compatible with the existing distribution system protection. All equipment in the customer's installation must be suitable for use at 50 Hz and at the specified voltage and stipulated short-circuit rating and must be controlled within the approved limits.

Distributed generators must ensure that the reliability and quality of supply from their equipment complies with the terms of their connection agreements, including the ability to operate in voltage control mode as required. The Primary Grid Code specifies requirements for distributed generators in section 11.

5.5 Principle of the “minimum technical solution”

The principle of the “minimum technical solution” applies to the design and costing of all new connections. This is intended to substantially limit the level of shared costs that are incurred by customers in connection charges.

The connection costs which are shown in Table 4, Table 5, Appendix 5 and Appendix 6 have been estimated based on assessment of typical solutions, unit quantities and costs, under the principle of the minimum technical solution. This principle is also applicable to the costing of more complex connections. This means that the selected solutions and associated quantities of equipment, labour and transport items are based on the minimum requirement to provide connections in each category in generally occurring situations.

The principle of the minimum technical solution requires that the designs do not provide excessive quantities or capacities of equipment. For this purpose, direct costs are considered to be the costs of all equipment items, and associated installation, that are directly triggered by the connection. Selection of equipment from standard ranges of options at each voltage level means that there is likely to be some excess capacity in the equipment installed. However, subject to demonstration by the utility that the minimum technical solution has been selected, any additional capacity included in the design of the connection shall not be taken into account in determining the connection cost, or inclusion within the connection charge.

Finally, in the case of large developments where connections need to be provided for 10’s or 100’s of customers, utilities are required to consider all applications on a collective basis. This means that the minimum technical solution for each customer should be based on a well-reasoned assessment of the necessary shared infrastructure which should be provided through a overall project design undertaken by the utility.

5.6 Obligations of distribution utilities

Distribution utilities must provide open and non-discriminatory access for the use of their network to all customers including distributed generators.

Distribution utilities are responsible for the planning, design and preparation of engineering specifications of work required for distribution system connections or expansions. The utilities’ protection systems must be appropriately designed and maintained to ensure optimal discrimination, safety and minimum interruptions to customers. As previously mentioned, utilities are expected to prepare and publish their own design rules and equipment specifications for connection, based on national and international standards. Customer equipment at the connection point must be required to comply with these standards.

Connection costs should be assessed based on the principle of the “minimum technical solution” to provide the requested connection. This means selecting the equipment

that should be provided based on meeting the need of the individual customer in question (for example, the amount of power that has been requested), with appropriate selection of equipment from the range of standard sizes used by the utility and minimising any resulting excess capacity. Should utilities choose to adopt solutions that provide additional capacity, above that directly required for the connection requested, then the additional costs should not be separately identified. The costs of special reliability requirements for certain customers such as, for example, hospitals, process industries, etc. should also be separately identified.

Distributed generators are responsible for the design, construction, maintenance and operation of the equipment on the generation side of the point of connection. The technical specifications of the connection must be agreed by the participants based on the distribution system impact assessment studies. To provide electrical isolation between distribution systems and generators, circuit breakers and visible isolation must be installed at connection points. Developers of distributed generation are responsible for these circuit breakers.

5.7 Nature of network studies that should be undertaken and expected outputs

5.7.1 Distribution

Each distribution utility must conduct distribution planning studies and evaluations to ensure the safety and reliability of the distribution system for which it is responsible.

The utilities are responsible for preparing load forecasts and network development plans for a minimum planning horizon of five years. These network development plans must be reviewed and updated at least every three years. The plans should include all relevant activities including electrification of new areas and refurbishment of the existing network. Network development plans should be reviewed and approved by the Authority.

Based on the data supplied by connecting customers, utilities must conduct all necessary and appropriate distribution impact studies, relative to existing plans, to evaluate the impact of the proposed connection (or modification to an existing connection) on the distribution system. The evaluation should include:

- Short circuit currents: evaluation of the effect of network extension to the operation of protection devices;
- Voltage drop: checking that the impact of additional load to the voltage level is within permissible range; and
- Other factors that may influence the quality of the network.

Where a new customer is a small residential customer, distribution studies should be limited to a brief review of the impact on the immediately surrounding available network capacity.

5.7.2 Transmission

The transmission system operator should prepare a power system development plan with a minimum planning horizon of 10 years, to be reviewed and updated at least every five years. The plan should take into account alternative scenarios for load development and least-cost generation expansion plans to satisfy the expected load growth. Additionally, international interconnections, transmission expansion needs, and refurbishment of the existing networks should be accounted for. The power system development plan should be reviewed and approved by the Authority.

Based on the data supplied by connecting customers (which potentially could be either generation or demand), the transmission system operator must perform the system impact studies that are required to evaluate, in detail, the impact of the proposed user development on the transmission system. The studies may include:

- Steady-state power flow;
- Fault currents;
- Dynamic stability;
- Transient stability;
- Harmonic currents; and
- Other studies as may be needed depending on the conditions of the case.

Upon request by the proposed user, the system operator must provide to the user adequate and sufficient information regarding the transmission system, to enable the user to conduct impact studies on the user's system, and/or the transmission system as it considers appropriate. This may consist of an equivalent short circuit level at the point of interconnection.

5.7.3 The security of supply planning criteria

The "N-1" criterion is the minimum planning standard on the main part of the transmission network. "N-1" means that the power system is planned and operated such that, for any single credible contingency event (for example, an unplanned outage), the system remains in a satisfactory state (for example, no equipment is overloaded, no voltage limits are breached, frequency stays within normal operating limits and there is no loss of supply to customers). Hence "N" represents the secure system before the contingency event, and the "-1" represents the need to still be secure following the "1" event. However, if more than one contingency event was to occur, then the system may become subject to thermal, voltage or frequency excursions, and there is the potential that some customers may lose supply.

In remote parts of the transmission network radial lines and/or single transformers can be used, but the utility must have clear action plans for the restoration of supply after disturbances, so that the interruption time for consumers can be minimised.

If the customer has special needs related to the security of supply, and additional network investments are required, the costs involved should be borne entirely by the customer.

5.8 Competition in connections

International experience shows that the provision of connections is an area where competitive market influence can be introduced into the electricity sector. Aside from outsourcing activities of utilities to provide resources, which is a way in which the private sector already can participate in the electricity sector, the option for customers to contract directly with private contractors for the provision of connection assets should also be facilitated by utilities.

Under this approach, in seeking connections to a utility's distribution system, customers have the option to select an independent contractor to undertake certain elements of the connection works that would otherwise be undertaken by the utility. Such elements of work are described as contestable works – and can be undertaken either by the utility or by a contractor appointed by the customer. Other work which is called non-contestable work can only be carried out by the utility.

Examples of non-contestable work are:

- Processing the connection application and distribution system planning for the connection;
- Deciding upon the point of connection to the distribution system;
- Connection of contestable works to the distribution system other than at low voltage;
- Design, planning and specification of any works for reinforcement or diversion of the utilities distribution system where reinforcement is defined as the addition of assets that add capacity to the existing shared use system;
- Carrying out of reinforcement or diversion works; and
- Removal of existing electrical plant and electric lines.

Examples of contestable work are:

- Design of the contestable work (subject to approval by the utility and in line with the utilities existing design rules and equipment specifications);
- The procurement and provision of equipment and materials to the utilities current design rules and equipment specifications;
- Site preparation of the site, including the routes between the customer and the point of connection;
- Construction of the contestable work;

- Connection of contestable works to the distribution system and their energisation at LV only;
- Recording of work done and of the location of cable routes and other equipment on site or elsewhere (where those assets are installed by the contractor), and the provision of this information to the utility;
- Reinstatement (both temporary, if appropriate, and permanent); and
- Making provision for the installation of metering equipment.

Utilities should indicate in their connection offers which assets that are being installed are contestable and which are non-contestable, and the connection charge associated with each.

Disputes regarding whether works should be regarded as contestable or non-contestable should be referred to the Authority.

Customers can only select contractors to undertake contestable work who have been appropriately certified for the work to be undertaken under the Electricity Act, 1999 and the Electricity (Installation Permits) Regulations SI No. 19 2003.

Where a work is carried out by a contractor, the latter must consult the utility to ensure that the work is performed in accordance with approved construction standards.

When a customer elects to appoint a suitably certified contractor to undertake contestable work, then the customer and the utility must enter into a legally enforceable adoption agreement which transfer the ownership of the successfully installed assets to the utility. This would define the assets involved, approval arrangements, the process for dealing with disputes and other relevant aspects.

5.9 Rebates to eligible customers who design, finance and construct electricity distribution infrastructure

An energy rebate policy has been developed that provides for a reimbursement framework under which industrial consumers that finance and construct lines are, on connection onto the distribution system, compensated by way of offsetting a portion of energy costs from the line investment costs until the customer has been fully compensated. In these cases, the investment is made by an industrial consumer who provides a network (which is, at least, 500 meters in length) including line extensions and its own connections. However, it is assumed that there will be spare capacity in this network such that, at least, 10 new customers can connect to it within one year of commissioning. The industrial consumer can then deduct a proportion of his subsequent energy bill for the next three years until the investment that has been made has been recovered. If it is not recovered in the three-year period, then it is forfeited.

5.10 Treatment of costs for subsequent connections ("second comer" rules)

Situations can arise where assets initially installed and fully paid for by a customer for their sole use can subsequently be used in the connection of a later customer. For example, this could occur where a line is installed to a customer who is reasonably remote from the existing network. This could require, say three, four or more poles to be established and commissioned. The full cost of this new extension to the network is likely to be taken account of in the calculation of connection charge and be charged to this first customer – unless the cost is met through funding from a Government or donor agency or otherwise. Perhaps, at a later date, an additional closely located customer will seek connection and the most effective way to do this would be to link at some point to the previously provided line. If the second customer is only charged the costs of the new assets provided at the time of their connection, this would seem unfair to the first customer who has paid all the costs of the existing line.

An approach for dealing with such cases is outlined below. It is recognised that there may be some implementation challenges to this and hence it should be limited, at this stage, to a fairly small number of circumstances, as described below.

Hence, where a new customer connects to an existing **high voltage network** utilising asset that were:

(a) installed exclusively to connect the previous customer,

(b) paid for by that original customer in full, and

(c) the connection date of the previous customer is no more than 5 years before the connection date of the new customer,

the new customer shall refund the original customer for an appropriate portion of the shared network asset (or assets) that the new customer will use. This portion is based on the location of the new connection on the existing assets and the proportion of the capacity of the assets used by it.

The detailed calculation approach is described in Appendix 7.

5.11 Key principles of the connection cost methodology

Listed below are the key principles which should underpin the connection cost methodology:

- cost assessment should be based on the "minimum technical solution", according to design and equipment specification rules published by utilities and approved by the Authority and using the cost assessment model provided and approved by the Authority;
- any costs incurred to provide further capacity for the network or to meet specific additional customer requirements should be separately identified.

- a survey/inspection should be undertaken for all connections requested;
- standard cost assessments (based on standard connection arrangements and the cost assessment model) should generally be used for simpler connections such as zero, one or two poles single-phase and zero pole three-phase connections.
- for larger or more complex individual case-by-case cost assessments should be made again based on the “minimum technical solution” approach, according to design and equipment specification rules published by utilities and approved by the Authority and using the cost assessment model provided and approved by the Authority. These should take account of the information obtained from surveys and any relevant utility cost assumptions;
- documentation must be retained to provide evidence and justification for cost assessments made for periodic review by the Authority;
- a detailed record of all connections must be kept (connection type; capacity; location; distance from network; equipment provided; cost; charge applied etc);
- connection cost information should be made publicly available by utilities by means of a database on their websites
- ready boards and internal wiring are not generally owned or operated by utilities and therefore should be excluded from connection cost assessments;
- these arrangements are applicable to all connections provided by licensed utilities (or those who are eligible for licence exemption);
- contingency costs should not be included in cost assessments;
- arrangements for updating the connection cost methodology are outlined in section 6.4.

The connection cost methodology provided in section 6 is based on these principles.

5.12 Disputes

On occasions disputes may arise between a person seeking a connection to the distribution network and the utility. Where a connection applicant feels aggrieved and wishes to make a complaint about a utility, they should firstly approach that utility and seek to come to an agreement with it. The Authority expects all utilities to respond speedily to such complaints and urges the parties to discuss them in good faith with the aim of reaching solutions that that are acceptable to all.

If the connection applicant, after discussion with the utility, continues to feel that the complaint has not been appropriately dealt with, then it should be raised with the Authority. Full details of the situation and the reasons for the complaint should be provided.

6 Connection cost methodology

6.1 Introduction

This section describes the methodology for assessing the costs of connections and applies this to a range of typical reference connection arrangements including the resulting estimated costs.

The first task that underpins the connection cost methodology is to undertake an assessment of the costs of providing different types of connections and associated wider network reinforcement costs.

The total cost is the sum of the costs for the following categories:

- **Direct costs**, i.e. costs of dedicated assets, i.e. costs of equipment that is for the sole use of the customer being connected, referred to as **service materials**. Ready boards are not included in these costs given that they do not form part of the distribution network;
- **Indirect costs**, i.e. costs of shared assets, including costs for equipment to connect to the nearest point on the network that is directly triggered by the new connection, but that may be shared subsequently, referred to as **line materials**;
- **Wider network reinforcement costs,** again costs of shared assets but these are electrically and usually physically further from the connection. Often there are no such costs. They are not included in standardised costs, and if required they are calculated based on unit costs.

A costing tool (a Microsoft Excel workbook) has been developed and is used to calculate and present the costs of service and line materials. Wider network reinforcement costs are considered as part of the case-by-case assessment of particular connections. This tool can be used to assess the total cost of the materials that are required to make the connection, the associated labour and other costs such as transport and meter testing.

Fixed standardised cost for labour and transport are indicated in Table 1. They are applicable for single phase customers no pole and 1 pole services, and for three phase customers no pole service.

Table 1: Standardised labour and transport costs

Type of connection	Labour and transport standardised cost (USh)
Single phase – No pole	50,000
Single phase – 1 pole	80,000
Three phase – No pole	90,000

Before installation, all meters must be tested at a cost of USh 8,000. This cost is included in the connection cost for all types of connections.

The assessment is applicable to all technical solutions, taking account of the need to be suitable for the connection requested and following the principles of the "minimum technical solution" that is described in section 5.5.

6.2 Reference connection designs - drawings

Appendix 4 provides drawings of reference designs for certain simpler connections which should be used by utilities in making connections. These should be incorporated into the design rules and equipment specifications that utilities develop for approval by the Authority. These designs are intended to represent the minimum installations that must be implemented by utilities. If a utility believes that any of the reference designs are in excess of the minimum requirements, it should approach the Authority and request that the design be amended. Where a utility makes installations that exceed the requirements of the design rules and equipment specifications it must document the reasons why an alternative approach has been adopted and provide explanations to the Authority, if requested.

Also provided as part of the drawings in Appendix 4 are detailed lists of the materials that it is expected will be required and the expected quantities of such materials. This may be the number of items or the length of line or other appropriate metric according to the particular material concerned. Specific quantities of certain materials are directly linked to specific circumstance of the connection such as the individual distances over which a connection needs to be made.

The Authority will use these reference designs, list of materials, and quantities as the presumption of what is required for a particular connection type. Where the approach, materials or quantities materially differ from those shown utilities must be able to justify the reasons for such differences.

The reference drawings are listed in Table 2 below.

Table 2: Reference Drawings – Connection designs

Design Number	Appendix 4 Figure Number	Customer type	Type of meter	Existing network	Conductor used for connection of the new pole
1	**1**	Single-phase	Traditional meter	Bare conductor	Bare conductor
2	**2**	Single-phase	Wired pre-paid split meter	Bare conductor	Bare conductor

Design Number	Appendix 4 Figure Number	Customer type	Type of meter	Existing network	Conductor used for connection of the new pole
3	**3**	Single-phase	Traditional meter	ABC	ABC
4	**4**	Single-phase	Wired pre-paid split meter	ABC	ABC
5	**5**	Three-phase	Time of use meter	Bare conductor	Bare conductor
6	**6**	Three-phase	Three-phase wired pre-paid split meter	Bare conductor	Bare conductor
7	**7**	Three-phase	kVA meter	Bare conductor	Bare conductor
8	**8**	Three-phase	Time of use meter	ABC	ABC
9	**9**	Three-phase	Three-phase wired pre-paid split meter	ABC	ABC
10	**10**	Three-phase	kVA meter	ABC	ABC

ABC – Aerial bundled conductors

In order to avoid a large number of nearly identical drawings some other reference designs for very similar cases have also been identified although not shown on separate drawings. These are shown in Table 3 below which also indicates those drawings which are most closely associated with the particular connection arrangements and explains the differences:

Table 3: Additional connection designs

Design Number	Related Drawing	Customer type	Type of meter	Existing network	Conductor used for connection	Differences from related drawings
11	**2**	Single-phase	Pre-paid split meter - wireless	Bare conductor	Bare conductor	Wireless split meter instead of standard wired split meter (and no communication cable required)
12	**4**	Single-phase	Pre-paid split meter - wireless	ABC	ABC	Wireless split meter instead of standard wired split meter (and no communication cable required)
13	**3**	Single-phase	Traditional meter	Bare conductor	ABC	Connection to the existing network which requires a few different materials as an ABC is connected to the existing bare conductor (as detailed in Appendix 6)
14	**4**	Single-phase	Wired pre-paid split meter	Bare conductor	ABC	Connection to the existing network which requires a few different materials as an ABC is connected to the existing bare conductor (as detailed in Appendix 6)

Design Number	Related Drawing	Customer type	Type of meter	Existing network	Conductor used for connection	Differences from related drawings
15	**4**	Single-phase	Pre-paid split meter - wireless	Bare conductor	ABC	Wireless split meter instead of standard wired split meter (and no communication cable required) Connection to the existing network which requires a few different materials as an ABC is connected to the existing bare conductor (as detailed in Appendix 6)
16	**6**	Three-phase	Three-phase pre-paid split meter - wireless	Bare conductor	Bare conductor	Wireless split meter instead of standard wired split meter (and no communication cable required)
17	**9**	Three-phase	Three-phase pre-paid split meter - wireless	ABC	ABC	Wireless split meter instead of standard wired split meter (and no communication cable required)

For more complex connections requiring upstream network reinforcement individual designs will need to be produced in line with the utility's design rules and equipment specifications.

6.3 Reference connection designs – costs

Based on the connection designs listed in Table 2 and Table 3 and the associated drawings and lists of materials provided in Appendix 4 the connection cost for each of the connection designs has been estimated based on unit costs (which have taken account of market information, and are listed in Appendix 5) and other assumptions. The resulting indicative costs (at 2018 cost levels) are shown in Table 4 for low voltage single-phase connections and in Table 5 for low voltage three-phase connections with detailed breakdowns for each provided in Appendix 6.

For each of the arrangements listed in Table 2 and Table 3 estimated costs have been derived based on a number of assumptions including market information. The resulting indicative costs (at 2018 price levels) are listed in Table 4 below.

In the case of three-phase connections, costs assume that no transformer is provided.

Table 4: Connection cost – single-phase connections

Design number	Characteristics of the Design		Cost (USh)
1	Type of meter: Existing network: Conductor used for connection:	Traditional meter Bare conductor Bare conductor	• No pole: 446,369 • 1 pole: 1,728,732
2	Type of meter: Existing network: Conductor used for connection:	Wired pre-paid split meter Bare conductor Bare conductor	• No pole: 576,773 • 1 pole: 1,859,135
3	Type of meter: Existing network: Conductor used for connection:	Traditional meter ABC ABC	• No pole: 445,749 • 1 pole: 2,028,492
4	Type of meter: Existing network: Conductor used for connection:	Wired pre-paid split meter ABC ABC	• No pole: 576,152 • 1 pole: 2,158,896

Design number	Characteristics of the Design		Cost (USh)
11	Type of meter: Existing network: Conductor used for connection:	Pre-paid split meter - wireless Bare conductor Bare conductor	• No pole: 610,918 • 1 pole: 1,893,281
12	Type of meter: Existing network: Conductor used for connection:	Pre-paid split meter - wireless ABC ABC	• No pole: 610,297 • 1 pole: 2,193,041
13	Type of meter: Existing network: Conductor used for connection:	Traditional meter Bare conductor ABC	• No pole: N/A • 1 pole: 2,047,616
14	Type of meter: Existing network: Conductor used for connection:	Wired pre-paid split meter Bare conductor ABC	• No pole: N/A • 1 pole: 2,178,019
15	Type of meter: Existing network: Conductor used for connection:	Pre-paid split meter - wireless Bare conductor ABC	• No pole: N/A • 1 pole: 2,212,165

Table 5: Connection cost – three-phase connections

Design number	Characteristics of the Design		Cost (USh)
5	Type of meter: Existing network: Conductor used for connection:	Time of use meter Bare conductor Bare conductor	• No pole: 2,031,325
6	Type of meter: Existing network: Conductor used for connection:	Three-phase wired pre-paid split meter Bare conductor Bare conductor	• No pole: 2,882,288
7	Type of meter: Existing network: Conductor used for connection:	kVA meter Bare conductor Bare conductor	• No pole: 3,446,497
8	Type of meter: Existing network: Conductor used for connection:	Time of use meter ABC ABC	• No pole: 2,030,083
9	Type of meter: Existing network: Conductor used for connection:	Three-phase wired pre-paid split meter ABC ABC	• No pole: 2,881,046
10	Type of meter: Existing network: Conductor used for connection:	kVA meter ABC ABC	• No pole: 3,445,256
16	Type of meter: Existing network: Conductor used for connection:	Three-phase pre-paid split meter - wireless Bare conductor Bare conductor	• No pole: 2,990,960

Design number	Characteristics of the Design		Cost (USh)
17	Type of meter: Existing network: Conductor used for connection:	Three-phase pre-paid split meter - wireless ABC ABC	• No pole: 2,989,719

6.4 Updating the costs of the reference connection designs

Clearly, the costs shown in Table 4, Table 5, Appendix 5 and Appendix 6 are applicable to 2018 and that underlying cost levels will change in future years. Hence the estimated costs for each of the reference connection designs should be indexed and reviewed in future years.

The approach that will be adopted is that the estimated costs will be amended annually in line with the consumer prices index for a period of three years. After this both the designs and the underlying costs will be reviewed and reset.

At any point in time, should the Authority come to the view that there has been material changes - either to the reference connection arrangements, or the level of indexed costs substantially differs from the costs that are being incurred, or both - then it will initiate a review of the designs and the costs.

6.5 Requirements for record keeping

In order to provide transparency for judgements to be made about the compliance with this policy) and potential refinements to the policy in future, the following requirements apply to the utilities to keep records, as follows:

- A consolidated summary of all connections provided by each utility in the form of a database with a line for each connection provided that includes details of the following:
    - unique identifier;
    - customer type;
    - connection type;
    - capacity and voltage of connection;
    - location;
    - distance from the network (length of line extension);
    - distance from terminal pole to customer property;

  - summary of types and quantities of equipment items provided (including justification that these corresponded to the minimum technical solution), and associated cost;
  - total staff hours, and associated cost;
  - total distance travelled, and associated cost;
  - total cost;
  - details of whether the maximum cost criterion was exceeded;
  - standard / non-standard connection charge applied;
  - payment terms (assumed up front);
  - costs capitalised into the tariff;
  - costs subject to second comer rules;
  - costs paid by a third party (e.g. government/donor programme);
- this database should be made publicly available by utilities on their websites
- the working files developed and utilised when considering designs and charges for connections, including the documentation received from customers, records of surveys, design material, justifications, and connection offers submitted to customers. This material must be submitted to the Authority at any time, on request;
- details of procurement costs of equipment items, as well as staff hourly remuneration rates and per-kilometre fuel and vehicle maintenance costs. This information must be available for submission to the Authority in the form of a report, with explanations of any significant changes, on an annual basis.

7 Connection charges

As explained above, the amount of work – and the associated cost – for a utility to provide a new connection to its network to a customer that requests it varies enormously depending on many factors including, for example, the quantity of power to be distributed either from or to the network, the type of connection required (single-phase or three phases), the distance to the point of connection from the existing network, and whether the utility needs to reinforce the existing network to accommodate the new load.

These costs include those that are local to the new point of connection (sometimes referred to as direct costs, or the costs of equipment items that are dedicated to the particular connection and immediate line materials), but may also include others such as those that result from the fact that the network may need to be reinforced in places which are geographically and electrically some distance from the connection point.

The connection cost methodology outlined in section 6 is used to assess the level of such costs.

An important matter to be established is how the costs that are incurred in making such connections should be recovered, from whom, and when.

Generally, there are two sources of such cost recovery – firstly, as an element of the on-going tariff that the occupiers of the site will pay, or, secondly, as an up-front payment required from the person requesting the connection. The latter is generally called a connection charge and represents some or all of the costs of connection - with the balance effectively being recovered through the tariff.

The approach to setting connection charges determines what a utility may charge when asked to connect an applicant to the distribution network. Such connection charges allow utilities to recover part or all of the capital expenditure that is directly triggered by new connections.

It should be noted that this charge is a contribution to the cost that the utility incurs in making a connection – and does not represent the purchase of the assets used to make the connection by the applicant. These assets are operated by the relevant licensee, but the ultimate owner is not necessarily the operator.

There are two broad methods of setting connections charges characterised by different levels of standardisation of the payments that that customers make, as follows:

- *standard connection charges (*calculated such that costs are recovered on an average basis from all customers that request connections of the particular category); and

- *case-by-case or non-standard connection charges* (developed on the basis of case-by-case assessment of individual connection requests and their specific costs).

In general, standard connection charges will be used where the range of costs that occur within a specific connection category where a standard charge is to apply is not too wide. This is intended to make such charges simple to apply and easy for customers to understand whilst limiting the level of cost subsidisation between different customers.

Non-standard charges will be applied where such cost differences are too great.

The Authority will generally require a *hybrid approach* where standard charges are applied to low voltage (single-phase and small three-phase) connections situated relatively closely to the existing network, and case-by-case (or non-standard) charges for the connection of larger customers, or customers more distant from the existing network.

In setting the approaches for the setting of connection charges will aim to achieve the same objectives as those summarised for the new customer connection policy and connection cost methodology in section 4. This states that the approaches have been developed to achieve the following objectives with appropriate trade-offs between simplicity and cost reflectivity:

- meet relevant legal and regulatory requirements;
- facilitate cost reflectivity by identifying the costs associated with a particular connection;
- provide transparency and consistency of approach for different customers in similar circumstances;
- provide simplicity to aid understanding and consistency;
- facilitate the avoidance of discrimination and perceived unfairness by the avoidance of cross-subsidies between customer groups;
- ensure efficient provision of connections to encourage the economic and efficient use of both electricity and energy, in general;
- encourage new connections and increase electricity access rates as far as possible; and
- ensure ease of application for connections and minimised transaction costs.

In particular, the application of these approaches will also take account of Government policies to increase the level of electricity access to those who do not have it.

The Authority will use the connection cost methodology (together with a supporting model) to set, and from time to time to amend, the applicability of standard connection charges and their levels, and the calculation of non-standard charges.

Appendices

Appendix 1 - Sample connection application form

Appendix 2 – Sample wayleave consent form

Appendix 3 – Sample connection agreement

Appendix 4 - Drawings illustrating technical details of connections

Appendix 5 - Unit costs of reference materials

Appendix 6 - Detailed costing of reference connection designs

Appendix 7 – Treatment of costs for subsequent connections ("second comer" rules) - detailed calculations

Appendix 1 - Sample connection application form

The following sample application form has been prepared:

Section A - Your Details	
1. Customer details	
Title:	
First Name:	
Last Name:	
Company name and registration number (if applicable):	
Street address:	
Town/city:	
Postcode:	
Daytime telephone number:	
Mobile telephone number:	
Email address:	
2. Site details - the location of the new connection(s)	
Site name/plot numbers:	
Street address:	
Town/city:	
Postcode:	
To help us locate your site please include the address of any adjacent properties and/or a description of the access arrangements:	

Section B – Details of connection required	
How many connection(s) are being requested in this application?	
When is the connection(s) required? (please specify the date, unless it is required immediately in which case indicate “Immediately”)	
Confirm the type of connection(s) required:	
New connection: domestic dwelling - Proceed to Section C	
New connection: commercial property - Proceed to Section C	
New connection: medium industrial property - Proceed to Section D	
New connection: large industrial property - Proceed to Section D	
Modification to an existing connection: domestic dwelling - Proceed to Section C	
Modification to an existing connection: commercial property - Proceed to Section C	
Modification to an existing connection: medium industrial property - Proceed to Section D	
Modification to an existing connection: large industrial property - Proceed to Section D	

Section C – Domestic and commercial connections	
Do you require a single phase or three phase connection(s)?	
Please enter your maximum power requirement: *The normal maximum capacity for individual domestic properties is 15kVA. If you require a different maximum power for each property, please enter the kVA value here.*	
If your enquiry is for an increase in power, please state the existing load (kVA):	
Do you require your connection to accommodate motors, welders or other disturbing equipment?	*If yes, proceed to Section E, otherwise proceed to Section F..*

Section D – Three phase medium and large industrial connections	
Please enter your maximum power requirement, after diversity is applied (kVA)	
If your enquiry is for an increase in power, please state the existing load (kVA)	
Do you require your connection to accommodate motors, welders or other disturbing equipment?	*If yes, proceed to Section E, otherwise proceed to Section F.*

Section E – Disturbing loads	
Motor(s):	
Single phase or three phase?	
Delta OnLine or Star Delta?	
Starting current (Amps):	
Anticipated number of starts per hour:	
Welder(s):	
Single phase or three phase?	
Delta OnLine or Star Delta?	
Input current (Amps):	
Rating:	
Number of welds per minute:	
Other potentially disturbing equipment – please provide details:	

Section F – Details of electrical load	
Please provide details of the number and type of equipment:	
Lighting points	
Appliances (including: television, radio, cooking and refrigeration, and clothes washing)	
Socket outlets	
Power equipment	
Other equipment (including for: heat pumps, electric space heating, electric water heating, electric showers)	
Alternatively, please provide the following details to allow us to estimate:	
Number of rooms	
Floor area	

Section G – Generation	
Will there be any on site electricity generation?	
If yes, please provide details of:	
installed generation capacity (kW)	
type of generation installed (solar panels, wind, battery storage, other)	
If the generators will be capable of exporting to the grid, the maximum export capacity (kVA)	

Section H – Additional information	
Please provide a copy of the location plan, site layout plan, and any relevant plans or drawings	
Please provide any additional information relevant to your connection application	
Date of Application	
Signature of Applicant	

Appendix 2 – Sample wayleave consent form

I/We,

[Name(s) of owner]

[Address of owner]

[Phone number of owner]

[Address of property if different]

[Phone number of property if different]

The owners of the land shown on the attached map agree to let *[Utility name]* install its network across our land following the route shown on the map.

[Utility name] agrees to take every care to minimise any inconvenience during the installation and also to make good any damage done, according to the detail provided in the following table:

Name of Item (crop, tree, fruit etc[2])	Qty	District Rate	Signature of authorized person from utility

I/We the owners of the land agree to let *[Utility name]* have future access to the land for the purpose of maintaining or repairing the network.

Signed on behalf of the landowner:

[Signature]

[Print name], [Date]

[2] The crops or fruit are considered in addition to the tree. *[Utility name]* will request that the owner harvest the crops or fruit, and may wait a reasonable period for this to be completed.

Signed on behalf of *[Utility name]*

[Signature]

[Print name], [Date]

Signed on behalf of [Name of owner]

[Signature]

[Print name], [Date]

Signed on behalf of [LC1 with stamp]

Appendix 3 – Sample connection agreement

Connection Agreement – main terms

AGREEMENT FOR CONNECTION

BETWEEN

(1) *[Utility name] [Utility address]* (hereinafter referred to as *[Utility identifier]* which expression shall, unless excluded by or repugnant to the context or meaning thereof be deemed to include its successors and assignees) of the one part.

AND

(2) *[Customer name] [Customer address]* ("the Customer") of the other part.

This agreement consists of the following terms and the technical particulars provided in the Schedule (the completed application form amended as appropriate following the inspection by *[Inspector name]* on *[Inspection date]*).

In consideration of the payment of its charges, *[Utility name]* agrees to the Connection of *[Customer name]'s* Installation to its system subject to the terms of this agreement.

[Customer name] confirms that he has read and fully understands all of the terms of this agreement.

In entering into this agreement, *[Customer name]* understands that he shall be bound contractually by it on and from the Commencement Date of *[Date of commencement].*

Terms of the agreement

1. Interpretation

   In this connection agreement the terms ”we”, “our” and “local network operator” mean, for each connection to the network through which you are supplied.

2. Connection to our network

   The premises will remain connected to our network in accordance with the provisions of the Electricity Act 1999 (section 145), any other legal requirements that apply from time to time, and the terms of this agreement.

   We will supply and deliver electricity up to your metering point (the connection point), according to the terms of the Electricity Supply Agreement.

3. Network constraints

   Our obligations under this agreement are subject to the maximum capacity and any other design feature of the connection. You must contact us in advance if you propose to make any significant change to the connection or to the electric lines or electrical equipment at the premises, or if you propose to do anything else that could affect our network or if you require alterations to the connection.

4. Generating Equipment

   If you wish to install, or arrange for the installation of, small-scale generating equipment at the premises-which means one or more sources of electrical energy you should notify the utility to which are connected before commissioning the generation.

5. Providing information

You must provide us with information we request in relation to the nature, or use by you, of electrical equipment at the premises. We will only ask for information that we need in relation to this agreement or meeting the requirements of the Primary Grid Code that applies under our licence.

6. Conveying electricity

We do not guarantee that we will convey electricity through our network at all times, or that electricity delivered through our network will be free of brief variations in voltage or frequency.

7. Cutting off the supply

We may cut off the flow of electricity through the connection where we are entitled to do so under the circumstances prescribed in the Electricity Supply Agreement, and the conditions about time of disconnection and provision of written notice are met.

8. Unauthorised use of our network

This agreement entitles the premises to be connected to our network for the propose of receiving electricity from, or exporting electricity to, our network. Any other use of our network including the transmission of data or communications, is strictly prohibited unless with our prior written consent. Unless we have given consent any such use of our network by you, or relating to the connection, shall be breach of this agreement, and you shall be liable for the losses we incur as result whether directly or indirectly.

9. If something goes wrong

If we fail to comply with any term of this agreement or are negligent, you may be entitled under general law to recover compensation from us for any loss you have suffered. However, we will not be required to compensate you for (and you should consider obtaining insurance against) loss caused by anything beyond our reasonable control, any indirect loss, or any direct loss or indirect economic or financial loss (including wasted expenses or any loss of revenue, profit, or interest any loss of business, commercial, market, or economic opportunity, or any loss of contact or goodwill) other than where you are entitled to recover compensation for loss under the general law in relation to death or personal injury.

10. Business customers

If the electricity supplied to the premises is wholly or mainly business purposes, our liability to you in relation to that premises, and your liability to us in relation to that premises, will (subject to the limitations in clause 9) be limited.

11. Changing the connection agreement

The terms of this agreement will be changed automatically to incorporate any changes which are approved by the Electricity Regulatory Authority. Notice of any changes which are approved will be advertised in the national press, and the new terms will be published on the Electricity Regulatory Authority website.

12. Agreeing other connection terms

You and we may each, at any time, ask the other to enter into an alternative connection agreement in respect of the connection if you or we believe an alternative agreement is needed because of the nature of the connection.

13. Ending this agreement

This agreement will end when one of the following occurs:

(i) you and we agree a replacement agreement in respect of the connection;

(ii) the flow of electricity through the connection is permanently stopped; or

(iii) any circumstances arise which legally entitle us to cut-off the electricity flow through the connection and we write to you advising you that this agreement is ended.

The ending of this agreement for any reason will not affect any rights, remedies or obligations which may have come into being under agreement prior to its ending and clauses 9 and 10 will continue to apply.

14. Transferring this connection agreement

[Customer name] shall, prior to selling or leasing its interest in the connected premises (or otherwise permitting a third party to occupy them), ensure that the existence and provisions of this agreement are brought to the attention of such third party. For information, any such third party should note that it may automatically be bound by the provisions of this agreement.

You are not entitled to transfer this agreement to another person without our consent.

Connection Agreement - Schedule for simple single-phase connections

The schedule consists of the technical particulars in the completed application form, amended as appropriate following the inspection by *[Inspector name]* on *[Inspection date].*

Where technical conditions specified in this Schedule conflict with the body of this agreement then, to the extent that conflict exists, the relevant technical condition or part of the relevant technical condition shall take precedence.

Connection Agreement - Additional terms in the sample connection agreement for more complex connections

In addition to the terms of the sample connection agreement for simple single-phase connections, the following terms will apply for more complex connections:

Additional terms of the agreement

1. The connection point is defined as follows:
   (i) where *[Customer name]'s* service cable terminates in a cut-out fuse, the connection point is the outgoing terminals of the cut-out; or
   (ii) where the connection is provided direct into *[Customer name]'s* intake switch, the connection point is the incoming terminals of the intake switch; or
   (iii) where the connection is provided from a *[Customer name]* switch fuse or circuit breaker, the connection point is the outgoing terminals of that switch fuse or circuit breaker.

2. The maximum power requirement and maximum export capacity may be subject to operational and technical restrictions and these are set out in:

   (i) Schedule 4 "Operating arrangements applicable to specific connection points"; and
   (ii) Schedule 5 "Technical conditions applicable to specific connection points"

3. The first date for review and consideration of reductions of the export or import capacities is as follows: *[Earliest review date(s)]*

Additional schedules to the sample connection agreement for more complex connections

Where technical conditions specified in these Schedules conflict with the body of this agreement then, to the extent that conflict exists, the relevant technical condition or part of the relevant technical condition shall take precedence. Not all of these schedules will be required in all circumstances. For example, schedules covering generation equipment are only required when such equipment is in place. Similarly, small and simple three phase may need few, if any, of them.

List of schedules:

Schedule 1: Connection point details

Schedule 2: Technical supply capacities and sole use assets

Schedule 3: Site responsibility schedules

Schedule 4: Site specific operating arrangements

Schedule 5: Site specific technical conditions

Schedule 6: Site geographic plans

Schedule 7: Site operational diagrams

Schedule 8: *[customer name]'s* generating equipment

Schedule 9: Technical derogations

Schedule 10: Generating equipment connected to [customer name]'s installation

Schedule 11: Exclusion and limitations of liability for distributed generation unavailability payment

SCHEDULE 1: CONNECTION POINT DETAILS

Maximum permitted reactive power capacity	[kVAr import] (lagging p.f.) [kVAr export] (leading p.f.)
Default power factor at the connection point* * the nominal operating power factor shall be XXX	[Power factor leading or lagging]

SCHEDULE 2: TECHNICAL SUPPLY CAPACITIES AND SOLE USE ASSETS

Supply Point and Sole Use Assets Registration Sheet

Circuit name:		
Supply voltage		
Supply point		
Metering point substation		
Network Capacity	Thermal (kVA)	
Sole Use Cables	Voltage	
	Type & Length (m)	
	Capacity (distribution rating)	
	Capacity (continuous rating)	
	Impedance	
Sole Use Switchgear	Make/Type	
	Capacity (continuous rating)	

SCHEDULE 3: SITE RESPONSIBILITY SCHEDULES

Unless otherwise stated, responsibility follows ownership, but the site responsibilities shall be detailed in separate documentation between the parties in the form of a separate Site Responsibility Schedule Document.

SCHEDULE 4: SITE SPECIFIC OPERATING ARRANGEMENTS

GENERAL OPERATING ARRANGEMENTS FOR ALL SITES

1. DIVISION OF RESPONSIBILITY FOR CONTROL MAINTENANCE AND OPERATION

1.1. Unless otherwise stated in this agreement all apparatus on *[Utility name]'s* side of the Connection Point shall be controlled and operated by *[Utility name].*

1.2. Unless otherwise stated in this agreement all apparatus on [Customer name]'s side of the Connection Point shall be the responsibility of the *[Customer name].*

1.3. Drawings contained within Schedule 7 indicate the operational boundaries which shall apply.

2. SWITCHING OPERATIONS ON COMPANY CONTROLLED APPARATUS

[Customer name] may, in an emergency, trip the outgoing circuit breaker by remote emergency tripping facility provided by [*Utility name]* but *[Utility name]'s* Control Engineer must be informed immediately afterwards.

Energisation (or any subsequent re-energisation) or any non-emergency de-energisation of the connection point shall only be performed by *[Utility name]'s* authorised staff to the direct instructions of *[Utility name]'s* Control Engineer

Isolating and earthing operations on all high voltage apparatus controlled by *[Utility name]* shall only be performed by *[Utility name]'s* authorised staff to the direct instructions of *[Utility name]'s* Control Engineer.

3. WORK ON HIGH VOLTAGE EQUIPMENT

All work on high voltage apparatus controlled by *[Utility name]* shall be carried out in accordance with the *[Utility name]'s* Safety Rules and Operational Practice Manual utilising the *[Utility name]'s* Safety Documents.

Where such apparatus is capable of being energised from switchgear under the control of *[Customer name], [Customer name]* shall provide *[Utility name]* with an Operation, Isolation and Earthing (OIE) Certificate confirming actions taken to ensure safety and, where requested, demonstrate that the actions taken are appropriate in the circumstances. Unless otherwise agreed with *[Utility name]*, where *[Customer name]* operates its own control room a Record of Inter-System Safety Precautions (RISSP) procedure shall be utilised to ensure safe coordinated interaction of *[Customer name]'s* and *[Utility name]'s* control room activities and on-site work activities.

All work on high voltage apparatus controlled by *[Customer name]* shall be carried out in accordance with *[Customer name]'s* current arrangements OIE certificate(s) being provided by *[Utility name]* when necessary. When requested, any work by the *[Utility name]'s* staff shall be carried out under the approved safety document procedures utilising, where necessary, OIE certificate(s) provided by *[Customer name]* or the *[Utility name]'s*.

.

4. LOCKING OF SWITCHGEAR

4.1. On all *[Utility name]* controlled switchgear, *[Utility name]'s* locks shall be used to secure:

(a) all opening facilities apart from those specified in paragraph 2 above,

(b) all closing facilities apart from those specified in paragraph 2 above,

(c) all isolation and earthing facilities.

Responsibility for locking *[Customer name]* controlled apparatus rests with *[Customer name].*

5. IRREGULARITIES OF SUPPLY

   All faults or irregularities on both *[Utility name]'s* and *[Customer name]'s* high voltage equipment shall be reported immediately to the *[Utility name]'s* Control Engineer.

6. COMMUNICATION WITH THE CONTROL ENGINEER

   [Utility name]'s staff are on are on duty at all times in the *[Utility name]'s* Control Centre:

   [Contact details for *[Utility name]'s* Control Centre]

   When speaking to the *[Utility name]'s* Control Centre *[Customer name]'s* Representative should identify themselves and the substation they are calling about. Reports should be clear and concise.

7. COMMUNICATIONS WITH *[CUSTOMER NAME]'S* ENGINEERS

   [Customer name]'s engineers may be contacted as follows:

   [24hr contact details for Customer]

OPERATING ARRANGEMENTS APPLICABLE TO THE ENTIRE CUSTOMER SITE

Where connection points are sourced from a single tee point connection to *[Utility name]'s* distribution system the connection point may be subject to long-term de-energisation during abnormal network conditions and/or during periods of network maintenance.

The normal operating regime will be for *[Customer name]* to operate at a power factor prescribed in Schedule 1. Due to conditions on the distribution system and the transmission system, *[Utility name]* may by instruction from *[Utility name]'s* control engineer or instruction from *[Utility name]'s* autonomous control systems require *[Customer name]* where it operates generating equipment to operate such generating equipment within the range of 0.95 leading and 0.95 lagging as instructed by *[Utility name]'s* Control Centre. If *[Customer name]* cannot operate its generating equipment at the required power factor, *[Customer name]* may be instructed to reduce or disconnect their generating equipment from the distribution system.

OPERATING ARRANGEMENTS APPLICABLE TO SPECIFIC CONNECTION POINTS

Details of specific operating arrangements applicable to each operating point	

RESTRICTIONS ON USAGE BY TIME OF DAY, WEEK, MONTH OR YEAR The maximum import and/or export capacity is subject to the following restrictions:				
	Maximum Import (kVA)		**Maximum Export (kVA)**	
	Months or seasons as appropriate		**Months or seasons as appropriate**	
Time	**Working day**	**Non- working day**	**Working day**	**Non- working day**
Each 30-minute time period of the day				

The above restrictions shall be subject to review between the Parties every *[to be agreed between the parties]* years whereby the parties shall review the *[Customer name]'s* actual use

of the capacity against these restrictions for the purpose of ensuring efficient management of the network.

In this Schedule 4, the following expressions shall have the following meanings (unless the context requires otherwise):

(a) Working day: means any day other than a Saturday, a Sunday, or a day which is a public holiday;

(b) Non-working day: means any day that is not a working day

SCHEDULE 5 - SITE SPECIFIC TECHNICAL CONDITIONS

GENERAL TECHNICAL CONDITIONS

[Customer name] must inform t*[Utility name]* in writing of any intended or actual material changes to the magnitude or timing of the consumption of electricity (i.e. load) or generation covered by this agreement.

Protection Settings

[Customer name] shall provide suitable protection.

The exact test and protection settings will be notified to the parties in writing at a future date to be agreed.

The protection tests should include the testing of vector shift relays response to the change of voltage vector by secondary injection or to rate of change of frequency relays response to the change of frequency by secondary injection as is relevant to the nature of the *[Customer name]* installation and generating equipment connected to it.

Earthing System Impedance

[Customer name] should endeavour to ensure that the rise of earth potential at the site under earth fault conditions remains below 430volts.

Details of site specific technical conditions	

SCHEDULE 6: SITE GEOGRAPHIC PLANS

Plans sufficient to detail all connection points included within this agreement shall be appended to this Schedule.

SCHEDULE 7: SITE OPERATIONAL DIAGRAMS

Diagrams sufficient to detail all connection points included within this agreement and their connection arrangements shall be appended to this Schedule.

SCHEDULE 8: *[CUSTOMER NAME]'S* GENERATING EQUIPMENT

1. *[Customer name]'s* Generating Equipment consists of:
   (a) [*Detailed inventory of generating equipment, if applicable]; and*
   (b) *[Detailed inventory of connection control and protection equipment].*

SCHEDULE 9: TECHNICAL DEROGATIONS

[Details of technical derogations applicable to the whole site and/or each individual connection point].

SCHEDULE 10: GENERATING EQUIPMENT CONNECTED TO *[CUSTOMER NAME]'S* INSTALLATION

[Customer name] shall notify *[Utility name]* of generating equipment capability connected to *[Customer name]'s* installation, as follows:

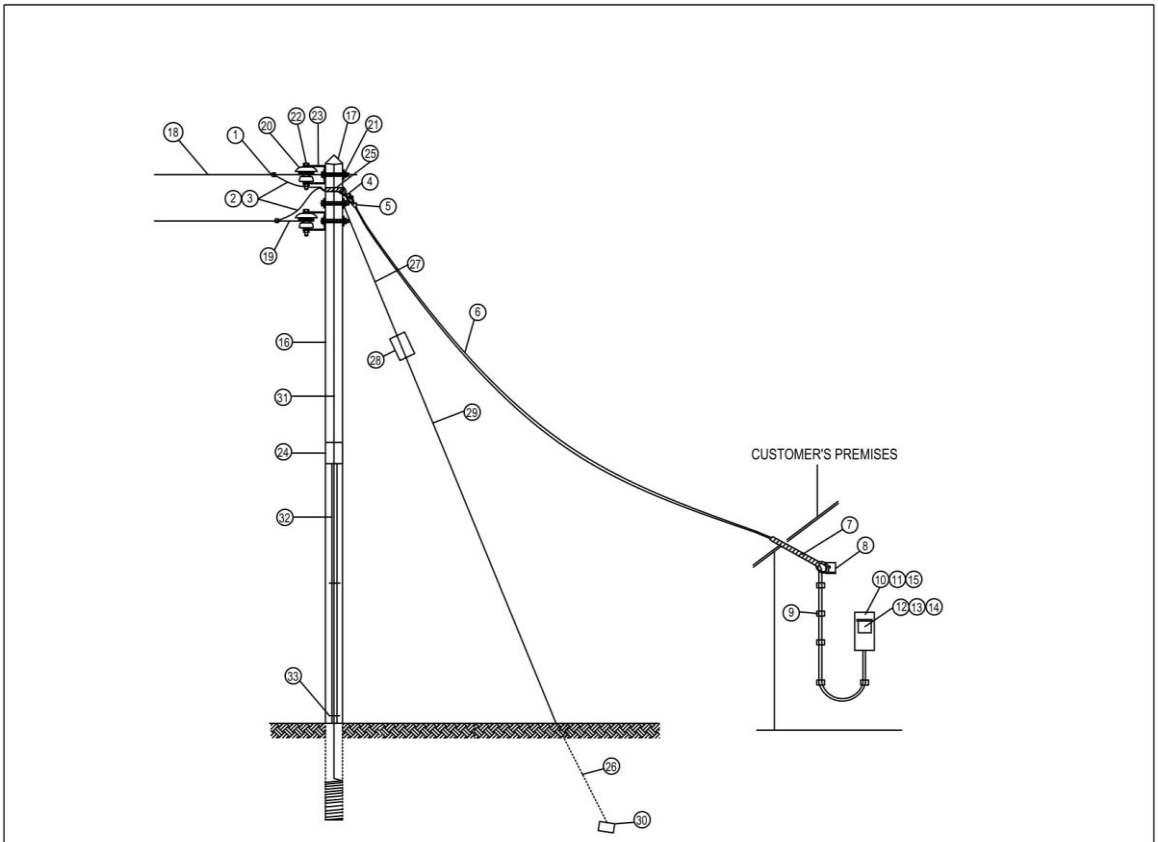
Date of Installation	Generating Equipment Type	Nature of Generating Equipment connection (Long-term parallel / infrequent short-term parallel / switched alternative-only)	Generating equipment capacity (kW) Alternating Current Root Mean Squared magnitude of power output into the Alternating Current part of the Customer's Installation)	Generating Equipment Fault Level Contribution (kA) Alternating Current contribution at the Connection Point			
				Ik" sub-transient		Ik' transient	
				1 phase	3 phase	1 phase	3 phase

SCHEDULE 11: EXCLUSION AND LIMITATIONS OF LIABILITY FOR DISTRIBUTED GENERATION UNAVAILABILITY

Notwithstanding the provisions of Schedule 10, *[Utility name]* shall not be liable for availability of distributed generation connection at low voltage to *[Utility name]'s* distribution network.

Appendix 4 - Drawings illustrating technical details of connections

Figure 2: LV single-phase no pole / one pole service connection using traditional meter (bare conductor network)



DRAWING LABELLING

ITEM	DESCRIPTION	UNIT	QTY	ITEM	DESCRIPTION	UNIT	QTY
SERVICE MATERIALS				LINE MATERIALS			
1	LINE TAP / PARALLEL GROOVE CLAMP	PIECE	2	16	TREATED WOOD POLE	PIECE	1
2	SINGLE CORE CABLE - RED	METRE	1.5	17	POLE CAP	PIECE	1
3	SINGLE CORE CABLE - BLACK	METRE	1.5	18	BARE CONDUCTOR	METRE	140 *
4	PIG TAIL SCREW	PIECE	1	19	PREFORMED DEAD-END	PIECE	4
5	STRAIN CLAMP	PIECE	1	20	REEL INSULATOR	PIECE	4
6	CONCENTRIC SOLIDAL CABLE 16sqmm	METRE	35 *	21	BOLT AND NUT 5/8 x 11"	PIECE	4
7	PREFORMED DEAD-END	PIECE	1	22	BOLT AND NUT 5/8 x 4"	PIECE	4
8	LANDING BRACKET	PIECE	1	23	D-IRON	PIECE	4
9	SERVICE CABLE ROUND CLIP	PIECE	20	24	DANGER SIGN PLATE	PIECE	1
10	WALL PLUG	PIECE	4	25	POLE TOP MAKE OFF FOR 7/12 SWG	PIECE	1
11	WALL SCREW	PIECE	4	26	STAY ROD 6FT X 7/12"	PIECE	1
12	SINGLE PHASE MAGNETIC CIRCUIT BREAKER	PIECE	1	27	GUY GRIP FOR 7/12 SWG	PIECE	4
13	TRADITIONAL METER 1 PHASE	PIECE	1	28	STAY INSULATOR	PIECE	1
14	INSULATING TAPE	PIECE	1	29	STAY WIRE 7/12 SWG	METRE	10
15	RAWLPLUG / WALL BOLT	PIECE	1	30	KICKING BLOCK (STUB)	PIECE	1
				31	EARTH WIRE, STEEL 3/.102 SWG	METRE	15
				32	PVC EARTH WIRE SHEATH	PIECE	1
				33	STEEL STAPLE / U NAIL	PIECE	15

FOR A NO-POLE SERVICE CONNECTION, MATERIALS IN THE RIGHT-HAND COLUMN "LINE MATERIALS" SHOULD BE EXCLUDED FROM THE BILL OF MATERIALS.

* MAXIMUM VALUE - ACTUAL LENGTH TO BE DEFINED IN EACH CASE AS REQUIRED.

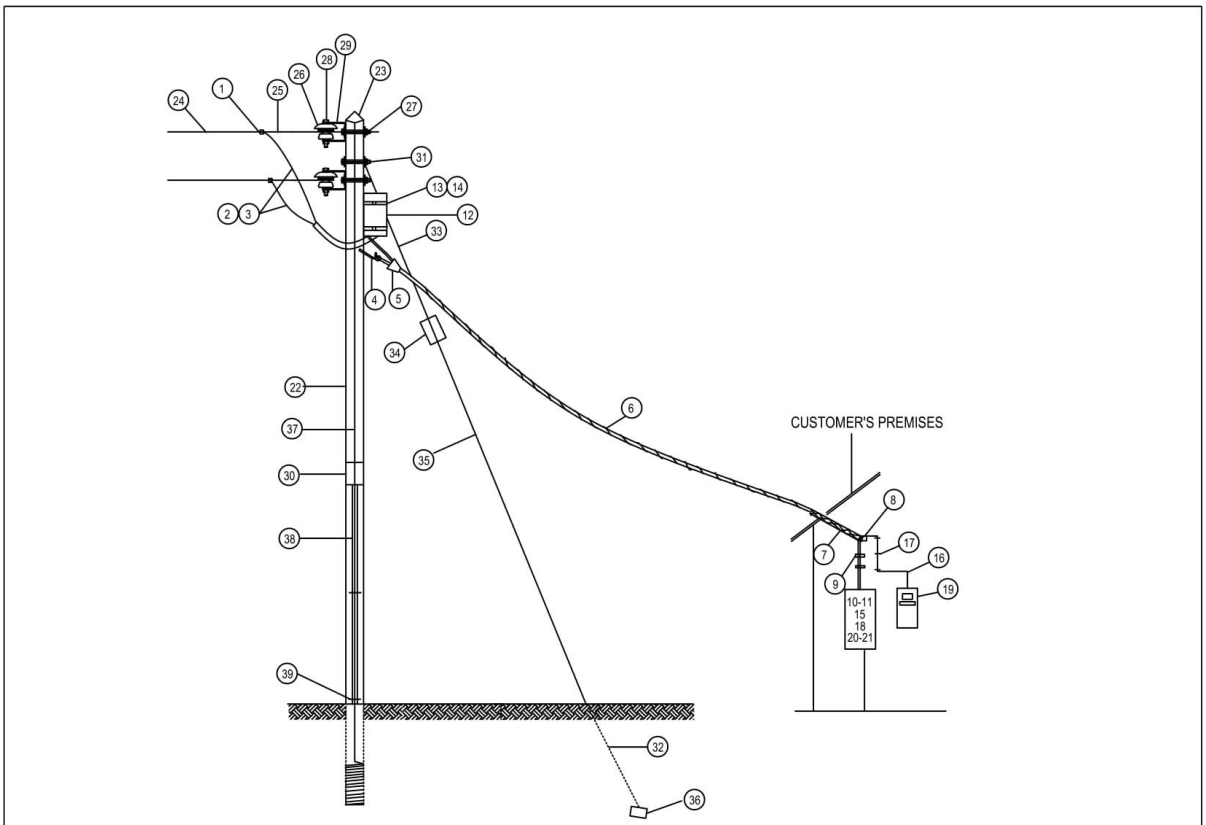
1-PHASE TRADITIONAL METER CONNECTION
(BARE CONDUCTOR)

A B C D E F

APPROVED BY:
DATE:

PRODUCED BY
DRAWN BY:
CHECKED BY:
DATE:
SCALE:

Figure 3: LV single-phase no pole / one pole service connection using wired pre-paid split meter (bare conductor network)



DRAWING LABELLING

ITEM	DESCRIPTION	UNIT	QTY	ITEM	DESCRIPTION	UNIT	QTY
	SERVICE MATERIALS				LINE MATERIALS		
1	LINE TAP / PARALLEL GROOVE CLAMP	PIECE	2	22	TREATED WOOD POLE	PIECE	1
2	SINGLE CORE CABLE RED	METRE	1.5	23	POLE CAP	PIECE	1
3	SINGLE CORE CABLE BLACK	METRE	1.5	24	BARE CONDUCTOR	METRE	140 *
4	PIG TAIL SCREW	PIECE	1	25	PREFORMED DEAD-END	PIECE	4
5	STRAIN CLAMP	PIECE	1	26	REEL INSULATOR	PIECE	4
6	CONCENTRIC SOLIDAL CABLE 16sqmm	METRE	35 *	27	BOLT AND NUT 5/8 x 11"	PIECE	4
7	PREFORMED DEAD-END	PIECE	1	28	BOLT AND NUT 5/8 x 4"	PIECE	4
8	LANDING BRACKET	PIECE	1	29	D-IRON	PIECE	4
9	SERVICE CABLE ROUND CLIP	PIECE	20	30	DANGER SIGN PLATE	PIECE	1
10	WALL PLUG	PIECE	4	31	POLE TOP MAKE OFF FOR 7/12 SWG	PIECE	1
11	WALL SCREW	PIECE	4	32	STAY ROD 6FT x 7/12"	PIECE	1
12	PRE-WIRED PRE-PAID METER FULLY BOXED - STANDARD WIRED VERSION	PIECE	1	33	GUY GRIP FOR 7/12 SWG	PIECE	4
13	BAND-IT STRAP	PIECE	2	34	STAY INSULATOR	PIECE	1
14	STRAP BUCKLE	PIECE	2	35	STAY WIRE 7/12 SWG	METRE	10
15	SINGLE PHASE MAGNETIC CIRCUIT BREAKER	PIECE	1	36	KICKING BLOCK (STUB)	PIECE	1
16	COMMUNICATION CABLE	METRE	20	37	EARTH WIRE, STEEL 3/.102 SWG	METRE	15
17	COMMUNICATION CABLE CLIPS	PIECE	20	38	PVC EARTH WIRE SHEATH	PIECE	1
18	COMMUNICATION JUNCTION BOX	PIECE	1	39	STEEL STAPLE / U NAIL	PIECE	15
19	CUSTOMER INTERFACE UNIT	PIECE	1				
20	INSULATING TAPE	PIECE	1				
21	RAWLPLUG / WALL BOLT	PIECE	1				

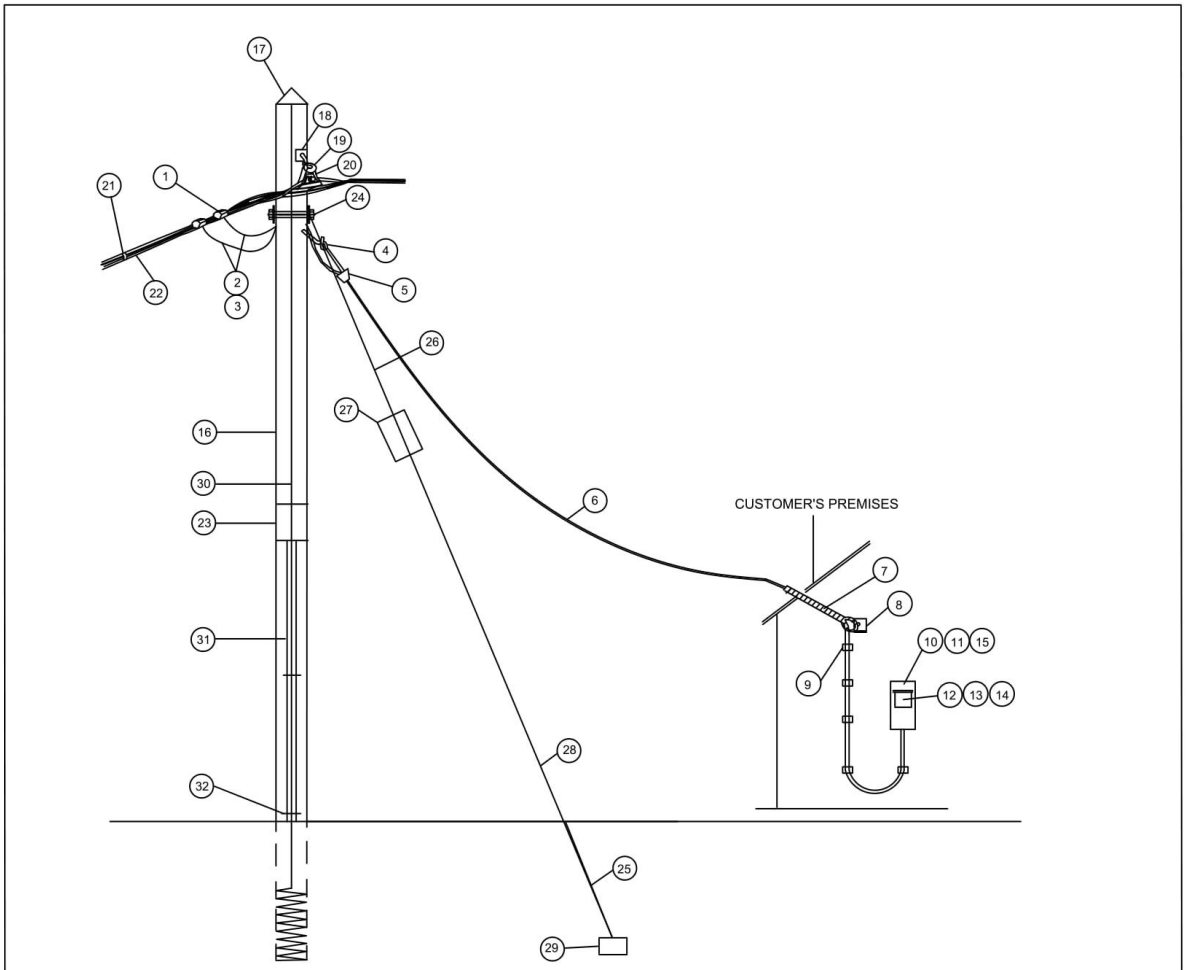
FOR A NO-POLE SERVICE CONNECTION, MATERIALS IN THE RIGHT-HAND COLUMN "LINE MATERIALS" SHOULD BE EXCLUDED FROM THE BILL OF MATERIALS.

* MAXIMUM VALUE - ACTUAL LENGTH TO BE DEFINED IN EACH CASE AS REQUIRED.

1-PHASE PRE-PAID WIRED SPLIT-METER CONNECTION
(BARE CONDUCTOR)

A		D		APPROVED BY:	PRODUCED BY / DRAWN BY:
B		E			CHECKED BY: / DATE:
C		F		DATE:	SCALE:

Figure 4: LV single-phase no pole / one pole service connection using traditional meter (aerial bundled conductors (ABC) network)



DRAWING LABELLING

ITEM	DESCRIPTION	UNIT	QTY	ITEM	DESCRIPTION	UNIT	QTY
	SERVICE MATERIALS				LINE MATERIALS		
1	INSULATION PIERCING CONNECTOR	PIECE	2	16	TREATED WOOD POLE	PIECE	1
2	SINGLE CORE CABLE RED	METRE	1.5	17	POLE CAP	PIECE	1
3	SINGLE CORE CABLE BLACK	METRE	1.5	18	SQUARE CURVED WASHER	PIECE	2
4	PIG TAIL SCREW	PIECE	1	19	PIG TAIL HOOK BOLT AND NUT M16 x 12"	PIECE	1
5	STRAIN CLAMP	PIECE	1	20	SUSPENSION CLAMP	PIECE	1
6	CONCENTRIC SOLIDAL CABLE 16sqmm	METRE	35 *	21	CABLE TIE	PIECE	10
7	PREFORMED DEAD-END	PIECE	1	22	ABC CONDUCTOR	METRE	70 *
8	LANDING BRACKET	PIECE	1	23	DANGER SIGN PLATE	PIECE	1
9	SERVICE CABLE ROUND CLIP	PIECE	20	24	POLE TOP MAKE OFF FOR 7/12 SWG	PIECE	1
10	WALL PLUG	PIECE	4	25	STAY ROD 6FT x 7/12"	PIECE	1
11	WALL SCREW	PIECE	4	26	GUY GRIP FOR 7/12 SWG	PIECE	4
12	SINGLE PHASE MAGNETIC CIRCUIT BREAKER	PIECE	1	27	STAY INSULATOR	PIECE	1
13	TRADITIONAL METER 1 PHASE	PIECE	1	28	STAY WIRE 7/12 SWG	METRE	10
14	INSULATING TAPE	PIECE	1	29	KICKING BLOCK (STUB)	PIECE	1
15	RAWLPLUG / WALL BOLT	PIECE	1	30	EARTH WIRE, STEEL 3/.102 SWG	METRE	15
				31	PVC EARTH WIRE SHEATH	PIECE	1
				32	STEEL STAPLE / U NAIL	PIECE	15

FOR A NO-POLE SERVICE CONNECTION, MATERIALS IN RIGHT-HAND COLUMN "LINE MATERIALS" SHOULD BE EXCLUDED FROM THE BILL OF MATERIALS.

* MAXIMUM VALUE - ACTUAL LENGTH TO BE DEFINED IN EACH CASE AS REQUIRED.

1-PHASE TRADITIONAL METER CONNECTION (ABC)

A B C D E F

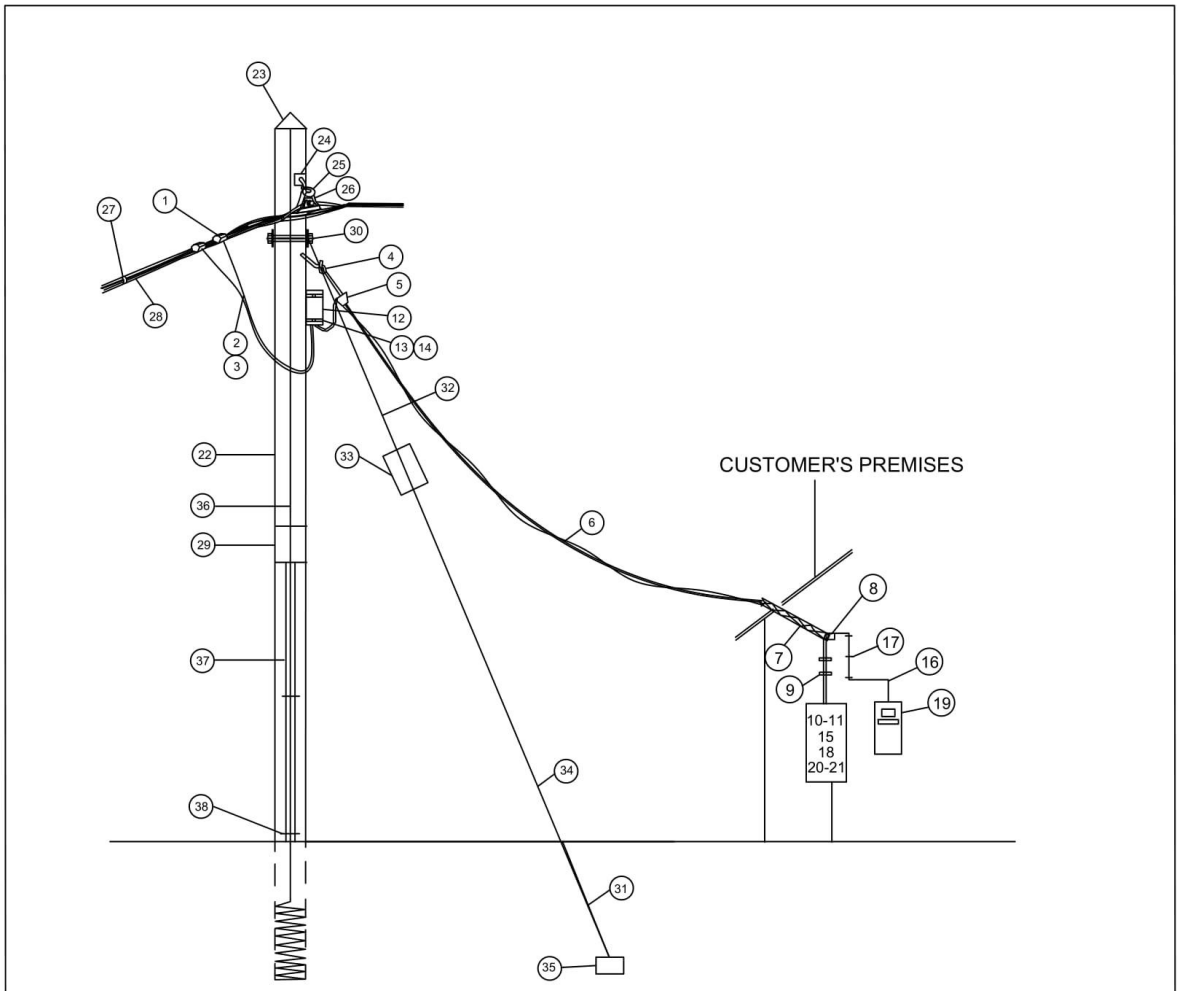
APPROVED BY: DATE:

PRODUCED BY DRAWN BY:

CHECKED BY: DATE:

SCALE:

Figure 5: LV single-phase no pole / one pole service connection using wired pre-paid split meter (aerial bundled conductors (ABC) network)



DRAWING LABELLING

ITEM	DESCRIPTION	UNIT	QTY	ITEM	DESCRIPTION	UNIT	QTY
	SERVICE MATERIALS				LINE MATERIALS		
1	INSULATION PIERCING CONNECTOR	PIECE	2	22	TREATED WOOD POLE	PIECE	1
2	SINGLE CORE CABLE RED	METRE	1.5	23	POLE CAP	PIECE	1
3	SINGLE CORE CABLE BLACK	METRE	1.5	24	SQUARE CURVED WASHER	PIECE	2
4	PIG TAIL SCREW	PIECE	1	25	PIG TAIL HOOK BOLT AND NUT M16 x 12"	PIECE	1
5	STRAIN CLAMP	PIECE	1	26	SUSPENSION CLAMP	PIECE	1
6	CONCENTRIC SOLIDAL CABLE 16sqmm	METRE	35 *	27	CABLE TIE	PIECE	10
7	PREFORMED DEAD-END	PIECE	1	28	ABC CONDUCTOR	METRE	70 *
8	LANDING BRACKET	PIECE	1	29	DANGER SIGN PLATE	PIECE	1
9	SERVICE CABLE ROUND CLIP	PIECE	20	30	POLE TOP MAKE OFF FOR 7/12 SWG	PIECE	1
10	WALL PLUG	PIECE	4	31	STAY ROD 6FT x 7/12"	PIECE	1
11	WALL SCREW	PIECE	4	32	GUY GRIP FOR 7/12 SWG	PIECE	4
12	PRE-WIRED PRE-PAID METER FULLY BOXED - STANDARD WIRED VERSION	PIECE	1	33	STAY INSULATOR	PIECE	1
13	BAND-IT STRAP	PIECE	2	34	STAY WIRE 7/12 SWG	METRE	10
14	STRAP BUCKLE	PIECE	2	35	KICKING BLOCK (STUB)	PIECE	1
15	SINGLE PHASE MAGNETIC CIRCUIT BREAKER	PIECE	1	36	EARTH WIRE, STEEL 3/.102 SWG	METRE	15
16	COMMUNICATION CABLE	METRE	20	37	PVC EARTH WIRE SHEATH	PIECE	1
17	COMMUNICATION CABLE CLIPS	PIECE	20	38	STEEL STAPLE / U NAIL	PIECE	15
18	COMMUNICATION JUNCTION BOX	PIECE	1				
19	CUSTOMER INTERFACE UNIT	PIECE	1				
20	INSULATING TAPE	PIECE	1				
21	RAWLPLUG / WALL BOLT	PIECE	1				

FOR A NO-POLE SERVICE CONNECTION, MATERIALS IN THE RIGHT-HAND COLUMN "LINE MATERIALS" SHOULD BE EXCLUDED FROM THE BILL OF MATERIALS.

* MAXIMUM VALUE - ACTUAL LENGTH TO BE DEFINED IN EACH CASE AS REQUIRED.

1-PHASE PRE-PAID WIRED SPLIT-METER CONNECTION (ABC)

A B C D E F

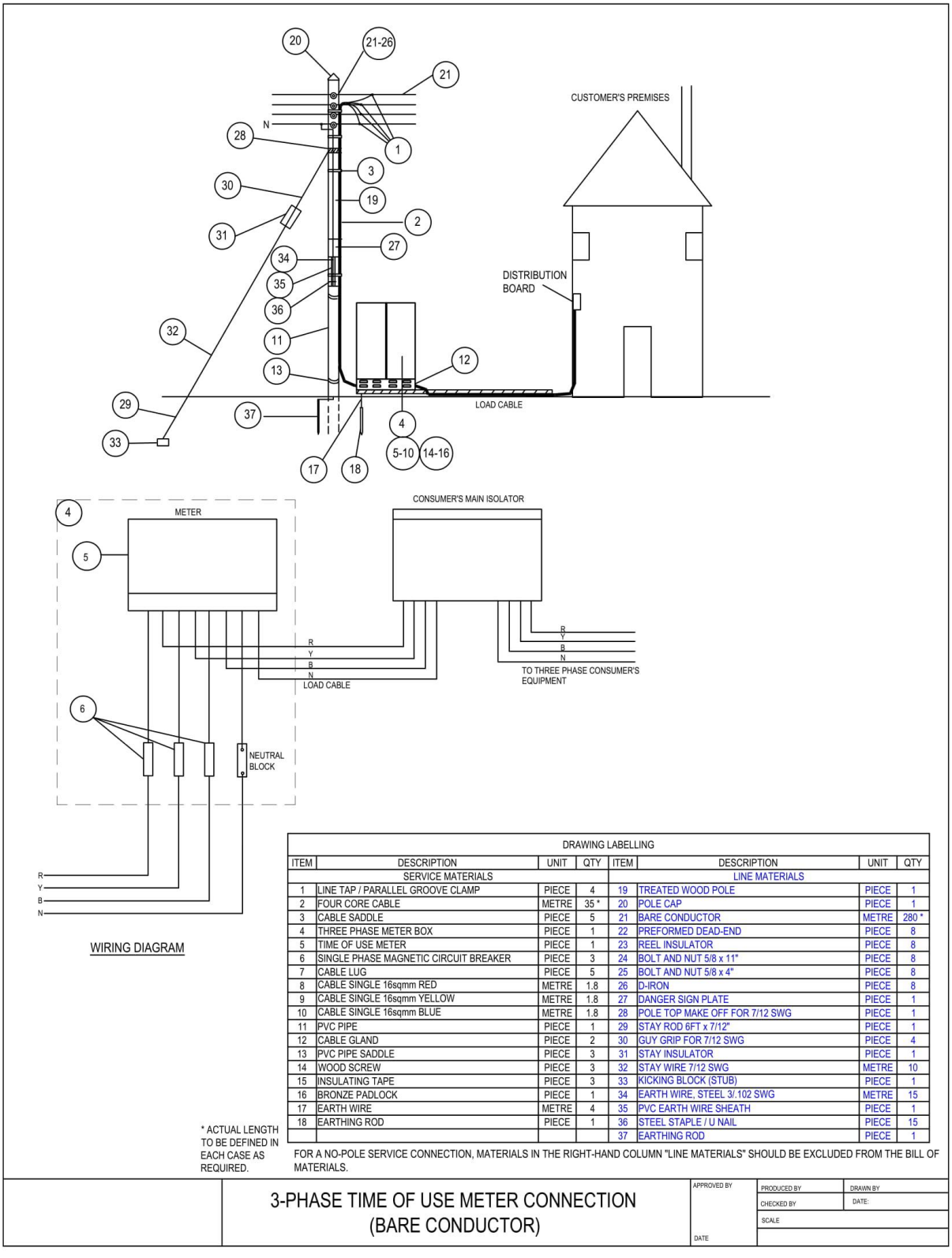
APPROVED BY: DATE:

PRODUCED BY DRAWN BY:

CHECKED BY: DATE:

SCALE:

Figure 6: LV three-phase no pole / one pole service connection using time-of-use meter (bare conductor network)



DRAWING LABELLING

ITEM	DESCRIPTION	UNIT	QTY	ITEM	DESCRIPTION	UNIT	QTY
	SERVICE MATERIALS				LINE MATERIALS		
1	LINE TAP / PARALLEL GROOVE CLAMP	PIECE	4	19	TREATED WOOD POLE	PIECE	1
2	FOUR CORE CABLE	METRE	35 *	20	POLE CAP	PIECE	1
3	CABLE SADDLE	PIECE	5	21	BARE CONDUCTOR	METRE	280 *
4	THREE PHASE METER BOX	PIECE	1	22	PREFORMED DEAD-END	PIECE	8
5	TIME OF USE METER	PIECE	1	23	REEL INSULATOR	PIECE	8
6	SINGLE PHASE MAGNETIC CIRCUIT BREAKER	PIECE	3	24	BOLT AND NUT 5/8 x 11"	PIECE	8
7	CABLE LUG	PIECE	5	25	BOLT AND NUT 5/8 x 4"	PIECE	8
8	CABLE SINGLE 16sqmm RED	METRE	1.8	26	D-IRON	PIECE	8
9	CABLE SINGLE 16sqmm YELLOW	METRE	1.8	27	DANGER SIGN PLATE	PIECE	1
10	CABLE SINGLE 16sqmm BLUE	METRE	1.8	28	POLE TOP MAKE OFF FOR 7/12 SWG	PIECE	1
11	PVC PIPE	PIECE	1	29	STAY ROD 6FT x 7/12"	PIECE	1
12	CABLE GLAND	PIECE	2	30	GUY GRIP FOR 7/12 SWG	PIECE	4
13	PVC PIPE SADDLE	PIECE	3	31	STAY INSULATOR	PIECE	1
14	WOOD SCREW	PIECE	3	32	STAY WIRE 7/12 SWG	METRE	10
15	INSULATING TAPE	PIECE	3	33	KICKING BLOCK (STUB)	PIECE	1
16	BRONZE PADLOCK	PIECE	1	34	EARTH WIRE, STEEL 3/.102 SWG	METRE	15
17	EARTH WIRE	METRE	4	35	PVC EARTH WIRE SHEATH	PIECE	1
18	EARTHING ROD	PIECE	1	36	STEEL STAPLE / U NAIL	PIECE	15
				37	EARTHING ROD	PIECE	1

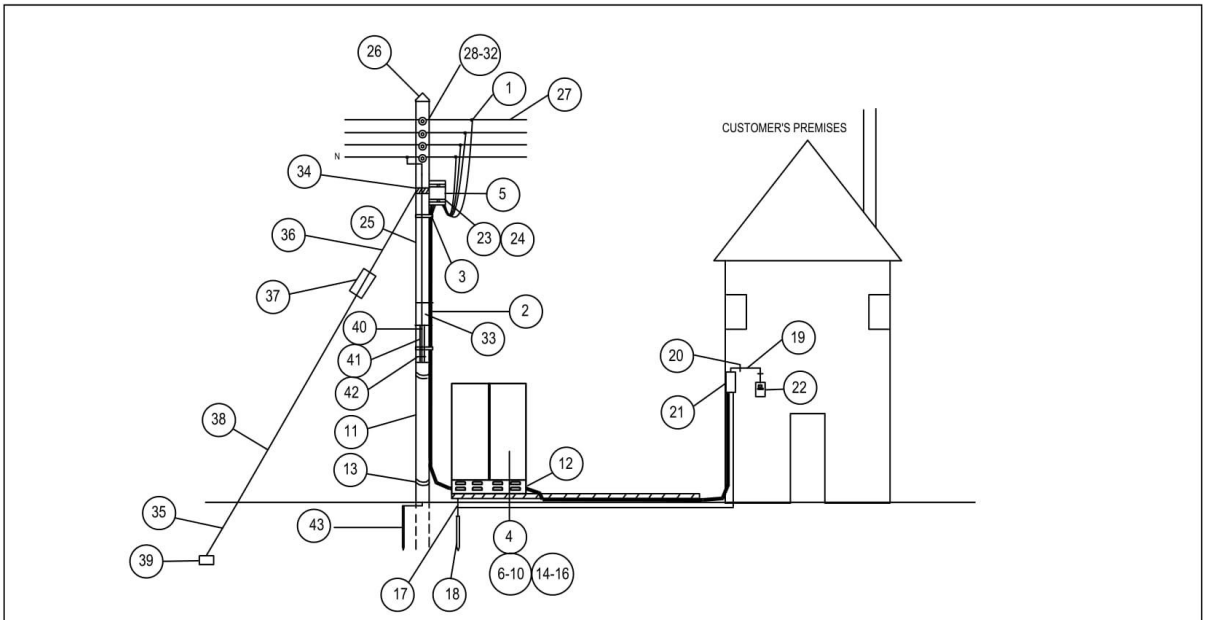
* ACTUAL LENGTH TO BE DEFINED IN EACH CASE AS REQUIRED.

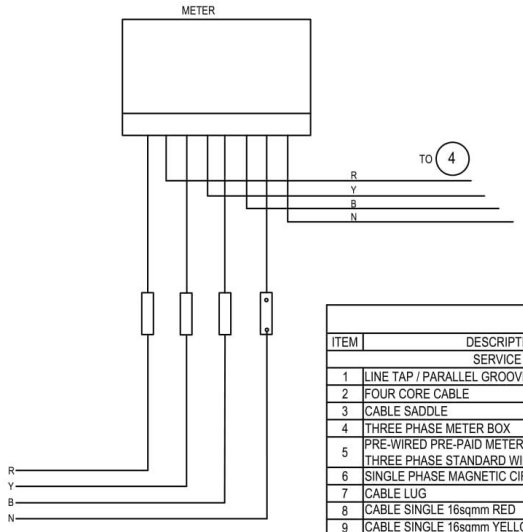
FOR A NO-POLE SERVICE CONNECTION, MATERIALS IN THE RIGHT-HAND COLUMN "LINE MATERIALS" SHOULD BE EXCLUDED FROM THE BILL OF MATERIALS.

3-PHASE TIME OF USE METER CONNECTION (BARE CONDUCTOR)

APPROVED BY | DATE | PRODUCED BY | DRAWN BY | CHECKED BY | DATE: | SCALE

Figure 7: LV three-phase no pole / one pole service connection using wired pre-paid split meter (bare conductor network)





PRE-PAID BOX WIRING DIAGRAM

DRAWING LABELLING

ITEM	DESCRIPTION	UNIT	QTY	ITEM	DESCRIPTION	UNIT	QTY
	SERVICE MATERIALS				LINE MATERIALS		
1	LINE TAP / PARALLEL GROOVE CLAMP	PIECE	4	25	TREATED WOOD POLE	PIECE	1
2	FOUR CORE CABLE	METRE	35 *	26	POLE CAP	PIECE	1
3	CABLE SADDLE	PIECE	5	27	BARE CONDUCTOR	METRE	280 *
4	THREE PHASE METER BOX	PIECE	1	28	PREFORMED DEAD-END	PIECE	8
5	PRE-WIRED PRE-PAID METER FULLY BOXED - THREE PHASE STANDARD WIRED VERSION	PIECE	1	29	REEL INSULATOR	PIECE	8
6	SINGLE PHASE MAGNETIC CIRCUIT BREAKER	PIECE	3	30	BOLT AND NUT 5/8 x 11"	PIECE	8
7	CABLE LUG	PIECE	5	31	BOLT AND NUT 5/8 x 4"	PIECE	8
8	CABLE SINGLE 16sqmm RED	METRE	1.8	32	D-IRON	PIECE	8
9	CABLE SINGLE 16sqmm YELLOW	METRE	1.8	33	DANGER SIGN PLATE	PIECE	1
10	CABLE SINGLE 16sqmm BLUE	METRE	1.8	34	POLE TOP MAKE OFF FOR 7/12 SWG	PIECE	1
11	PVC PIPE	PIECE	1	35	STAY ROD 6FT x 7/12"	PIECE	1
12	CABLE GLAND	PIECE	2	36	GUY GRIP FOR 7/12 SWG	PIECE	4
13	PVC PIPE SADDLE	PIECE	3	37	STAY INSULATOR	PIECE	1
14	WOOD SCREW	PIECE	3	38	STAY WIRE 7/12 SWG	METRE	10
15	INSULATING TAPE	PIECE	3	39	KICKING BLOCK (STUB)	PIECE	1
16	BRONZE PADLOCK	PIECE	1	40	EARTH WIRE, STEEL 3/.102 SWG	METRE	15
17	EARTH WIRE	METRE	4	41	PVC EARTH WIRE SHEATH	PIECE	1
18	EARTHING ROD	PIECE	1	42	STEEL STAPLE / U NAIL	PIECE	15
19	COMMUNICATION CABLE	METRE	20	43	EARTHING ROD	PIECE	1
20	COMMUNICATION CABLE CLIPS	PIECE	20				
21	COMMUNICATION JUNCTION BOX	PIECE	1				
22	CUSTOMER INTERFACE UNIT	PIECE	1				
23	BAND-IT STRAP	PIECE	2				
24	STRAP BUCKLE	PIECE	2				

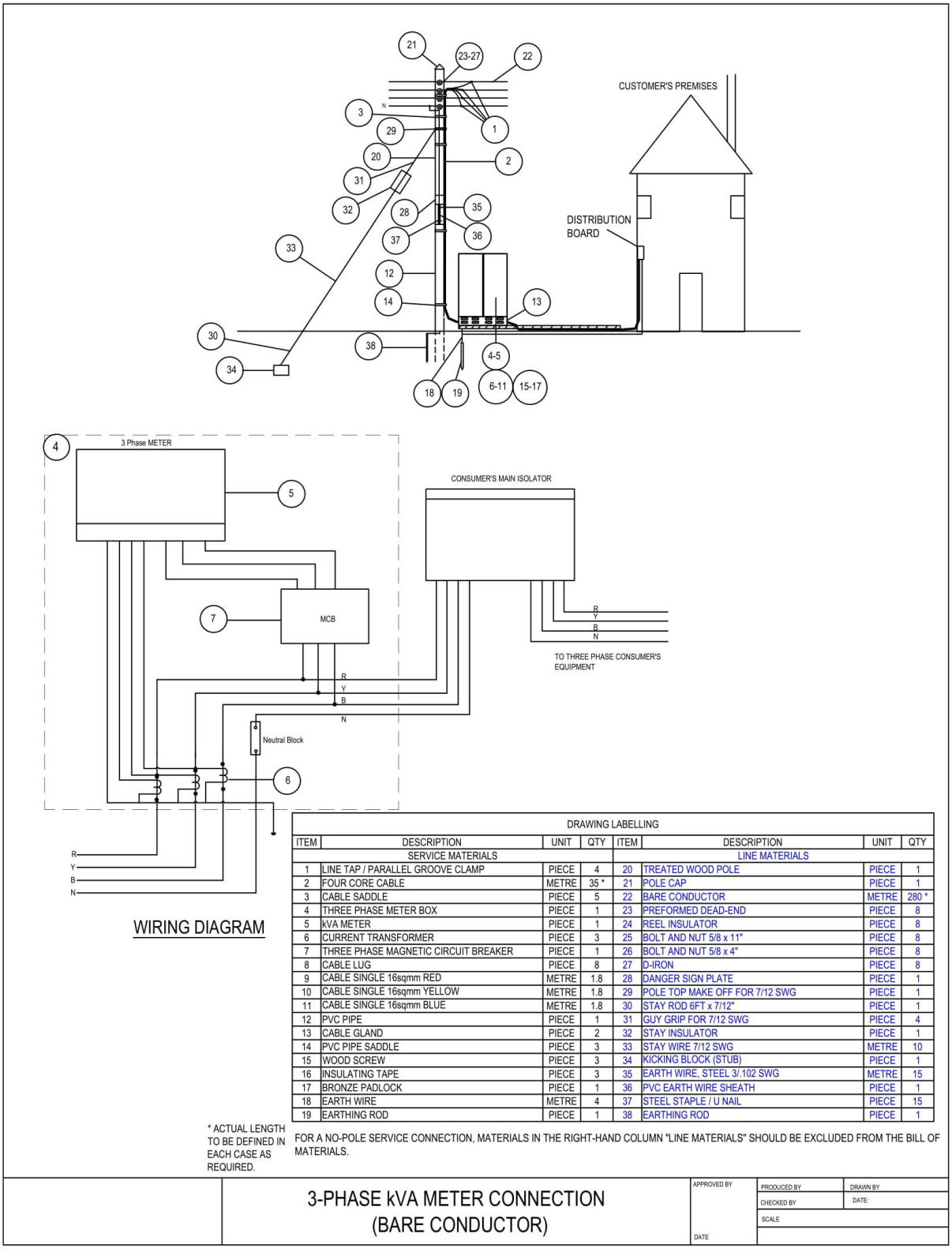
* ACTUAL LENGTH TO BE DEFINED IN EACH CASE AS REQUIRED.

FOR A NO-POLE SERVICE CONNECTION, MATERIALS IN THE RIGHT-HAND COLUMN "LINE MATERIALS" SHOULD BE EXCLUDED FROM THE BILL OF MATERIALS.

3-PHASE PRE-PAID WIRED SPLIT-METER CONNECTION (BARE CONDUCTOR)

APPROVED BY | DATE | PRODUCED BY | DRAWN BY | CHECKED BY | DATE: | SCALE

Figure 8: LV three-phase no pole / one pole service connection using kVA meter (bare conductor network)



DRAWING LABELLING

ITEM	DESCRIPTION	UNIT	QTY	ITEM	DESCRIPTION	UNIT	QTY
	SERVICE MATERIALS				LINE MATERIALS		
1	LINE TAP / PARALLEL GROOVE CLAMP	PIECE	4	20	TREATED WOOD POLE	PIECE	1
2	FOUR CORE CABLE	METRE	35 *	21	POLE CAP	PIECE	1
3	CABLE SADDLE	PIECE	5	22	BARE CONDUCTOR	METRE	280 *
4	THREE PHASE METER BOX	PIECE	1	23	PREFORMED DEAD-END	PIECE	8
5	kVA METER	PIECE	1	24	REEL INSULATOR	PIECE	8
6	CURRENT TRANSFORMER	PIECE	3	25	BOLT AND NUT 5/8 x 11"	PIECE	8
7	THREE PHASE MAGNETIC CIRCUIT BREAKER	PIECE	1	26	BOLT AND NUT 5/8 x 4"	PIECE	8
8	CABLE LUG	PIECE	8	27	D-IRON	PIECE	8
9	CABLE SINGLE 16sqmm RED	METRE	1.8	28	DANGER SIGN PLATE	PIECE	1
10	CABLE SINGLE 16sqmm YELLOW	METRE	1.8	29	POLE TOP MAKE OFF FOR 7/12 SWG	PIECE	1
11	CABLE SINGLE 16sqmm BLUE	METRE	1.8	30	STAY ROD 6FT x 7/12"	PIECE	1
12	PVC PIPE	PIECE	1	31	GUY GRIP FOR 7/12 SWG	PIECE	4
13	CABLE GLAND	PIECE	2	32	STAY INSULATOR	PIECE	1
14	PVC PIPE SADDLE	PIECE	3	33	STAY WIRE 7/12 SWG	METRE	10
15	WOOD SCREW	PIECE	3	34	KICKING BLOCK (STUB)	PIECE	1
16	INSULATING TAPE	PIECE	3	35	EARTH WIRE, STEEL 3/.102 SWG	METRE	15
17	BRONZE PADLOCK	PIECE	1	36	PVC EARTH WIRE SHEATH	PIECE	1
18	EARTH WIRE	METRE	4	37	STEEL STAPLE / U NAIL	PIECE	15
19	EARTHING ROD	PIECE	1	38	EARTHING ROD	PIECE	1

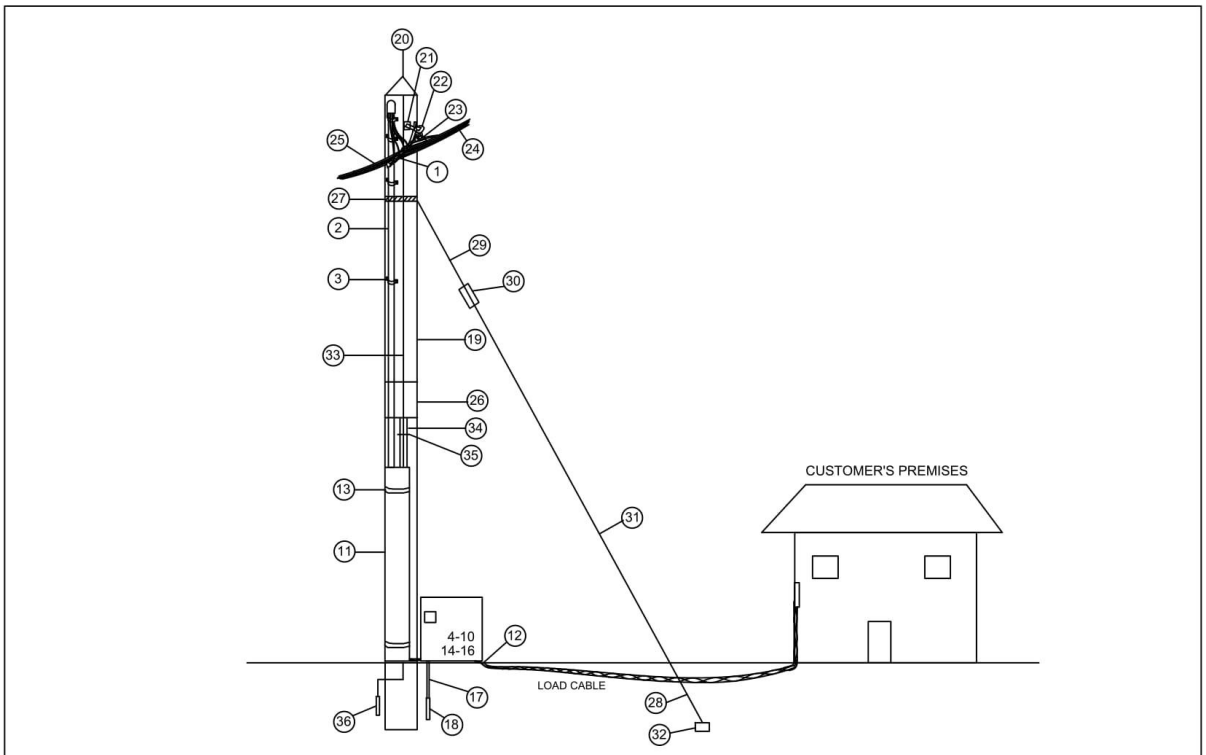
* ACTUAL LENGTH TO BE DEFINED IN EACH CASE AS REQUIRED.

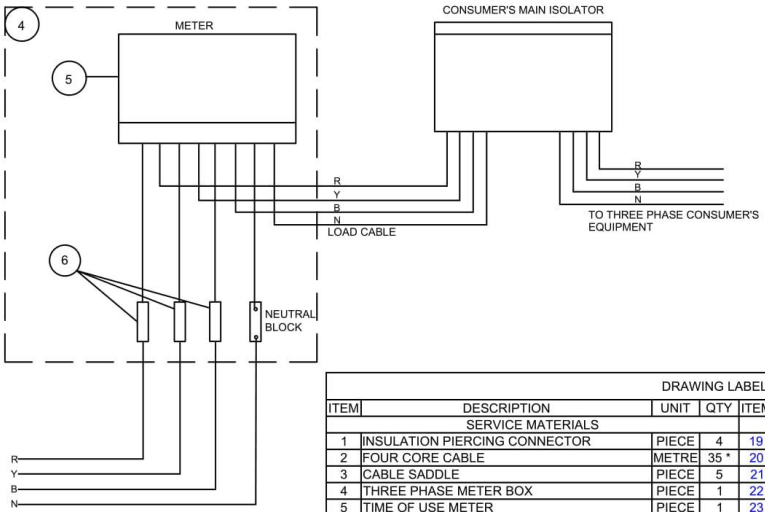
FOR A NO-POLE SERVICE CONNECTION, MATERIALS IN THE RIGHT-HAND COLUMN "LINE MATERIALS" SHOULD BE EXCLUDED FROM THE BILL OF MATERIALS.

3-PHASE kVA METER CONNECTION (BARE CONDUCTOR)

APPROVED BY | DATE | PRODUCED BY | DRAWN BY | CHECKED BY | DATE: | SCALE

Figure 9: LV three-phase no pole / one pole service connection using time-of-use meter (aerial bundled conductors (ABC) network)





WIRING DIAGRAM

DRAWING LABELLING

ITEM	DESCRIPTION	UNIT	QTY	ITEM	DESCRIPTION	UNIT	QTY
	SERVICE MATERIALS				LINE MATERIALS		
1	INSULATION PIERCING CONNECTOR	PIECE	4	19	TREATED WOOD POLE	PIECE	1
2	FOUR CORE CABLE	METRE	35 *	20	POLE CAP	PIECE	1
3	CABLE SADDLE	PIECE	5	21	SQUARE CURVED WASHER	PIECE	2
4	THREE PHASE METER BOX	PIECE	1	22	PIG TAIL HOOK BOLT AND NUT M16 x 12"	PIECE	1
5	TIME OF USE METER	PIECE	1	23	SUSPENSION CLAMP	PIECE	1
6	SINGLE PHASE MAGNETIC CIRCUIT BREAKER	PIECE	3	24	CABLE TIE	PIECE	10
7	CABLE LUG	PIECE	5	25	ABC CONDUCTOR	METRE	70 *
8	CABLE SINGLE 16sqmm RED	METRE	1.8	26	DANGER SIGN PLATE	PIECE	1
9	CABLE SINGLE 16sqmm YELLOW	METRE	1.8	27	POLE TOP MAKE OFF FOR 7/12 SWG	PIECE	1
10	CABLE SINGLE 16sqmm BLUE	METRE	1.8	28	STAY ROD 6FT x 7/12"	PIECE	1
11	PVC PIPE	PIECE	1	29	GUY GRIP FOR 7/12 SWG	PIECE	4
12	CABLE GLAND	PIECE	2	30	STAY INSULATOR	PIECE	1
13	PVC PIPE SADDLE	PIECE	3	31	STAY WIRE 7/12 SWG	METRE	10
14	WOOD SCREW	PIECE	3	32	KICKING BLOCK (STUB)	PIECE	1
15	INSULATING TAPE	PIECE	3	33	EARTH WIRE, STEEL 3/.102 SWG	METRE	15
16	BRONZE PADLOCK	PIECE	1	34	PVC EARTH WIRE SHEATH	PIECE	1
17	EARTH WIRE	METRE	4	35	STEEL STAPLE / U NAIL	PIECE	15
18	EARTHING ROD	PIECE	1	36	EARTHING ROD	PIECE	1

* ACTUAL LENGTH TO BE DEFINED IN EACH CASE AS REQUIRED.

FOR A NO-POLE SERVICE CONNECTION, MATERIALS IN THE RIGHT-HAND COLUMN "LINE MATERIALS" SHOULD BE EXCLUDED FROM THE BILL OF MATERIALS.

3-PHASE TIME OF USE METER CONNECTION (ABC)

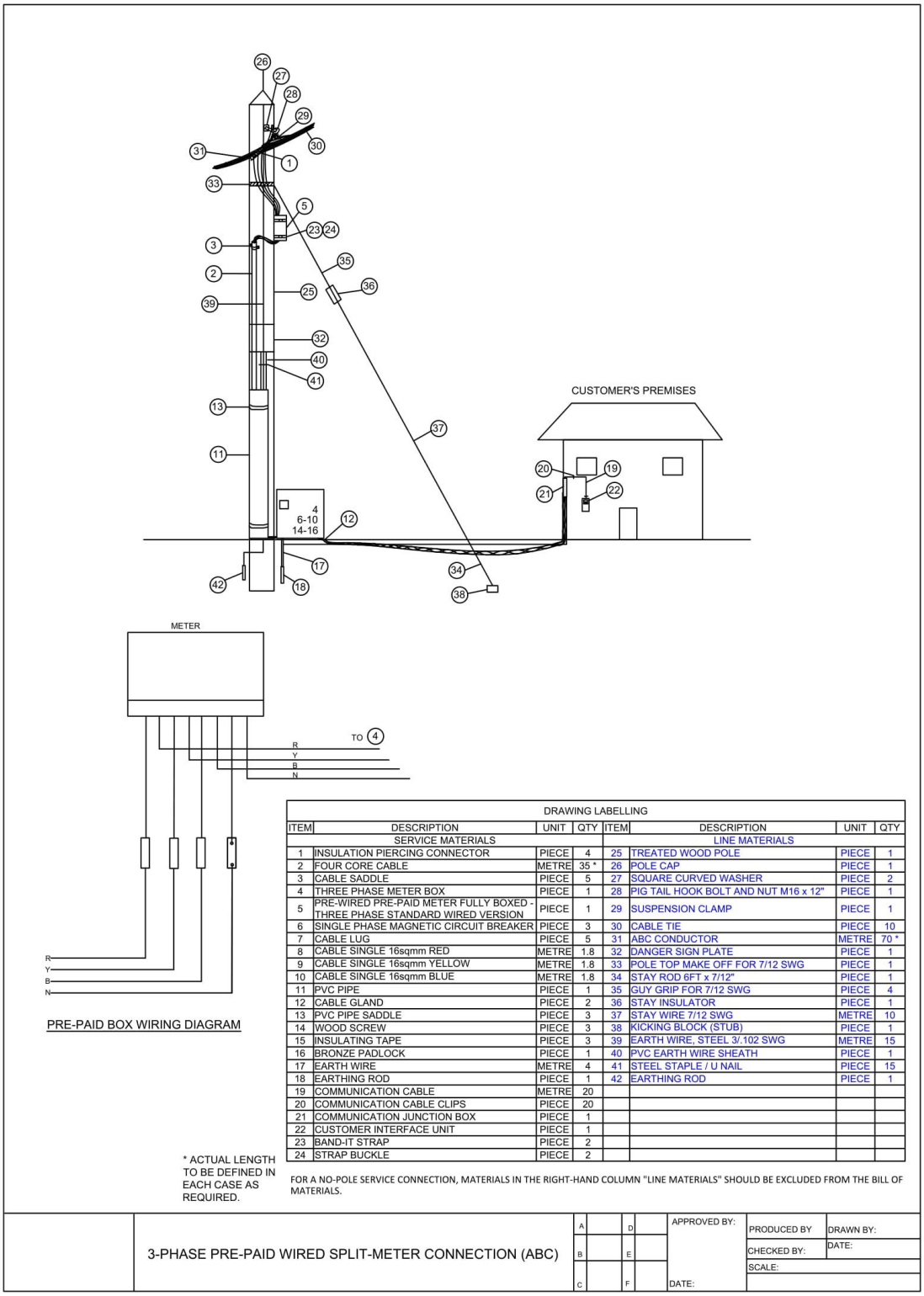
APPROVED BY: DATE:

PRODUCED BY DRAWN BY:

CHECKED BY: DATE:

SCALE:

Figure 10: LV three-phase no pole / one pole service connection three-phase wired pre-paid meter (aerial bundled conductors (ABC) network)



DRAWING LABELLING

ITEM	DESCRIPTION	UNIT	QTY	ITEM	DESCRIPTION	UNIT	QTY
	SERVICE MATERIALS				LINE MATERIALS		
1	INSULATION PIERCING CONNECTOR	PIECE	4	25	TREATED WOOD POLE	PIECE	1
2	FOUR CORE CABLE	METRE	35 *	26	POLE CAP	PIECE	1
3	CABLE SADDLE	PIECE	5	27	SQUARE CURVED WASHER	PIECE	2
4	THREE PHASE METER BOX	PIECE	1	28	PIG TAIL HOOK BOLT AND NUT M16 x 12"	PIECE	1
5	PRE-WIRED PRE-PAID METER FULLY BOXED - THREE PHASE STANDARD WIRED VERSION	PIECE	1	29	SUSPENSION CLAMP	PIECE	1
6	SINGLE PHASE MAGNETIC CIRCUIT BREAKER	PIECE	3	30	CABLE TIE	PIECE	10
7	CABLE LUG	PIECE	5	31	ABC CONDUCTOR	METRE	70 *
8	CABLE SINGLE 16sqmm RED	METRE	1.8	32	DANGER SIGN PLATE	PIECE	1
9	CABLE SINGLE 16sqmm YELLOW	METRE	1.8	33	POLE TOP MAKE OFF FOR 7/12 SWG	PIECE	1
10	CABLE SINGLE 16sqmm BLUE	METRE	1.8	34	STAY ROD 6FT x 7/12"	PIECE	1
11	PVC PIPE	PIECE	1	35	GUY GRIP FOR 7/12 SWG	PIECE	4
12	CABLE GLAND	PIECE	2	36	STAY INSULATOR	PIECE	1
13	PVC PIPE SADDLE	PIECE	3	37	STAY WIRE 7/12 SWG	METRE	10
14	WOOD SCREW	PIECE	3	38	KICKING BLOCK (STUB)	PIECE	1
15	INSULATING TAPE	PIECE	3	39	EARTH WIRE, STEEL 3/.102 SWG	METRE	15
16	BRONZE PADLOCK	PIECE	1	40	PVC EARTH WIRE SHEATH	PIECE	1
17	EARTH WIRE	METRE	4	41	STEEL STAPLE / U NAIL	PIECE	15
18	EARTHING ROD	PIECE	1	42	EARTHING ROD	PIECE	1
19	COMMUNICATION CABLE	METRE	20				
20	COMMUNICATION CABLE CLIPS	PIECE	20				
21	COMMUNICATION JUNCTION BOX	PIECE	1				
22	CUSTOMER INTERFACE UNIT	PIECE	1				
23	BAND-IT STRAP	PIECE	2				
24	STRAP BUCKLE	PIECE	2				

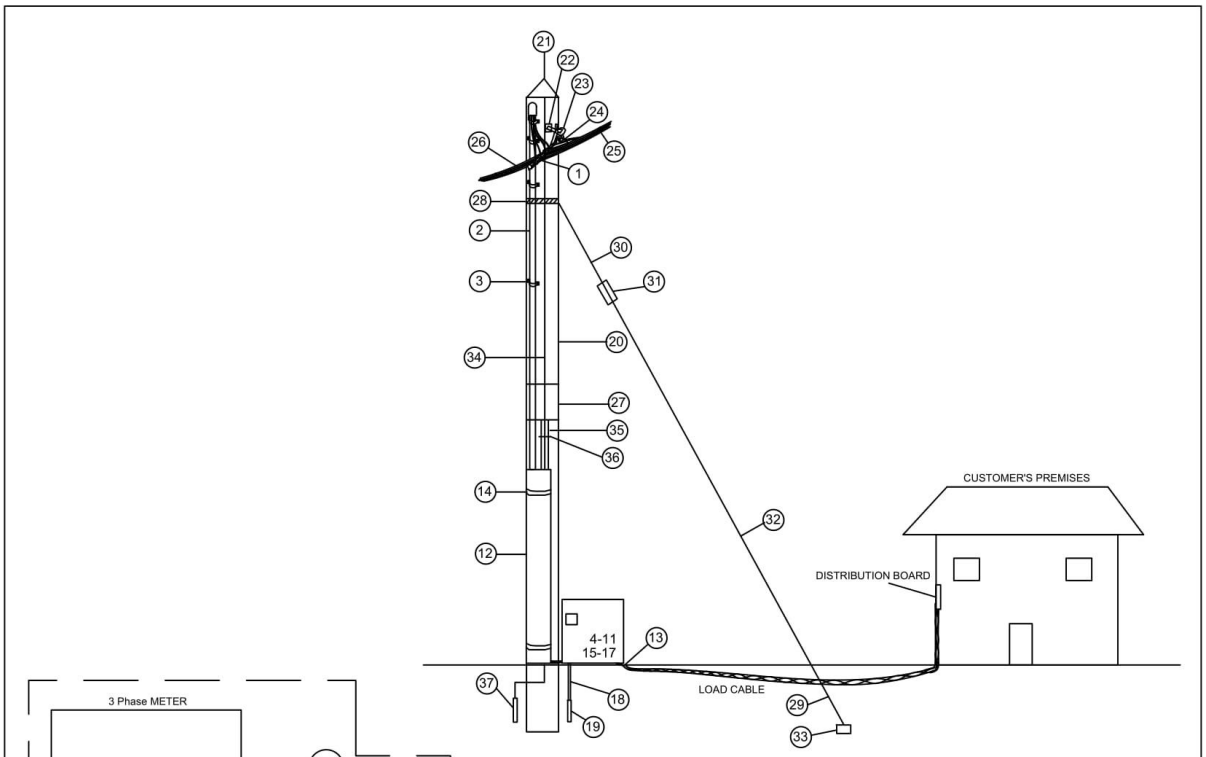
* ACTUAL LENGTH TO BE DEFINED IN EACH CASE AS REQUIRED.

FOR A NO-POLE SERVICE CONNECTION, MATERIALS IN THE RIGHT-HAND COLUMN "LINE MATERIALS" SHOULD BE EXCLUDED FROM THE BILL OF MATERIALS.

3-PHASE PRE-PAID WIRED SPLIT-METER CONNECTION (ABC)

A		D		APPROVED BY:	PRODUCED BY / DRAWN BY:
B		E			CHECKED BY: / DATE:
C		F		DATE:	SCALE:

Figure 11: LV three-phase no pole / one pole service connection kVA meter (aerial bundled conductors (ABC) network)



WIRING DIAGRAM

DRAWING LABELLING

ITEM	DESCRIPTION	UNIT	QTY	ITEM	DESCRIPTION	UNIT	QTY
	SERVICE MATERIALS				LINE MATERIALS		
1	INSULATION PIERCING CONNECTOR	PIECE	4	20	TREATED WOOD POLE	PIECE	1
2	FOUR CORE CABLE	METRE	35 *	21	POLE CAP	PIECE	1
3	CABLE SADDLE	PIECE	5	22	SQUARE CURVED WASHER	PIECE	2
4	THREE PHASE METER BOX	PIECE	1	23	PIG TAIL HOOK BOLT AND NUT M16 x 12"	PIECE	1
5	kVA METER	PIECE	1	24	SUSPENSION CLAMP	PIECE	1
6	CURRENT TRANSFORMER	PIECE	3	25	CABLE TIE	PIECE	10
7	THREE PHASE 400A MAGNETIC CIRCUIT BREAKER	PIECE	1	26	ABC CONDUCTOR	METRE	70 *
8	CABLE LUG	PIECE	8	27	DANGER SIGN PLATE	PIECE	1
9	CABLE SINGLE 16sqmm RED	METRE	1.8	28	POLE TOP MAKE OFF FOR 7/12 SWG	PIECE	1
10	CABLE SINGLE 16sqmm YELLOW	METRE	1.8	29	STAY ROD 6FT x 7/12"	PIECE	1
11	CABLE SINGLE 16sqmm BLUE	METRE	1.8	30	GUY GRIP FOR 7/12 SWG	PIECE	4
12	PVC PIPE	PIECE	1	31	STAY INSULATOR	PIECE	1
13	CABLE GLAND	PIECE	2	32	STAY WIRE 7/12 SWG	METRE	10
14	PVC PIPE SADDLE	PIECE	3	33	KICKING BLOCK (STUB)	PIECE	1
15	WOOD SCREW	PIECE	3	34	EARTH WIRE, STEEL 3/.102 SWG	METRE	15
16	INSULATING TAPE	PIECE	3	35	PVC EARTH WIRE SHEATH	PIECE	1
17	BRONZE PADLOCK	PIECE	1	36	STEEL STAPLE / U NAIL	PIECE	15
18	EARTH WIRE	METRE	4	37	EARTHING ROD	PIECE	1
19	EARTHING ROD	PIECE	1				

* ACTUAL LENGTH TO BE DEFINED IN EACH CASE AS REQUIRED.

FOR A NO-POLE SERVICE CONNECTION, MATERIALS IN THE RIGHT-HAND COLUMN "LINE MATERIALS" SHOULD BE EXCLUDED FROM THE BILL OF MATERIALS.

3-PHASE kVA METER CONNECTION (ABC)

APPROVED BY: DATE:

PRODUCED BY DRAWN BY:

CHECKED BY: DATE:

SCALE:

Appendix 5 – Unit costs of reference materials

Item	Unit	Unit Cost (USh)
SERVICE MATERIALS		
Single phase meters		
Traditional meter 1 phase 60A (post-payment)	Piece	151,577
Split meter 1 phase - wireless version (pre-payment) complete solution	Piece	265,164
Split meter 1 phase - standard wired version (pre-payment) complete solution	Piece	190,980
Three phase meters		
3 phase time of use meter 100A	Piece	399,859
3 phase pre-wired pre-paid meter fully boxed - standard wired version	Piece	1,159,821
3 phase pre-wired pre-paid meter fully boxed - wireless	Piece	1,310,953
3 phase KVA meter 200/5A	Piece	1,184,032
Protection devices		
Single phase 63A magnetic circuit breaker (including DIN rail and neutral block connector)	Piece	21,176
Current transformer	Piece	93,731
Three phase magnetic circuit breaker 400A	Piece	801,577
Communication materials		
Communication cable	Metre	1,338
Communication cable clip	Piece	340
Communication junction box	Piece	6,484
Communication interface unit	Piece	44,832
Meter housing		
Wall plug	Piece	106
Wall screw	Piece	107
Insulating tape	Piece	1,400
Rawlplug / Wall bolt	Piece	200
Band-it strap	Piece	2,422
Strap buckle	Piece	643
Three phase meter box	Piece	256,052
Bronze padlock	Piece	26,739
Cable		
Cable 16sqmm 1C red/black/yellow/blue	Metre	4,103
Cable 16sqmm Al 1C	Metre	4,103
Cable 35sqmm Al 4C	Metre	16,403
Conductor connections		
Line tap / Parallel groove clamp	Piece	7,649
Pig tail screw	Piece	9,014
Strain clamp	Piece	12,590
Preformed dead-end	Piece	9,396
Landing bracket	Piece	7,954
Service cable round clip	Piece	150
Cable saddle	Piece	5,191

Item	Unit	Unit Cost (USh)
PVC pipe for four-core cable along the pole (3 phase customer) - height 1.5m	Piece	18,339
Cable gland	Piece	14,299
PVC pipe saddle	Piece	5,145
Cable lug	Piece	3,165
Insulation Piercing Connector	Piece	7,339
Earthing		
Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	1,218
Earthing rod	Piece	49,000
LINE MATERIALS		
Conductors		
Conductor 50sqmm AAAC	Metre	2,401
ABC 4x25sqmm / 3x35sqmm	Metre	10,698
Conductor connections		
Preformed dead-end	Piece	9,396
Reel insulator	Piece	6,920
Bolt and nut 5/8 x 11"	Piece	7,392
Bolt and nut 5/8 x 4"	Piece	4,999
D-iron	Piece	6,070
Square curved washer	Piece	2,812
Pig tail hook bolt and nut M16 x 12"	Piece	16,236
Suspension clamp	Piece	3,562
Cable tie	Piece	135
Insulation Piercing Connector	Piece	7,339
Dead end clamp	Piece	4,445
Earthing		
Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Metre	1,218
Earthing rod	Piece	49,000
PVC earth wire sheath	Piece	6,557
Steel staple / U nail	Piece	1,099
Poles		
10-metre wood pole	Pole	522,093
12-metre wood pole	Pole	807,520
Pole cap	Piece	10,522
Danger sign plate	Piece	13,889
Stay		
Pole top make off for 7/12 swg	Piece	17,011
Stay rod 6 ft x 7/12 Inch.	Piece	42,000
Guy grips for 7/12 swg	Piece	11,850
Stay insulator	Piece	11,000
Stay wire 7/12 swg	Metre	4,084
Kicking block (stub)	Piece	31,034

Appendix 6 – Detailed costing of reference connection designs

Single-phase connections

Connection Design 1 – see Figure 2 and Table 2

Type of existing network:	Bare conductor network
Type of meter:	Traditional meter
Type of conductor used for the new pole connection:	Bare conductor

Table 6: Detailed costing for connection design 1 for a 1 pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Line tap / Parallel groove clamp	Piece	2	7,649	15,299
2	Cable 16sqmm 1C red	Metre	1.5	4,103	6,154
3	Cable 16sqmm 1C black	Metre	1.5	4,103	6,154
4	Pig tail screw	Piece	1	9,014	9,014
5	Strain clamp	Piece	1	12,590	12,590
6	Cable 16sqmm Al 1C	Metre	35	4,103	143,604
7	Preformed dead-end	Piece	1	9,396	9,396
8	Landing bracket	Piece	1	7,954	7,954
9	Service cable round clip	Piece	20	150	2,998
10	Wall plug	Piece	4	106	424
11	Wall screw	Piece	4	107	428
12	Single phase 63A magnetic circuit breaker (including DIN rail and neutral block connector)	Piece	1	21,176	21,176
13	Traditional meter 1 phase 60A (post-payment)	Piece	1	151,577	151,577
14	Insulating tape	Piece	1	1,400	1,400
15	Rawlplug / Wall bolt	Piece	1	200	200
Sub-total service materials					388,369
Line materials					
16	10 metre wood pole	Piece	1	522,093	522,093

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
17	Pole cap	Piece	1	10,522	10,522
18	Conductor 50sqmm AAAC	Metre	140	2,401	336,140
19	Preformed dead-end	Piece	4	9,396	37,583
20	Reel insulator	Piece	4	6,920	27,679
21	Bolt and nut 5/8 x 11"	Piece	4	7,392	29,569
22	Bolt and nut 5/8 x 4"	Piece	4	4,999	19,998
23	D-iron	Piece	4	6,070	24,282
24	Danger sign plate	Piece	1	13,889	13,889
25	Pole top make off for 7/12 swg	Piece	1	17,011	17,011
26	Stay rod 6 ft x 7/12 Inch.	Piece	1	42,000	42,000
27	Guy grips for 7/12 swg	Piece	4	11,850	47,400
28	Stay insulator	Piece	1	11,000	11,000
29	Stay wire 7/12 swg	Metre	10	4,084	40,844
30	Kicking block (stub)	Piece	1	31,034	31,034
31	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	15	1,218	18,276
32	PVC earth wire sheath	Piece	1	6,557	6,557
33	Steel staple / U nail	Piece	15	1,099	16,485
Sub-total line materials					1,252,363
Total materials					**1,640,732**
LABOUR, TRANSPORT & OTHER COSTS					
34	Standard Labour & Transport cost 1ph 1pole	Fixed allowance	1	80,000	80,000
35	Meter testing	Test	1	8,000	8,000
TOTAL					**1,728,732**

Table 7: Detailed costing for connection design 1 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1 - 15	Total service materials – as per previous table				**388,369**
LABOUR, TRANSPORT & OTHER COSTS					
16	Standard Labour & Transport cost 1ph 0pole	Fixed allowance	1	50,000	50,000
17	Meter testing	Test	1	8,000	8,000
TOTAL					**446,369**

Connection Design 2 – see Figure 3 and Table 2

Type of existing network:	Bare conductor network
Type of meter:	Wired pre-paid split meter
Type of conductor used for the new pole connection:	Bare conductor

Table 8: Detailed costing for connection design 2 for a 1 pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Line tap / Parallel groove clamp	Piece	2	7,649	15,299
2	Cable 16sqmm 1C red	Metre	1.5	4,103	6,154
3	Cable 16sqmm 1C black	Metre	1.5	4,103	6,154
4	Pig tail screw	Piece	1	9,014	9,014
5	Strain clamp	Piece	1	12,590	12,590
6	Cable 16sqmm Al 1C	Metre	35	4,103	143,604
7	Preformed dead-end	Piece	1	9,396	9,396
8	Landing bracket	Piece	1	7,954	7,954
9	Service cable round clip	Piece	20	150	2,998
10	Wall plug	Piece	4	106	424
11	Wall screw	Piece	4	107	428
12	Split meter 1 phase - standard wired version (pre-payment) complete solution	Piece	1	190,980	190,980
13	Band-it strap	Piece	2	2,422	4,843
14	Strap buckle	Piece	2	643	1,287
15	Single phase 63A magnetic circuit breaker (including DIN rail and neutral block connector)	Piece	1	21,176	21,176
16	Communication cable	Metre	20	1,338	26,755
17	Communication cable clip	Piece	20	340	6,799
18	Communication junction box	Piece	1	6,484	6,484
19	Customer interface unit	Piece	1	44,832	44,832
20	Insulating tape	Piece	1	1,400	1,400
21	Rawlplug / Wall bolt	Piece	1	200	200

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
Sub-total service materials					518,773
Line materials					
22	10 metre wood pole	Piece	1	522,093	522,093
23	Pole cap	Piece	1	10,522	10,522
24	Conductor 50sqmm AAAC	Metre	140	2,401	336,140
25	Preformed dead-end	Piece	4	9,396	37,583
26	Reel insulator	Piece	4	6,920	27,679
27	Bolt and nut 5/8 x 11"	Piece	4	7,392	29,569
28	Bolt and nut 5/8 x 4"	Piece	4	4,999	19,998
29	D-iron	Piece	4	6,070	24,282
30	Danger sign plate	Piece	1	13,889	13,889
31	Pole top make off for 7/12 swg	Piece	1	17,011	17,011
32	Stay rod 6 ft x 7/12 Inch.	Piece	1	42,000	42,000
33	Guy grips for 7/12 swg	Piece	4	11,850	47,400
34	Stay insulator	Piece	1	11,000	11,000
35	Stay wire 7/12 swg	Metre	10	4,084	40,844
36	Kicking block (stub)	Piece	1	31,034	31,034
37	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	15	1,218	18,276
38	PVC earth wire sheath	Piece	1	6,557	6,557
39	Steel staple / U nail	Piece	15	1,099	16,485
Sub-total line materials					1,252,363
Total materials					**1,771,135**
LABOUR, TRANSPORT & OTHER COSTS					
40	Standard Labour & Transport cost 1ph 1pole	Fixed allowance	1	80,000	80,000
41	Meter testing	Test	1	8,000	8,000
TOTAL					**1,859,135**

Table 9: Detailed costing for connection design 2 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1 - 21	Total service materials – as per previous table				**518,773**
LABOUR, TRANSPORT & OTHER COSTS					
22	Standard Labour & Transport cost 1ph 0pole	Fixed allowance	1	50,000	50,000
23	Meter testing	Test	1	8,000	8,000
TOTAL					**576,773**

Connection Design 3 – see Figure 4 and Table 2

Type of existing network:	ABC
Type of meter:	Traditional meter
Type of conductor used for the new pole connection:	ABC

Table 10: Detailed costing for connection design 3 for a 1 pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Insulation Piercing Connector	Piece	2	7,339	14,678
2	Cable 16sqmm 1C red	Metre	1.5	4,103	6,154
3	Cable 16sqmm 1C black	Metre	1.5	4,103	6,154
4	Pig tail screw	Piece	1	9,014	9,014
5	Strain clamp	Piece	1	12,590	12,590
6	Cable 16sqmm Al 1C	Metre	35	4,103	143,604
7	Preformed dead-end	Piece	1	9,396	9,396
8	Landing bracket	Piece	1	7,954	7,954
9	Service cable round clip	Piece	20	150	2,998
10	Wall plug	Piece	4	106	424
11	Wall screw	Piece	4	107	428
12	Single phase 63A magnetic circuit breaker (including DIN rail and neutral block connector)	Piece	1	21,176	21,176
13	Traditional meter 1 phase 60A (post-payment)	Piece	1	151,577	151,577
14	Insulating tape	Piece	1	1,400	1,400
15	Rawlplug / Wall bolt	Piece	1	200	200
Sub-total service materials					387,749
Line materials					
16	10 metre wood pole	Piece	1	522,093	522,093
17	Pole cap	Piece	1	10,522	10,522
18	Square curved washer	Piece	2	2,812	5,624
19	Pig tail hook bolt and nut M16 x 12"	Piece	1	16,236	16,236

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
20	Suspension clamp	Piece	1	3,562	3,562
21	Cable tie	Piece	10	135	1,350
22	ABC 4x25sqmm / 3x35sqmm	Metre	70	10,698	748,860
23	Danger sign plate	Piece	1	13,889	13,889
24	Pole top make off for 7/12 swg	Piece	1	17,011	17,011
25	Stay rod 6 ft x 7/12 Inch.	Piece	1	42,000	42,000
26	Guy grips for 7/12 swg	Piece	4	11,850	47,400
27	Stay insulator	Piece	1	11,000	11,000
28	Stay wire 7/12 swg	Metre	10	4,084	40,844
29	Kicking block (stub)	Piece	1	31,034	31,034
30	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	15	1,218	18,276
31	PVC earth wire sheath	Piece	1	6,557	6,557
32	Steel staple / U nail	Piece	15	1,099	16,485
Sub-total line materials					1,552,744
Total materials					**1,940,492**
LABOUR, TRANSPORT & OTHER COSTS					
33	Standard Labour & Transport cost 1ph 1pole	Fixed allowance	1	80,000	80,000
34	Meter testing	Test	1	8,000	8,000
TOTAL					**2,028,492**

Table 11: Detailed costing for connection design 3 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1 - 15	Total service materials – as per previous table				**387,749**
LABOUR, TRANSPORT & OTHER COSTS					
16	Standard Labour & Transport cost 1ph 0pole	Fixed allowance	1	50,000	50,000
17	Meter testing	Test	1	8,000	8,000
TOTAL					**445,749**

Connection Design 4 – see Figure 5 and Table 2

Type of existing network:	ABC
Type of meter:	Wired pre-paid split meter
Type of conductor used for the new pole connection:	ABC

Table 12: Detailed costing for connection design 4 for a 1 pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Insulation Piercing Connector	Piece	2	7,339	14,678
2	Cable 16sqmm 1C red	Metre	1.5	4,103	6,154
3	Cable 16sqmm 1C black	Metre	1.5	4,103	6,154
4	Pig tail screw	Piece	1	9,014	9,014
5	Strain clamp	Piece	1	12,590	12,590
6	Cable 16sqmm Al 1C	Metre	35	4,103	143,604
7	Preformed dead-end	Piece	1	9,396	9,396
8	Landing bracket	Piece	1	7,954	7,954
9	Service cable round clip	Piece	20	150	2,998
10	Wall plug	Piece	4	106	424
11	Wall screw	Piece	4	107	428
12	Split meter 1 phase - standard wired version (pre-payment) complete solution	Piece	1	190,980	190,980
13	Band-it strap	Piece	2	2,422	4,843
14	Strap buckle	Piece	2	643	1,287
15	Single phase 63A magnetic circuit breaker (including DIN rail and neutral block connector)	Piece	1	21,176	21,176
16	Communication cable	Metre	20	1,338	26,755
17	Communication cable clip	Piece	20	340	6,799
18	Communication junction box	Piece	1	6,484	6,484
19	Customer interface unit	Piece	1	44,832	44,832
20	Insulating tape	Piece	1	1,400	1,400

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
21	Rawlplug / Wall bolt	Piece	1	200	200
Sub-total service materials					518,152
Line materials					
22	10 metre wood pole	Piece	1	522,093	522,093
23	Pole cap	Piece	1	10,522	10,522
24	Square curved washer	Piece	2	2,812	5,624
25	Pig tail hook bolt and nut M16 x 12"	Piece	1	16,236	16,236
26	Suspension clamp	Piece	1	3,562	3,562
27	Cable tie	Piece	10	135	1,350
28	ABC 4x25sqmm / 3x35sqmm	Metre	70	10,698	748,860
29	Danger sign plate	Piece	1	13,889	13,889
30	Pole top make off for 7/12 swg	Piece	1	17,011	17,011
31	Stay rod 6 ft x 7/12 Inch.	Piece	1	42,000	42,000
32	Guy grips for 7/12 swg	Piece	4	11,850	47,400
33	Stay insulator	Piece	1	11,000	11,000
34	Stay wire 7/12 swg	Piece	10	4,084	40,844
35	Kicking block (stub)	Metre	1	31,034	31,034
36	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Piece	15	1,218	18,276
37	PVC earth wire sheath	Meter	1	6,557	6,557
38	Steel staple / U nail	Piece	15	1,099	16,485
Sub-total line materials					1,552,744
Total materials					**2,070,896**
LABOUR, TRANSPORT & OTHER COSTS					
39	Standard Labour & Transport cost 1ph 1pole	Fixed allowance	1	80,000	80,000
40	Meter testing	Test	1	8,000	8,000
TOTAL					**2,158,896**

Table 13: Detailed costing for connection design 4 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1 - 21	Total service materials – as per previous table				**518,152**
LABOUR, TRANSPORT & OTHER COSTS					
22	Standard Labour & Transport cost 1ph 0pole	Fixed allowance	1	50,000	50,000
23	Meter testing	Test	1	8,000	8,000
TOTAL					**576,152**

Connection Design 11 – see Figure 3 and Table 3

Type of existing network:	Bare conductor network
Type of meter:	Pre-paid split meter - wireless
Type of conductor used for the new pole connection:	Bare conductor

Table 14: Detailed costing for connection design 11 for a 1 pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Line tap / Parallel groove clamp	Piece	2	7,649	15,299
2	Cable 16sqmm 1C red	Metre	1.5	4,103	6,154
3	Cable 16sqmm 1C black	Metre	1.5	4,103	6,154
4	Pig tail screw	Piece	1	9,014	9,014
5	Strain clamp	Piece	1	12,590	12,590
6	Cable 16sqmm Al 1C	Metre	35	4,103	143,604
7	Preformed dead-end	Piece	1	9,396	9,396
8	Landing bracket	Piece	1	7,954	7,954
9	Service cable round clip	Piece	20	150	2,998
10	Wall plug	Piece	4	106	424
11	Wall screw	Piece	4	107	428
12	Split meter 1 phase - wireless version (pre-payment) complete solution	Piece	1	265,164	265,164
13	Band-it strap	Piece	2	2,422	4,843
14	Strap buckle	Piece	2	643	1,287
15	Single phase 63A magnetic circuit breaker (including DIN rail and neutral block connector)	Piece	1	21,176	21,176
16	Customer interface unit	Piece	1	44,832	44,832
17	Insulating tape	Piece	1	1,400	1,400
18	Rawlplug / Wall bolt	Piece	1	200	200
Sub-total service materials					552,918
Line materials					
19	10 metre wood pole	Piece	1	522,093	522,093

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
20	Pole cap	Piece	1	10,522	10,522
21	Conductor 50sqmm AAAC	Metre	140	2,401	336,140
22	Preformed dead-end	Piece	4	9,396	37,583
23	Reel insulator	Piece	4	6,920	27,679
24	Bolt and nut 5/8 x 11"	Piece	4	7,392	29,569
25	Bolt and nut 5/8 x 4"	Piece	4	4,999	19,998
26	D-iron	Piece	4	6,070	24,282
27	Danger sign plate	Piece	1	13,889	13,889
28	Pole top make off for 7/12 swg	Piece	1	17,011	17,011
29	Stay rod 6 ft x 7/12 Inch.	Piece	1	42,000	42,000
30	Guy grips for 7/12 swg	Piece	4	11,850	47,400
31	Stay insulator	Piece	1	11,000	11,000
32	Stay wire 7/12 swg	Metre	10	4,084	40,844
33	Kicking block (stub)	Piece	1	31,034	31,034
34	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	15	1,218	18,276
35	PVC earth wire sheath	Piece	1	6,557	6,557
36	Steel staple / U nail	Piece	15	1,099	16,485
Sub-total line materials					1,252,363
Total materials					**1,805,281**
LABOUR, TRANSPORT & OTHER COSTS					
37	Standard Labour & Transport cost 1ph 1pole	Fixed allowance	1	80,000	80,000
38	Meter testing	Test	1	8,000	8,000
TOTAL					**1,893,281**

Table 15: Detailed costing for connection design 11 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1 - 18	Total service materials – as per previous table				**552,918**
LABOUR, TRANSPORT & OTHER COSTS					
19	Standard Labour & Transport cost 1ph 0pole	Fixed allowance	1	50,000	50,000
20	Meter testing	Test	1	8,000	8,000
TOTAL					**610,918**

Connection Design 12 - see Figure 5 and Table 3

Type of existing network:	ABC
Type of meter:	Pre-paid split meter - wireless
Type of conductor used for the new pole connection:	ABC

Table 16: Detailed costing for connection design 12 for a 1 pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Insulation Piercing Connector	Piece	2	7,339	14,678
2	Cable 16sqmm 1C red	Metre	1.5	4,103	6,154
3	Cable 16sqmm 1C black	Metre	1.5	4,103	6,154
4	Pig tail screw	Piece	1	9,014	9,014
5	Strain clamp	Piece	1	12,590	12,590
6	Cable 16sqmm Al 1C	Metre	35	4,103	143,604
7	Preformed dead-end	Piece	1	9,396	9,396
8	Landing bracket	Piece	1	7,954	7,954
9	Service cable round clip	Piece	20	150	2,998
10	Wall plug	Piece	4	106	424
11	Wall screw	Piece	4	107	428
12	Split meter 1 phase 60A - wireless version (pre-payment)	Piece	1	265,164	265,164
13	Band-it strap	Piece	2	2,422	4,843
14	Strap buckle	Piece	2	643	1,287
15	Single phase 63A magnetic circuit breaker (including DIN rail and neutral block connector)	Piece	1	21,176	21,176
16	Customer interface unit	Piece	1	44,832	44,832
17	Insulating tape	Piece	1	1,400	1,400
18	Rawlplug / Wall bolt	Piece	1	200	200
Sub-total service materials					552,297
Line materials					
19	10 metre wood pole	Piece	1	522,093	522,093

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
20	Pole cap	Piece	1	10,522	10,522
21	Square curved washer	Piece	2	2,812	5,624
22	Pig tail hook bolt and nut M16 x 12"	Piece	1	16,236	16,236
23	Suspension clamp	Piece	1	3,562	3,562
24	Cable tie	Piece	10	135	1,350
25	ABC 4x25sqmm / 3x35sqmm	Metre	70	10,698	748,860
26	Danger sign plate	Piece	1	13,889	13,889
27	Pole top make off for 7/12 swg	Piece	1	17,011	17,011
28	Stay rod 6 ft x 7/12 Inch.	Piece	1	42,000	42,000
29	Guy grips for 7/12 swg	Piece	4	11,850	47,400
30	Stay insulator	Piece	1	11,000	11,000
31	Stay wire 7/12 swg	Metre	10	4,084	40,844
32	Kicking block (stub)	Piece	1	31,034	31,034
33	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	15	1,218	18,276
34	PVC earth wire sheath	Piece	1	6,557	6,557
35	Steel staple / U nail	Piece	15	1,099	16,485
Sub-total line materials					1,552,744
Total materials					**2,105,041**
LABOUR, TRANSPORT & OTHER COSTS					
36	Standard Labour & Transport cost 1ph 1pole	Fixed allowance	1	80,000	80,000
37	Meter testing	Test	1	8,000	8,000
TOTAL					**2,193,041**

Table 17: Detailed costing for connection design 12 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1 - 18	Total service materials – as per previous table				**552,297**
LABOUR, TRANSPORT & OTHER COSTS					
19	Standard Labour & Transport cost 1ph 0pole	Fixed allowance	1	50,000	50,000
20	Meter testing	Test	1	8,000	8,000
TOTAL					**610,297**

Connection Design 13 – see Figure 4 and Table 3

Type of existing network:	Bare conductor network
Type of meter:	Traditional meter
Type of conductor used for the new pole connection:	ABC

Note that the no pole connection arrangement is not applicable in this case

Table 18: Detailed costing for connection design 13 for a 1 pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Insulation Piercing Connector	Piece	2	7,339	14,678
2	Cable 16sqmm 1C red	Metre	1.5	4,103	6,154
3	Cable 16sqmm 1C black	Metre	1.5	4,103	6,154
4	Pig tail screw	Piece	1	9,014	9,014
5	Strain clamp	Piece	1	12,590	12,590
6	Cable 16sqmm Al 1C	Metre	35	4,103	143,604
7	Preformed dead-end	Piece	1	9,396	9,396
8	Landing bracket	Piece	1	7,954	7,954
9	Service cable round clip	Piece	20	150	2,998
10	Wall plug	Piece	4	106	424
11	Wall screw	Piece	4	107	428
12	Single phase 63A magnetic circuit breaker (including DIN rail and neutral block connector)	Piece	1	21,176	21,176
13	Traditional meter 1 phase 60A (post-payment)	Piece	1	151,577	151,577
14	Insulating tape	Piece	1	1,400	1,400
15	Rawlplug / Wall bolt	Piece	1	200	200
Sub-total service materials					387,749
Line materials					
16	Insulation Piercing Connector	Piece	2	7,339	14,678
17	Dead end clamp	Piece	1	4,445	4,445
18	10 metre wood pole	Piece	1	522,093	522,093
19	Pole cap	Piece	1	10,522	10,522

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
20	Square curved washer	Piece	2	2,812	5,624
21	Pig tail hook bolt and nut M16 x 12"	Piece	2	16,236	16,236
22	Suspension clamp	Piece	1	3,562	3,562
23	Cable tie	Piece	10	135	1,350
24	ABC 4x25sqmm / 3x35sqmm	Metre	70	10,698	748,860
25	Danger sign plate	Piece	1	13,889	13,889
26	Pole top make off for 7/12 swg	Piece	1	17,011	17,011
27	Stay rod 6 ft x 7/12 Inch.	Piece	1	42,000	42,000
28	Guy grips for 7/12 swg	Piece	4	11,850	47,400
29	Stay insulator	Piece	1	11,000	11,000
30	Stay wire 7/12 swg	Metre	10	4,084	40,844
31	Kicking block (stub)	Piece	1	31,034	31,034
32	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	15	1,218	18,276
33	PVC earth wire sheath	Piece	1	6,557	6,557
34	Steel staple / U nail	Piece	15	1,099	16,485
Sub-total line materials					1,571,867
Total materials					**1,959,616**
LABOUR, TRANSPORT & OTHER COSTS					
35	Standard Labour & Transport cost 1ph 1pole	Fixed allowance	1	80,000	80,000
36	Meter testing	Test	1	8,000	8,000
TOTAL					**2,047,616**

Connection Design 14 – see Figure 5 and Table 3

Type of existing network:	Bare conductor network
Type of meter:	Wired pre-paid split meter
Type of conductor used for the new pole connection:	ABC

Note that the no pole connection arrangement is not applicable in this case

Table 19: Detailed costing for connection design 14 for a 1 pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Insulation Piercing Connector	Piece	2	7,339	14,678
2	Cable 16sqmm 1C red	Metre	1.5	4,103	6,154
3	Cable 16sqmm 1C black	Metre	1.5	4,103	6,154
4	Pig tail screw	Piece	1	9,014	9,014
5	Strain clamp	Piece	1	12,590	12,590
6	Cable 16sqmm Al 1C	Metre	35	4,103	143,604
7	Preformed dead-end	Piece	1	9,396	9,396
8	Landing bracket	Piece	1	7,954	7,954
9	Service cable round clip	Piece	20	150	2,998
10	Wall plug	Piece	4	106	424
11	Wall screw	Piece	4	107	428
12	Split meter 1 phase - standard wired version (pre-payment) complete solution	Piece	1	190,980	190,980
13	Band-it strap	Piece	2	2,422	4,843
14	Strap buckle	Piece	2	643	1,287
15	Single phase 63A magnetic circuit breaker (including DIN rail and neutral block connector)	Piece	1	21,176	21,176
16	Communication cable	Metre	20	1,338	26,755
17	Communication cable clip	Piece	20	340	6,799
18	Communication junction box	Piece	1	6,484	6,484
19	Customer interface unit	Piece	1	44,832	44,832
20	Insulating tape	Piece	1	1,400	1,400
21	Rawlplug / Wall bolt	Piece	1	200	200

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
Sub-total service materials					518,152
Line materials					
22	Insulation Piercing Connector	Piece	2	7,339	14,678
23	Dead end clamp	Piece	1	4,445	4,445
24	10 metre wood pole	Piece	1	522,093	522,093
25	Pole cap	Piece	1	10,522	10,522
26	Square curved washer	Piece	2	2,812	5,624
27	Pig tail hook bolt and nut M16 x 12"	Piece	2	16,236	16,236
28	Suspension clamp	Piece	1	3,562	3,562
29	Cable tie	Piece	10	135	1,350
30	ABC 4x25sqmm / 3x35sqmm	Metre	70	10,698	748,860
31	Danger sign plate	Piece	1	13,889	13,889
32	Pole top make off for 7/12 swg	Piece	1	17,011	17,011
33	Stay rod 6 ft x 7/12 Inch.	Piece	1	42,000	42,000
34	Guy grips for 7/12 swg	Piece	4	11,850	47,400
35	Stay insulator	Piece	1	11,000	11,000
36	Stay wire 7/12 swg	Metre	10	4,084	40,844
37	Kicking block (stub)	Piece	1	31,034	31,034
38	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	15	1,218	18,276
39	PVC earth wire sheath	Piece	1	6,557	6,557
40	Steel staple / U nail	Piece	15	1,099	16,485
Sub-total line materials					1,571,867
Total materials					**2,090,019**
LABOUR, TRANSPORT & OTHER COSTS					
41	Standard Labour & Transport cost 1ph 1pole	Fixed allowance	1	80,000	80,000
42	Meter testing	Test	1	8,000	8,000
TOTAL					**2,178,019**

Connection Design 15 – see Figure 5 and Table 3

Type of existing network:	Bare conductor network
Type of meter:	Pre-paid split meter - wireless
Type of conductor used for the new pole connection:	ABC

Note that the no pole connection arrangement is not applicable in this case

Table 20: Detailed costing for connection design 15 for a 1 pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Insulation Piercing Connector	Piece	2	7,339	14,678
2	Cable 16sqmm 1C red	Metre	1.5	4,103	6,154
3	Cable 16sqmm 1C black	Metre	1.5	4,103	6,154
4	Pig tail screw	Piece	1	9,014	9,014
5	Strain clamp	Piece	1	12,590	12,590
6	Cable 16sqmm Al 1C	Metre	35	4,103	143,604
7	Preformed dead-end	Piece	1	9,396	9,396
8	Landing bracket	Piece	1	7,954	7,954
9	Service cable round clip	Piece	20	150	2,998
10	Wall plug	Piece	4	106	424
11	Wall screw	Piece	4	107	428
12	Split meter 1 phase - wireless version (pre-payment) complete solution	Piece	1	265,164	265,164
13	Band-it strap	Piece	2	2,422	4,843
14	Strap buckle	Piece	2	643	1,287
15	Single phase 63A magnetic circuit breaker (including DIN rail and neutral block connector)	Piece	1	21,176	21,176
16	Customer interface unit	Piece	1	44,832	44,832
17	Insulating tape	Piece	1	1,400	1,400
18	Rawlplug / Wall bolt	Piece	1	200	200
Sub-total service materials					552,297
Line materials					
19	Insulation Piercing Connector	Piece	2	7,339	14,678

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
20	Dead end clamp	Piece	1	4,445	4,445
21	10 metre wood pole	Piece	1	522,093	522,093
22	Pole cap	Piece	1	10,522	10,522
23	Square curved washer	Piece	2	2,812	5,624
24	Pig tail hook bolt and nut M16 x 12"	Piece	2	16,236	16,236
25	Suspension clamp	Piece	1	3,562	3,562
26	Cable tie	Piece	10	135	1,350
27	ABC 4x25sqmm / 3x35sqmm	Metre	70	10,698	748,860
28	Danger sign plate	Piece	1	13,889	13,889
29	Pole top make off for 7/12 swg	Piece	1	17,011	17,011
30	Stay rod 6 ft x 7/12 Inch.	Piece	1	42,000	42,000
31	Guy grips for 7/12 swg	Piece	4	11,850	47,400
32	Stay insulator	Piece	1	11,000	11,000
33	Stay wire 7/12 swg	Metre	10	4,084	40,844
34	Kicking block (stub)	Piece	1	31,034	31,034
35	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	15	1,218	18,276
36	PVC earth wire sheath	Piece	1	6,557	6,557
37	Steel staple / U nail	Piece	15	1,099	16,485
Sub-total line materials					1,571,867
Total materials					**2,124,165**
LABOUR, TRANSPORT & OTHER COSTS					
38	Standard Labour & Transport cost 1ph 1pole	Fixed allowance	1	80,000	80,000
39	Meter testing	Test	1	8,000	8,000
TOTAL					**2,212,165**

Three-phase connections

Connection Design 5 – see Figure 6 and Table 2

Type of existing network:	Bare conductor network
Type of meter:	Time of use meter
Type of conductor used for the new pole connection:	Bare conductor

Table 21: Detailed costing for connection design 5 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Line tap / Parallel groove clamp	Piece	4	7,649	30,598
2	Cable 35sqmm Al 4C	Metre	35	16,403	574,105
3	Cable saddle	Piece	5	5,191	25,955
4	Three phase meter box	Piece	1	256,052	256,052
5	3 phase time of use meter 100A	Piece	1	399,859	399,859
6	Magnetic circuit breaker 100A	Piece	3	153,756	461,267
7	Cable lug	Piece	5	3,165	15,827
8	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
9	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
10	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
11	PVC pipe for four core cable along the pole (3 phase customer) - height 1.5m	Piece	1	18,339	18,339
12	Cable gland	Piece	2	14,299	28,598
13	PVC pipe saddle	Piece	3	5,145	15,436
14	Wall screw	Piece	3	107	321
15	Insulating tape	Piece	3	1,400	4,200
16	Bronze padlock	Piece	1	26,739	26,739
17	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	4	1,218	4,874
18	Earthing rod	Piece	1	49,000	49,000
Total materials					**1,933,325**

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
LABOUR, TRANSPORT & OTHER COSTS					
19	Standard Labour & Transport cost 3ph 1pole	Fixed allowance	1	90,000	90,000
20	Meter testing	Test	1	8,000	8,000
TOTAL					**2,031,325**

Connection Design 6 – see Figure 7 and Table 2

Type of existing network:	Bare conductor network
Type of meter:	Three-phase wired pre-paid split meter
Type of conductor used for the new pole connection:	Bare conductor

Table 22: Detailed costing for connection design 6 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Line tap / Parallel groove clamp	Piece	4	7,649	30,598
2	Cable 35sqmm Al 4C	Metre	35	16,403	574,105
3	Cable saddle	Piece	5	5,191	25,955
4	Three phase meter box	Piece	1	256,052	256,052
5	Pre-wired pre-paid meter fully boxed - three phase standard wired version	Piece	1	1,159,821	1,159,821
6	Magnetic circuit breaker 100A	Piece	3	153,756	461,267
7	Cable lug	Piece	5	3,165	15,827
8	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
9	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
10	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
11	PVC pipe for four core cable along the pole (3 phase customer) - height 1.5m	Piece	1	18,339	18,339
12	Cable gland	Piece	2	14,299	28,598
13	PVC pipe saddle	Piece	3	5,145	15,436
14	Wall screw	Piece	3	107	321
15	Insulating tape	Piece	3	1,400	4,200
16	Bronze padlock	Piece	1	26,739	26,739
17	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	4	1,218	4,874
18	Earthing rod	Piece	1	49,000	49,000
19	Communication cable	Metre	20	1,338	26,755
20	Communication cable clip	Piece	20	340	6,799
21	Communication junction box	Piece	1	6,484	6,484

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
22	Customer interface unit	Piece	1	44,832	44,832
23	Band-it strap	Piece	2	2,422	4,843
24	Strap buckle	Piece	2	643	1,287
Total materials					**2,784,288**
LABOUR, TRANSPORT & OTHER COSTS					
25	Standard Labour & Transport cost 3ph 1pole	Fixed allowance	1	90,000	90,000
26	Meter testing	Test	1	8,000	8,000
TOTAL					**2,882,288**

Connection Design 7 – see Figure 8 and Table 2

Type of existing network:	Bare conductor network
Type of meter:	kVA meter
Type of conductor used for the new pole connection:	Bare conductor

Table 23: Detailed costing for connection design 7 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Line tap / Parallel groove clamp	Piece	4	7,649	30,598
2	Cable 35sqmm Al 4C	Metre	35	16,403	574,105
3	Cable saddle	Piece	5	5,191	25,955
4	Three phase meter box	Piece	1	256,052	256,052
5	KVA set 200/5A	Piece	1	1,184,032	1,184,032
6	Current transformer	Piece	3	93,731	281,193
7	Three phase magnetic circuit breaker 400A	Piece	1	801,577	801,577
8	Cable lug	Piece	8	3,165	25,324
9	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
10	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
11	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
12	PVC pipe for four core cable along the pole (3 phase customer) - height 1.5m	Piece	1	18,339	18,339
13	Cable gland	Piece	2	14,299	28,598
14	PVC pipe saddle	Piece	3	5,145	15,436
15	Wall screw	Piece	3	107	321
16	Insulating tape	Piece	3	1,400	4,200
17	Bronze padlock	Piece	1	26,739	26,739
18	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	4	1,218	4,874
19	Earthing rod	Piece	1	49,000	49,000

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
Total materials					**3,348,497**
LABOUR, TRANSPORT & OTHER COSTS					
20	Standard Labour & Transport cost 3ph 1pole	Fixed allowance	1	90,000	90,000
21	Meter testing	Test	1	8,000	8,000
TOTAL					**3,446,497**

Connection Design 8 – see Figure 9 and Table 2

Type of existing network:	ABC
Type of meter:	Time of use meter
Type of conductor used for the new pole connection:	ABC

Table 24: Detailed costing for connection design 8 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Insulation Piercing Connector	Piece	4	7,339	29,356
2	Cable 35sqmm Al 4C	Metre	35	16,403	574,105
3	Cable saddle	Piece	5	5,191	25,955
4	Three phase meter box	Piece	1	256,052	256,052
5	3 phase time of use meter 100A	Piece	1	399,859	399,859
6	Magnetic circuit breaker 100A	Piece	3	153,756	461,267
7	Cable lug	Piece	5	3,165	15,827
8	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
9	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
10	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
11	PVC pipe for four core cable along the pole (3 phase customer) - height 1.5m	Piece	1	18,339	18,339
12	Cable gland	Piece	2	14,299	28,598
13	PVC pipe saddle	Piece	3	5,145	15,436
14	Wall screw	Piece	3	107	321
15	Insulating tape	Piece	3	1,400	4,200
16	Bronze padlock	Piece	1	26,739	26,739
17	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	4	1,218	4,874
18	Earthing rod	Piece	1	49,000	49,000
Total materials					**1,932,083**

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
LABOUR, TRANSPORT & OTHER COSTS					
19	Standard Labour & Transport cost 3ph 1pole	Fixed allowance	1	90,000	90,000
20	Meter testing	Test	1	8,000	8,000
TOTAL					**2,030,083**

Connection Design 9 – see Figure 10 and Table 2

Type of existing network:	ABC
Type of meter:	Three-phase wired pre-paid split meter
Type of conductor used for the new pole connection:	ABC

Table 25: Detailed costing for connection design 9 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Insulation Piercing Connector	Piece	4	7,339	29,356
2	Cable 35sqmm Al 4C	Metre	35	16,403	574,105
3	Cable saddle	Piece	5	5,191	25,955
4	Three phase meter box	Piece	1	256,052	256,052
5	Pre-wired pre-paid meter fully boxed - three phase standard wired version	Piece	1	1,159,821	1,159,821
6	Magnetic circuit breaker 100A	Piece	3	153,756	461,267
7	Cable lug	Piece	5	3,165	15,827
8	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
9	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
10	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
11	PVC pipe for four core cable along the pole (3 phase customer) - height 1.5m	Piece	1	18,339	18,339
12	Cable gland	Piece	2	14,299	28,598
13	PVC pipe saddle	Piece	3	5,145	15,436
14	Wall screw	Piece	3	107	321
15	Insulating tape	Piece	3	1,400	4,200
16	Bronze padlock	Piece	1	26,739	26,739
17	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	4	1,218	4,874
18	Earthing rod	Piece	1	49,000	49,000

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
19	Communication cable	Metre	20	1,338	26,755
20	Communication cable clip	Piece	20	340	6,799
21	Communication junction box	Piece	1	6,484	6,484
22	Customer interface unit	Piece	1	44,832	44,832
23	Band-it strap	Piece	2	2,422	4,843
24	Strap buckle	Piece	2	643	1,287
Total materials					**2,783,046**
LABOUR, TRANSPORT & OTHER COSTS					
25	Standard Labour & Transport cost 3ph 1pole	Fixed allowance	1	90,000	90,000
26	Meter testing	Test	1	8,000	8,000
TOTAL					**2,881,046**

Connection Design 10 – see Figure 11 and Table 2

Type of existing network:	ABC
Type of meter:	kVA meter
Type of conductor used for the new pole connection:	ABC

Table 26: Detailed costing for connection design 10 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Insulation Piercing Connector	Piece	4	7,339	29,356
2	Cable 35sqmm Al 4C	Metre	35	16,403	574,105
3	Cable saddle	Piece	5	5,191	25,955
4	Three phase meter box	Piece	1	256,052	256,052
5	KVA set 200/5A	Piece	1	1,184,032	1,184,032
6	Current transformer	Piece	3	93,731	281,193
7	Three phase magnetic circuit breaker 400A	Piece	1	801,577	801,577
8	Cable lug	Piece	8	3,165	25,324
9	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
10	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
11	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
12	PVC pipe for four core cable along the pole (3 phase customer) - height 1.5m	Piece	1	18,339	18,339
13	Cable gland	Piece	2	14,299	28,598
14	PVC pipe saddle	Piece	3	5,145	15,436
15	Wall screw	Piece	3	107	321
16	Insulating tape	Piece	3	1,400	4,200
17	Bronze padlock	Piece	1	26,739	26,739
18	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	4	1,218	4,874
19	Earthing rod	Piece	1	49,000	49,000

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
Total materials					**3,347,256**
LABOUR, TRANSPORT & OTHER COSTS					
20	Standard Labour & Transport cost 3ph 1pole	Fixed allowance	1	90,000	90,000
21	Meter testing	Test	1	8,000	8,000
TOTAL					**3,445,256**

Connection Design 16 – see Figure 7 and Table 3

Type of existing network:	Bare conductor network
Type of meter:	Three-phase pre-paid split meter - wireless
Type of conductor used for the new pole connection:	Bare conductor

Table 27: Detailed costing for connection design 16 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Line tap / Parallel groove clamp	Piece	4	7,649	30,598
2	Cable 35sqmm Al 4C	Metre	35	16,403	574,105
3	Cable saddle	Piece	5	5,191	25,955
4	Three phase meter box	Piece	1	256,052	256,052
5	Pre-wired pre-paid meter fully boxed - three phase wireless	Piece	1	1,310,953	1,310,953
6	Magnetic circuit breaker 100A	Piece	3	153,756	461,267
7	Cable lug	Piece	5	3,165	15,827
8	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
9	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
10	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
11	PVC pipe for four core cable along the pole (3 phase customer) - height 1.5m	Piece	1	18,339	18,339
12	Cable gland	Piece	2	14,299	28,598
13	PVC pipe saddle	Piece	3	5,145	15,436
14	Wall screw	Piece	3	107	321
15	Insulating tape	Piece	3	1,400	4,200
16	Bronze padlock	Piece	1	26,739	26,739

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
17	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	4	1,218	4,874
18	Earthing rod	Piece	1	49,000	49,000
19	Customer interface unit	Piece	1	44,832	44,832
20	Band-it strap	Piece	1	2,422	2,422
21	Strap buckle	Piece	2	643	1,287
Total materials					**2,892,960**
LABOUR, TRANSPORT & OTHER COSTS					
22	Standard Labour & Transport cost 3ph 1pole	Fixed allowance	1	90,000	90,000
23	Meter testing	Test	1	8,000	8,000
TOTAL					**2,990,960**

Connection Design 17 – see Figure 10 and Table 3

Type of existing network:	ABC
Type of meter:	Three-phase pre-paid split meter - wireless
Type of conductor used for the new pole connection:	ABC

Table 28: Detailed costing for connection design 17 for a no pole connection

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
MATERIALS					
Service materials					
1	Insulation Piercing Connector	Piece	4	7,339	29,356
2	Cable 35sqmm Al 4C	Metre	35	16,403	574,105
3	Cable saddle	Piece	5	5,191	25,955
4	Three phase meter box	Piece	1	256,052	256,052
5	Pre-wired pre-paid meter fully boxed - three phase wireless	Piece	1	1,310,953	1,310,953
6	Magnetic circuit breaker 100A	Piece	3	153,756	461,267
7	Cable lug	Piece	5	3,165	15,827
8	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
9	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
10	Cable 16sqmm 1C red/black/yellow/blue	Metre	1.8	4,103	7,385
11	PVC pipe for four core cable along the pole (3 phase customer) - height 1.5m	Piece	1	18,339	18,339
12	Cable gland	Piece	2	14,299	28,598
13	PVC pipe saddle	Piece	3	5,145	15,436
14	Wall screw	Piece	3	107	321
15	Insulating tape	Piece	3	1,400	4,200
16	Bronze padlock	Piece	1	26,739	26,739
17	Earth wire 3/.304 steel / earth wire 3/102 swg galv.	Meter	4	1,218	4,874
18	Earthing rod	Piece	1	49,000	49,000

Item	Description	Unit	Quantity	Unit cost (USh)	Total cost (USh)
19	Customer interface unit	Piece	1	44,832	44,832
20	Band-it strap	Piece	1	2,422	2,422
21	Strap buckle	Piece	2	643	1,287
Total materials					**2,891,719**
LABOUR, TRANSPORT & OTHER COSTS					
22	Standard Labour & Transport cost 3ph 1pole	Fixed allowance	1	90,000	90,000
23	Meter testing	Test	1	8,000	8,000
TOTAL					**2,989,719**

Appendix 7 – Treatment of costs for subsequent connections ("second comer" rules) - detailed calculations

Section 5.10 describes situations that can arise where assets initially installed and fully paid for by a customer for their sole use can subsequently be used in the connection of a later customer. For example, this could occur where a line is installed to a customer who is reasonably remote from the existing network. This could require, say three, four or more poles to be established and commissioned. The full cost of this new extension to the network is likely to be taken account of in the calculation of connection charge and be charged to this first customer – unless the cost is met through funding from a Government or donor agency or otherwise. Perhaps, at a later date, an additional closely located customer will seek connection and the most effective way to do this would be to link at some point to the previously provided line. If the second customer is only charged the costs of the new assets provided at the time of their connection, this would seem unfair to the first customer who has paid all the costs of the existing line.

An approach for dealing with such cases is outlined below. It is recognised that there may be some implementation challenges to this and hence it should be limited, at this stage, to a fairly small number of circumstances, as described below.

Hence, where a new customer connects to an existing high voltage network utilising asset that were:

(a) installed exclusively to connect the previous customer,

(b) paid for by that original customer in full, and

(c) the connection date of the previous customer is no more than 5 years before the connection date of the new customer.

the new customer shall refund the original customer for an appropriate portion of the shared network asset (or assets) that the new customer will use. This portion is based on the location of the new connection on the existing assets and the proportion of the capacity of the assets used by it.

The detailed calculation approach is described in Appendix 6.

The refund will be calculated as a proportion of the sum paid by the original customer:

a) Without any adjustments for depreciation, discounting or inflation;

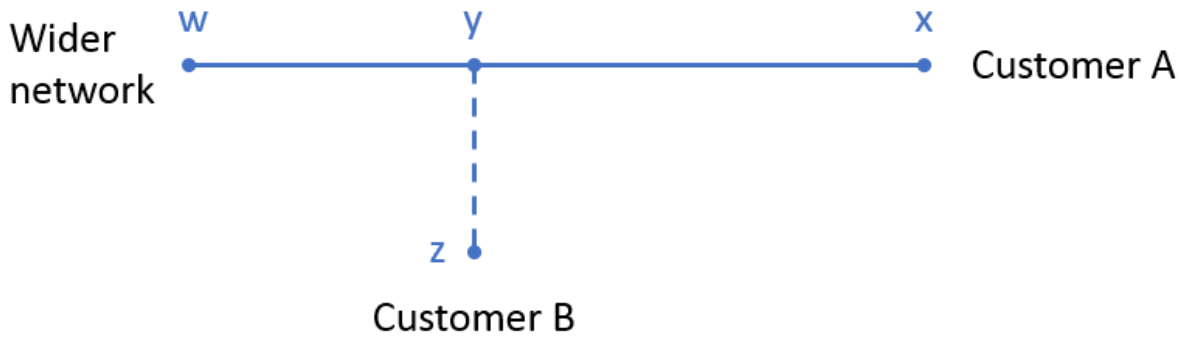
b) Based on the portion of the asset (or assets) used by the new customer; and

c) Based on the capacity of the shared asset (or assets) that the new customer will use;

d) As described below.

The refund should be calculated using Equation 1 with reference to Figure 12.

Figure 12: Diagram to illustrate the calculation of refunds to original customers for subsequent connections



$$R_B = C_{wy} \times {}^{D_{B,max}}\Big/_{Q_y} \qquad \text{- Equation 1}$$

Where:

i) Customer A is the original customer;

ii) Customer B is the new customer;

iii) w is the point at which the assets originally paid for by Customer A connect to the wider network;

iv) x is the connection point for Customer A;

v) Solid line w-y represents the assets originally paid for by Customer A;

vi) y is the point at which Customer B will connect to the assets originally paid for by Customer A;

vii) z is the connection point for Customer B;

viii) Dashed line y-z represents the new assets required to connect Customer B to line w-y;

ix) R_B is the refund payable by Customer B;

x) C_{wy} is the charge paid by Customer A for the assets between points w and y;

xi) $D_{B,max}$ is the maximum electricity demand of Customer B (in kVA);

xii) Q_y is the electrical capacity of the asset at point y (in kVA).

Utilities must keep records in sufficient detail to allow for an accurate calculation of C_{wy}, which would include cost details of the individual assets comprising line w-y. In the absence of detailed records, C_{wy} shall be calculated using Equation 2.

$$C_{wy} = C_{wx} \times {}^{L_{wy}}\Big/_{L_{wx}} \qquad \text{- Equation 2}$$

Where:

i) C_{wx} is the charge paid by Customer A for the assets in line w-y;

ii) L_{wy} and L_{wx} are the lengths of lines w-y and w-x respectively (in metres).

In cases where the licensee does not have records of the charges paid by the original customer, the original customer should provide to the licensee evidence of the charges or costs associated with the asset (or assets) that are to be shared. The licensee shall then review the evidence and evaluate it against similar charges at the time. If the licensee is satisfied that the evidence provided is reasonable considering the nature of the assets and when they were installed, it will use the costs or charges provided to calculate the refund due and present the results to the original customer and new customer for their review and acceptance. If the licensee is not satisfied that the evidence provided is reasonable considering the nature of the assets and when they were installed, it will advise the original customer of its findings with reasons and request that alternative or additional evidence be provided.

Where the refund is to be paid to a group of original customers, then the refund shall be paid to each customer within the group according to the proportion of the charge originally paid by that customer.

The aggregate refunds received by the original customer (or each customer within the original group of customers) from new customers shall not exceed $R_{A,max}$ in Equation 3.

$$R_{A,max} = C_{wx} \times \left(1 - {}^{D_{A,max}}\Big/_{Q_y}\right) \quad \text{- Equation 3}$$

Where:

iii) $R_{A,max}$ is the maximum aggregate refund receivable by Customer A;

iv) $D_{A,max}$ is the maximum electricity demand of Customer A (in kVA).

Where the refund is to be paid by a group of new customers at one time, then the refund shall be paid by each customer within the group according to Equation 4.

$$R_j = C_{wy} \times {}^{D_{j,max}}\Big/_{\sum D_{i,max}} \quad \text{- Equation 4}$$

Where:

v) R_j is the refund payable by Customer j within the group of new customers;

vi) $D_{j,max}$ is the maximum electricity demand of Customer j (in kVA);

vii) $\sum D_{i,max}$ is the sum of maximum demands of new customers within the group (in kVA).

The original customer may transfer the right to receive a refund to another legal entity, including but not limited to, another entity that owns or occupies the premises connected to point x when the refund is payable.

In the case of disputes about the calculation of refunds, the matter may be referred to the Authority for adjudication.

A worked example of the procedure is given in Box 1.

Box 1: Worked example of refund calculation for subsequent connections

The following worked example (with hypothetical values) is provided to demonstrate the procedure for calculating a refund to original customers.

Customer A paid USh 12.0 million for a new line 800 m in length to a new distribution transformer and new a line 200 m in length from the new transformer to its premises. The transformer has a maximum rating of 500 kVA, the line from the transformer to Customer A's premises has a maximum capacity of 400 kVA and Customer A's maximum demand is 200 kVA. There are no records of the breakdown of costs for the transformer and two lengths of line.

One year later Customer B applies for a new connection, which will tie into the distribution transformer paid for by Customer A. Customer B's maximum demand is 50 kVA. Customer A has already received a refund of USh 0.96 million from Customer C who connected to the distribution transformer 3 months earlier.

1. Use Equation 2 to calculate C_{wy}, the charge paid by Customer A for the assets up to Customer C's connection point:

   C_{wy} = (USh 12.0 million) x (800m) / (800m + 200m)

   = USh 9.6 million

2. Use Equation 1 to calculate R_B, is the refund payable by Customer B:

   R_B = (USh 9.6 million) x (50 kVA) / (500 kVA)

   = USh 0.96 million

3. Use Equation 3 to calculate $R_{A,max}$, the maximum aggregate refund receivable by Customer A:

   $R_{A,max}$ = (USh 12.0 million) x [1 - (200 kVA) / (500 kVA)]

   = USh 7.2 million

4. Check whether the payment of R_B would result in $R_{A,max}$ being exceeded:

   $R_B + R_C$ = (USh 0.96 million) + (USh 0.96 million)

   = USh 1.92 million

   Since $\boldsymbol{R_B + R_C}$ is less than $\boldsymbol{R_{A,max}}$, USh 0.96 million should be paid to Customer A.

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